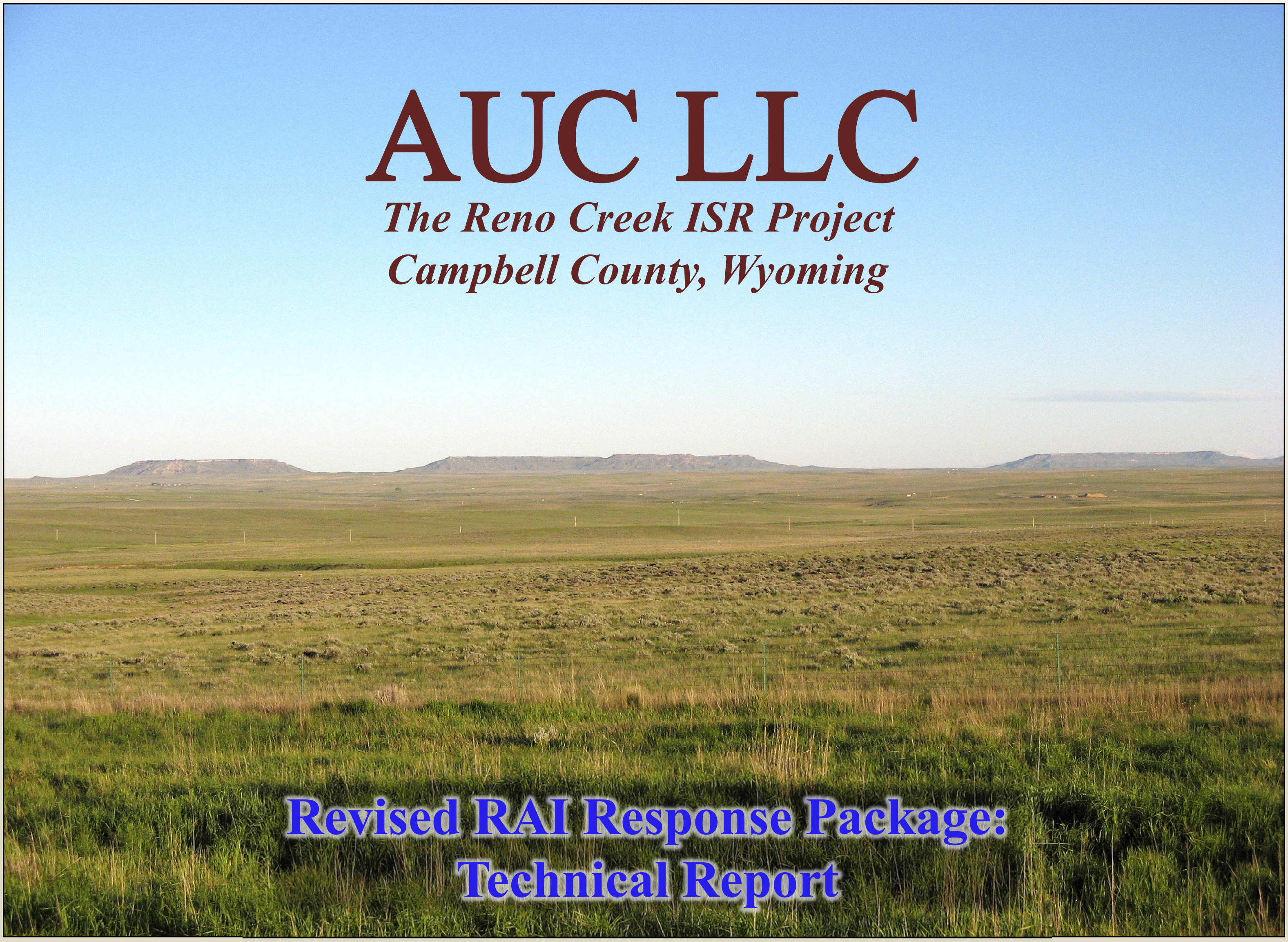
USNRC APPLICATION
Combined Source and 11e.(2)
Byproduct Material License



AUC LLC
The Reno Creek ISR Project
Campbell County, Wyoming

Revised RAI Response Package:
Technical Report

December 2014

AUC LLC
1536 Cole Blvd., Suite 230
Lakewood, Colorado 80401

PREFACE

AUC is pleased to provide this Revised Technical Report response package. Included in this package are responses to Clarification issues of the NRC staff's Request for Additional Information (RAI) dated Feb. 10, 2014. The staff presented their clarification requests in the form of PM to PM and Public Meetings held during August, September and October of 2014. Any response which quotes specific application content revisions is highlighted in quotations. Red text represents the original text revisions or new additional language proposed in the original RAI response package to the license application. All blue text and blue strikeouts present the revisions to the original RAI responses based on the NRC staff clarification requests. All responses which detail revisions or additional language to the application will clearly list the appropriate application location where those changes will be made.

TABLE OF CONTENTS

List of Tables

List of Figures

List of Appendices

1 PROPOSED ACTIVITIES

RAI- 1

Description of Deficiency

Section 1.2 (Project History) of the Technical Report (T0R) states:

> *"In 2004 Strathmore staked and filed new mining claims in the area acquiring over 16,000 acres of prospective lands including the proposed Reno Creek Project. In May 2007, Strathmore entered into a joint venture partnership with American Uranium Corporation Inc. of Nevada, to bring the Reno Creek property to a full-scale ISR operation. Strathmore and American Uranium subsequently sold the Reno Creek Project (the subject of this license application) and the nearby Pine Tree Trend Properties located approximately seven to eight miles to the west and northwest respectively of the Proposed Project, including its corporate owner AUC LLC, to AUC Holdings. Table 1-1 outlines all information known regarding the proposed property ownership and joint ventures."*

Basis for Request

The applicant's discussion of ownership is unclear. The above discussion refers to the filing of mining claims, the acquisition of over 16,000 acres of lands (including the Reno Creek project), and the selling of properties. This makes it difficult to understand if the transactions relate to surface ownership, mineral ownership, or other ownership. Also, Table 1-1 (Proposed Project Area Historical Ownership) shows AUC, LLC (AUC, the applicant) as the current company (corporate entity) and AUC Holdings as the partnership name, but the table does not identify the entity with ownership of the proposed project area. The NRC NUREG-1569, Standard Review Plan (SRP) for In Situ Leach Uranium Extraction License Applications, Section 1.3 states that the application summary of proposed activities includes descriptions of specific items (e.g., including corporate entities involved, location of the proposed facilities, and land ownership) sufficient to provide a basic understanding of the proposed activities and the likely consequences of any health, safety, and environmental impact.

Formulation of RAI

- *Revise text describing the nature of these transactions to clarify surface land ownership, mineral ownership, or other ownership. Please be specific as to which ownership is by the applicant (AUC) and any corporate-related body (e.g., AUC*

Holdings).

- *Revise Table 1-1 to identify entity with ownership of the proposed project area and the type of ownership (e.g., mineral, surface land, or other ownership).*
- *Provide additional information regarding ownership of AUC Holdings and AUC LLC.*

RAI-1 Response

AUC has revised the text on page 1-4, first two paragraphs to read:

"In 2004 Strathmore staked and filed new federal unpatented mining claims and renewed private (fee) mineral leases, and a State of Wyoming mineral lease within the proposed Reno Creek Proposed Project area.

In May 2007, Strathmore entered into a joint venture partnership with American Uranium Corporation Inc. of Nevada, to bring the Reno Creek property to a full-scale ISR operation. ~~Strathmore and American Uranium subsequently sold the Reno Creek Project (the subject of this license application) including its corporate owner and applicant AUC LLC, to AUC Holdings~~ Strathmore then formed AUC LLC, a limited liability company, wholly owned by Strathmore, to hold all of the Reno Creek assets and be the operator of the joint venture with American Uranium. In 2010, Pacific Road Capital and Bayswater Uranium jointly formed AUC Holdings, Inc., a U.S. corporation, which then acquired AUC LLC, the Reno Creek Project, and other uranium assets in the vicinity from Strathmore and American Uranium. All active mining claims and fee mineral leases were transferred from Strathmore to AUC LLC during the sale to AUC Holdings. AUC LLC is 100 percent owned by AUC Holdings, Inc."

Additional information on this subject is provided in the revisions made in the RAI-4 Response included in AUCs RAI Response Package submission under cover dated June 13, 2014 (ML14169A452).

Table 1-1 has also been revised to identify the entity with ownership of the Proposed Project area and the type of ownership and is shown below.

Table 1-1: Proposed Project Area Historical Ownership

Company(s)	Partner(s)	Date	Transaction Type	Partnership Name
Rocky Mountain Energy	Union Pacific Railroad	1967 (Est.)	Purchase	None
Rocky Mountain Energy	Mono Power Company and Halliburton	1975 (Est.)	Joint Venture	ISLCO
Energy Fuels, Inc.	None	1992	Purchase	None
International Uranium	Energy Fuels, Inc.	2000 (Est.)	Merger Acquisition	None
Rio Algom Mining Corporation	None	2001	Purchase	None
Power Resources, Inc.	CAMECO	2002 (Est.)	Purchase	None
Strathmore Mining Corporation	David Miller and Associates	2004	Claim Acquisition	None
Strathmore Mining Corporation	American Uranium Corporation, Inc.	2007	Joint Venture	None
AUC, LLC.	Bayswater Uranium Corporation; Pacific Road Resource Funds	2010	Purchase includes associated US Government unpatented mining claims, private (fee) mineral leases, and a state mineral lease currently under lease within Proposed Project Area	AUC Holdings

RAI- 2

Description of Deficiency

In Section 1.9 of the TR, the applicant refers to the proposed project schedule in Figure 1-3, which indicates that decommissioning activities start in year 14 following the completion of restoration activities for Production Unit (PU) 12A. Elsewhere, in this section, the applicant states that decontamination and decommissioning (D&D) and reclamation activities for PUs will likely commence after receiving U.S. Nuclear Regulatory Commission (NRC) and Wyoming Department of Environmental Quality/Land Quality Division (WDEQ/LQD) approval of successful groundwater restoration in each PU. In Section 1.7 of the TR, the applicant contemplates a phased, iterative approach, in which AUC will sequentially construct and operate a series of up to 12 PUs.

Basis for Request

The above information regarding the start of D&D activities appears contradictory and inconsistent with the requirements for timely decommissioning in Title 10 of the Code of Federal Regulations (CFR) 40.42. Also, the applicant does not commit to initiating decommissioning activities at a particular time. Figure 1-3, indicates that decommissioning activities start in year 14, and elsewhere the applicant indicates that D&D and reclamation activities for PUs will "likely" commence after receiving NRC and WDEQ approval of successful groundwater restoration in each PU. Deferring the start of decommissioning activities until year 14 is inconsistent with the requirements in 10 CFR 40.42(d) without first obtaining approval of licensee's request to delay or postpone initiation of the decommissioning process in accordance with 10 CFR 40.42(e). Based on Figure 1-3, under a phased decommissioning approach, decommissioning activities could conceptually start in year 6 (after the successful restoration of PU 1), and final decommissioning would conceptually occur in year 15 following the D&D of PU 12A, Central Processing Plant (CPP), Deep Disposal Wells (DDWs). For additional information, see the NRC rule "Timeliness in Decommissioning of Material Facilities" (59 Federal Register 36026-36040, July 15, 1994), and NRC Administrative Letter 96-05: Compliance with the Rule "Timeliness in Decommissioning of Material Facilities". The effect of the final rule is to require the uranium recovery licensees to notify the NRC within 60 days when they have permanently ceased operations or have not conducted operations for 24 months (Section 40.42(d)) and to submit an updated decommissioning plan within 12 months of this notification or license expiration.

Formulation of RAI

- *Revise the discussion in this section to clarify AUC's approach for initiating decommissioning activities following NRC and WDEQ approval of successful groundwater restoration in each PU. Include a commitment as to when decommissioning activities will be implemented. If AUC commits to implement a phased decommissioning approach, revise Figure 1-3 to show how the approach affects the start of all remaining decommissioning activities.*
- *If AUC plans to pursue some other decommissioning approach, describe the approach including how the approach complies with the requirements for timely decommissioning in 10 CFR 40.42.*

<u>RAI-2 Response</u>

AUC has revised TR Section 1.9 (Proposed Operating Schedule) as follows to clarify when Production Unit decommissioning activities will begin:

"Similar to Production Unit construction, groundwater restoration will be a phased approach and is anticipated that two to three Production Units will be in various stages of active restoration or stability monitoring at one time. As AUC completes uranium recovery operations in each Production Unit (PU), it will sequentially commence groundwater restoration. Following completion of groundwater restoration, AUC will conduct stability monitoring and obtain final approval from WDEQ and NRC. At this stage, AUC will commence decommissioning of the PU based on an NRC approved decommissioning plan. Therefore, PUs will be decommissioned in a timely manner consistent with 10 CFR 40.42."

The proposed plan incorporates water balance calculations so deep disposal well(s) and back up storage capacity can accommodate the proposed recovery and restoration efforts at any given time. The total duration of groundwater restoration is expected to be approximately eight years for the Proposed Project.

RAI-3

Description of Deficiency

In Section 1.9 (Proposed Operating Schedule) of the TR, the applicant states:

> *"Once groundwater restoration, D&D, and reclamation activities conclude and AUC has met the requirements of 10 CFR 20, Subpart E, the site will be released for unrestricted use."*

Basis for Request

The above statement incorrectly cites 10 CFR Part 20 Subpart E as the regulatory standard for the clean-up and release for the proposed Reno Creek Project. This statement is also inconsistent with other correct statements in the application that discuss the remediation of disturbed areas to meet the requirements of 10 CFR Part 40, Appendix A, Criterion 6(6). The general provisions in 10 CFR Part 20 Subpart E, at 10 CFR 20.1401, specifically state that criteria in this part "… do not apply to uranium and thorium recovery facilities already subject to appendix A to 10 CFR part 40 or the uranium solution extraction facilities."

Formulation of RAI

Revise the discussion in this section, and related sections, to cite the applicable regulatory standard for remediating disturbed areas at the Proposed Reno Creek Project.

RAI-3 Response

AUC has revised the citation in both TR Sec. 1.9 (p. 1-11) and ER Sec. 1.3 (p. 1-17). Both citations reflect the correct 10 CFR Part 40, Appendix A, Criterion 6(6) and now read:

"Once groundwater restoration, D&D, and reclamation activities conclude and AUC has met the requirements of 10 CFR 40, Appendix A, Criterion 6(6), the site will be released for unrestricted use."

2 SITE CHARACTERIZATION

RAI- 4

Description of Deficiency

Section 2.1 (Site Location and Layout) and Table 2.1-1 (Surface and Mineral Ownership Distribution) of the TR indicates that the proposed project consists of 157 Federal unpatented lode mining claims (encompassing 2,873 acres or 47.4% of Proposed Project Property), one private mineral lease (encompassing 2,544 acres or 42% of Proposed Project Property), and one State of Wyoming mineral lease (encompassing 651 acres or 10.6% of Proposed Project Property).

Basis for Request

The application discussion of mineral ownership of proposed project property is unclear. This section does not identify the entity that currently holds the mineral ownership for the above areas of the Proposed Reno Creek Project. SRP, Section 1.3 states that the application summary of proposed activities includes descriptions of specific items (e.g., including corporate entities involved, location of the proposed facilities, and land ownership) sufficient to provide a basic understanding of the proposed activities and the likely consequences of any health, safety, and environmental impact.

Formulation of RAI

- *Clarify whether the applicant or AUC Holdings currently owns/holds the above mining claims/mineral leases. If the applicant or AUC Holdings does not currently own/hold all of these mining claims/mineral leases, revise the text and associated figures (e.g. Figure 2.1-2) to clarify the fraction of these mining claims/mineral leases currently owned/held by the applicant or AUC Holdings, and address any potential impacts of proposed project activities on adjacent in-situ recovery (ISR) mining claims/mineral leases.*
- *In Table 2.1-1, correct or clarify why the total proposed project acreage for surface ownership (6,057 acres) and mineral ownership (4,793 acres) are different. Also, correct or clarify why there is a difference in acreage for State surface ownership (640 acres) and State mineral ownership (651 acres).*

RAI-4 Response

AUC has clarified the mineral claim/lease language in TR Section 2.1 to read as follows:

"The Proposed Project consists of 157 AUC-owned unpatented lode mining claims (SC 1-47, WR 3-80, BFR 1-18, 21-83), one AUC-held State of Wyoming mineral lease, and two AUC-held private mineral leases."

AUC has also revised Table 2.1-1 to clarify the total project acreage surface ownership and mineral ownership. The revised table is shown below:

Ownership Type	**Surface Ownership**		**Mineral Ownership (AUC)**		**Mineral Ownership (Others)**	
	Acres	Percent of Total Proposed Project Property	Acres	Percent of Total Proposed Project Property	Acres	Percent of Total Proposed Project Property
Federal (Lode Claims)	0	0%	2,587	50.0%	292	12.7%
Private	5,417	89.4%	666	33.5%	1,872	87.3%
State	640	10.6%	640	16.5%	0	0%
Total Proposed Project Acreage	6,057	100%	3,893	100%	2,164	100%

RAI- 5

Description of Deficiency

TR Section 2, Figure 2.1-3, provides mapping of the proposed wellfields areas but does not provide mapping that demonstrates the ore trends including the oxidation and reductions zones, stacking of the ore bodies, or vertical depiction of the ore body.

Basis for Request

The application fails to include adequate information on the ore body.

Section 2.7.3 of the SRP states:

> *"If zones of distinct water quality characteristics are identified, they are delineated and referenced on a topographic map. For example, since uranium roll front deposits are formed at the interface between chemically oxidizing and reducing environments, water quality characteristics may differ significantly across the rollfront."*

Formulation of RAI

a) *Please provide mapping (including depicting the ore body on the cross-sections) that demonstrates the ore trends including the oxidation and reductions zones.*

b) *Please clarify whether or not Figure 2.6A-17 displays all ore-trend labels, including oxidation and reduction zones.*

RAI-5(a) Response

AUC has revised the reference in the third paragraph on page 2.1-2 from Figure 2.1-3 to the new figure references as shown below:

"The proposed CPP will be located in the southeast quarter of the northeast quarter of Section 1, Township 42 North, Range 74 West. The coordinates for the Proposed Project CPP are North American Datum (NAD) 83 Universal Transverse Mercator (UTM) Zone 13N 448,593 meters and 4,834,906 meters. Figure 2.1-3 shows generalized ore body outlines with the proposed site plan and infrastructure for the Proposed Project superimposed, including the CPP, Production Units, trunk lines, utility corridors, access roads, and DDW. For a detailed depiction of the ore trends, including oxidation/reduction boundaries, see revised TR Figure 2.6A-17. Cross sections depicting the vertical stacking of the ore trends are included as TR Figures 2.6A-18 through 2.6A-23."

RAI-5(b) Response

All currently known ore trends labels and associated oxidation and reduction zone indicators are correctly labeled in Figure 2.6A-17. A hard copy will be difficult to identify labels so reviewers should use the electronic submittal for enhanced detail.

RAI- 6

Description of Deficiency

Section 2.1 (Site Location and Layout) of the TR, states:

> *"Controlled areas will be fenced to limit access to project associated operations and is estimated to encompass 481 acres or approximately 8 percent of the Proposed Project Area. Anticipated controlled areas include all fenced areas around the CPP, wellfields, backup pond, and DDWs. "*

Basis for Request

The application description of controlled areas does not include monitoring wells around planned production units. The application refers to the 10 CFR Part 20 definition of a controlled area as an area outside of a restricted area but inside the site boundary, access to which can be limited by the licensee for any reason. The applicant should clarify if monitoring wells are controlled areas which will be fenced to limit access to project associated operations.

Formulation of RAI:

Clarify in text and related maps if monitoring wells will be fenced and included as controlled areas. If monitoring wells are not considered controlled areas, please provide a justification for not including monitoring wells as controlled areas.

RAI-6 Response

Consistent with practices of other licensed operating facilities Production Unit perimeter ring monitoring wells will be located outside of the controlled fenced wellfield areas. AUC will take precautions to prevent unauthorized access to the ring monitoring wells by installing locked protective covers. AUC has revised TR Sections 2.1and 5.6 as shown in below:~~monitoring wells will not be within the fenced areas of production units. Monitoring wells will be located in unrestricted areas however AUC will control access to the monitoring wells by installing protective, locked covers as is common industry practice. More detailed information regarding controlled areas can be found in the response to RAI-44 including Figure 5-2.~~

~~AUC has revised Section 2.1 to provide this clarification as shown in red below:~~

"Controlled areas will have limited access by fencing~~ be fenced to limit access ~~to project associated operations and is estimated to encompass 481 acres or approximately 8 percent of the Proposed Project Area. Anticipated controlled areas include all fenced areas around the CPP, wellfields, backup pond and DDWs. ~~Wellfield monitoring wells will not be fenced and are not included within the controlled areas. AUC will control access to monitoring wells by installing protective, locked covers as is common industry practice."~~ Production Unit perimeter ring monitoring wells will be located outside of the fenced wellfield areas. AUC will take precautions to control access to the ring monitoring wells by installing locked protective covers as is common industry practice."

More detailed information regarding controlled areas can be found in the response to RAI-44 including Figure 5-2.

RAI- 7

Description of Deficiency

In TR Section 2.1 on Figure 2.1-3, the applicant proposes to construct wellfields that bisect by a publicly used paved road.

Basis for Request

The application does not discuss procedures to implement operations at that setting that will ensure safe operations (accidents, security, access, engineering.)

Section 3.2.2 of the SRP states:

> *"Staff should determine whether the hazards associated with the storage and processing of the radioactive materials and those hazardous materials with the potential to impact radiological safety, have been sufficiently addressed in the process design for the recovery plant, satellite processing facilities, well fields, and chemical storage facilities."*

Formulation of RAI

Please describe how operations in areas which are bisected by the publicly used paved road will be conducted to ensure safety. Include a description of any controls that will be used.

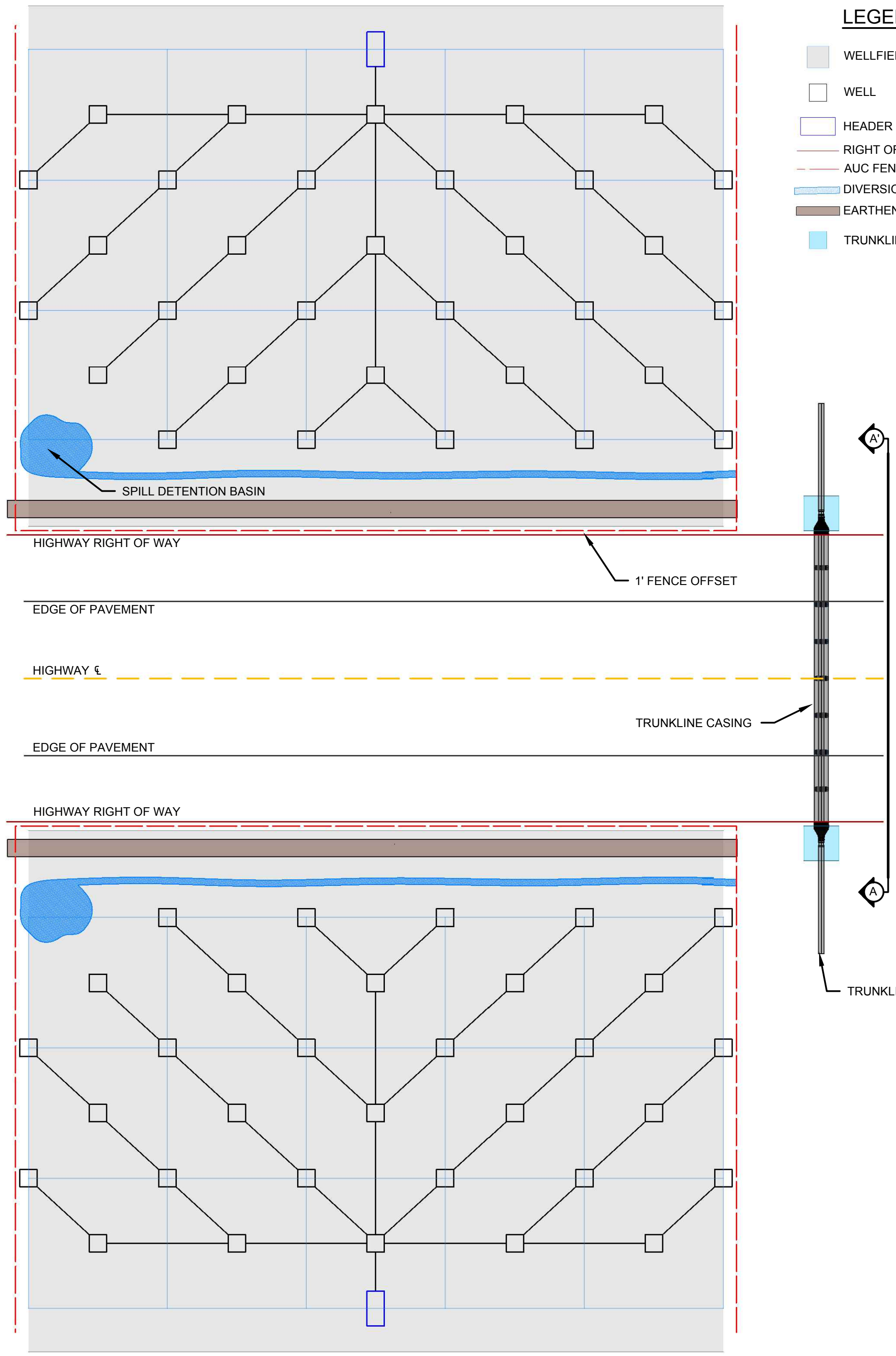
RAI-7 Response

AUC has developed a new Figure 3-5 (shown below) to include a conceptual design of how a berm or a ditch or a combination berm/ditch within/along the AUC fence line (where the topography will allow) to control a potential leak or spill from entering the highway/county road right-of-way. A more detailed discussion of spill containment for each individual wellfield located along a highway or county road will be presented in the associated wellfield data package.

AUC believes that spill prevention is the way to address potential leaks from trunklines installed beneath the highway or county roads. Therefore the following text was added to TR Section 3.1.5:

"When a trunkline is installed beneath a highway or county road AUC will use a double walled pipe system (Figure 3-5). The pipe that will be transferring the process solutions to or from the wellfields will be centered inside a protective outer pipe that will be sealed at each end to prevent a release of fluid if the carrier pipe should leak. Each double walled pipe system that is installed beneath a highway or county road will have a leak detection system in place so that if the carrier pipe leaks operators will be alerted and the trunkline will be shut down before the outer containment pipe is breached. Additionally, the containment pipe will extend beyond the highway or county road right-of-way."

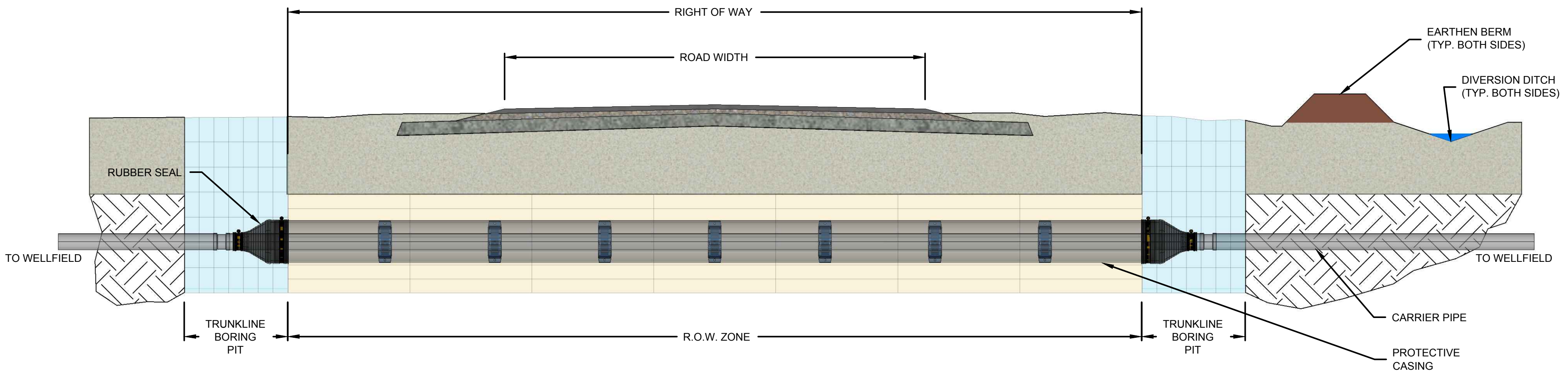
ROAD CROSSING SECONDARY LEAK PROTECTION



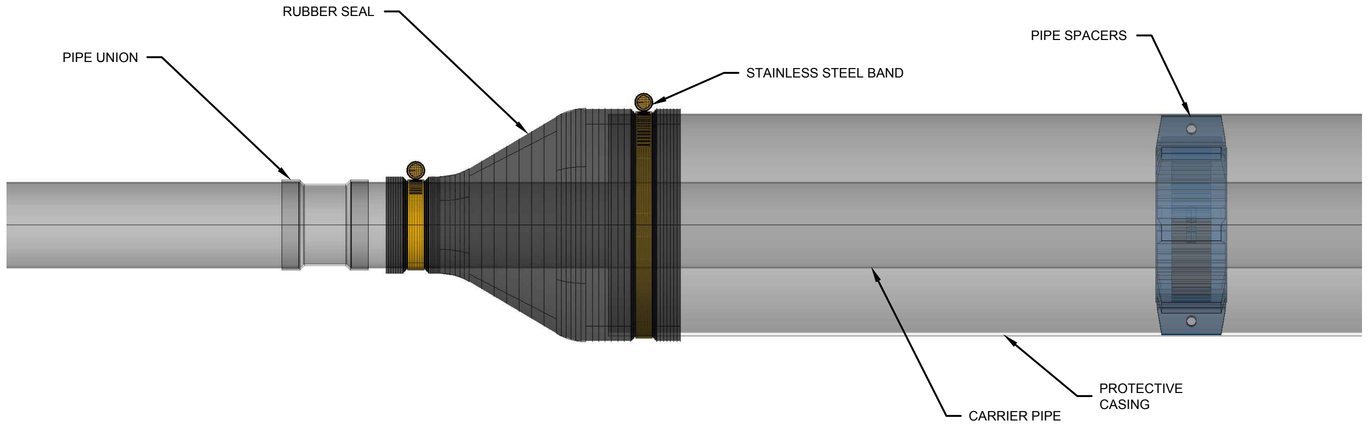
1 PIPE CROSSING PLAN VIEW
TYPICAL
NTS

LEGEND

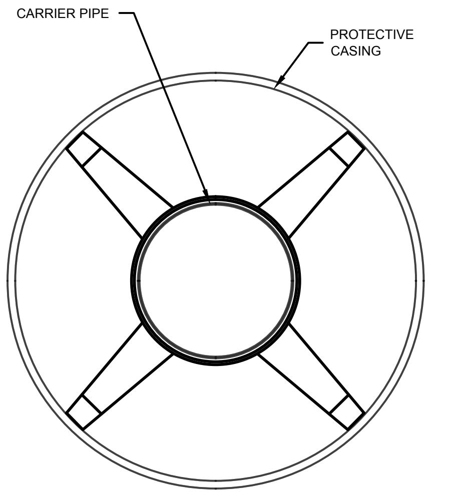
▨	WELLFIELD
☐	WELL
▭	HEADER HOUSE
——	RIGHT OF WAY
— —	AUC FENCE
▭	DIVERSION DITCH
▬	EARTHEN BERM
▨	TRUNKLINE BORING PIT



2 ROAD X-SECTION A - A'
TYPICAL
NTS



3 RUBBER BOOT END SEAL
TYPICAL
NTS



4 PIPE SPACER
TYPICAL END VIEW
NTS

DRAWING ISSUE TYPES: **PRB** = PRE-BID **POB** = POST-BID **IFC** = ISSUED FOR CONSTRUCTION **NFC** = NOT FOR CONSTRUCTION

NO:	DATE	CADD	CHECK	APP'D	ISSUE / REVISION DESCRIPTION	NO:	DATE	CADD	CHECK	APP'D	ISSUE / REVISION DESCRIPTION
1	09/19/12	AJE	CT	RD	NFC CONCEPTUAL DESIGN	----	----	----	----	----	---- ----
----	----	----	----	----	---- ----	----	----	----	----	----	---- ----
----	----	----	----	----	---- ----	----	----	----	----	----	---- ----
----	----	----	----	----	---- ----	----	----	----	----	----	---- ----
----	----	----	----	----	---- ----	----	----	----	----	----	---- ----
----	----	----	----	----	---- ----	----	----	----	----	----	---- ----

AUC LLC

TREC, Inc.
Engineering & Environmental Management
www.treccorp.com

BOZEMAN OFFICE
1800 West Koch, Suite 6
Bozeman, MT 59715
Tel: (406) 586-8364
Fax: (406) 522-8460

CASPER OFFICE
900 Werner Court, Suite 150
Casper, WY 82601
Tel: (307) 265-0696
Fax: (307) 265-2498

GREAT FALLS OFFICE
600 Central, Suite 204
Great Falls, MT 59401
Tel: (406) 952-0745

BUTTE OFFICE
521 East Front Street
Butte, MT 59701
Tel: (406) 491-0912

IF THIS BAR DOES NOT EQUAL ONE INCH ADJUST SCALES ACCORDINGLY

PROJECT NO.:	CADD:	CHECKED BY:	APPROVED BY:	PLOT DATE:
2012-250	AJE	----	----	

CONCEPTUAL SECONDARY LEAK PROTECTION
AUC PROJECT
PREPARED FOR
AUC LLC,

FIGURE
3-5

DRAWING: Z:\CURRENT PROJECTS\3001 AUC\3001-2013-100 RENO CREEK RAIS\020-CAD\FIGURES\3001-2013-100 CD301 UTIL.DWG

RAI- 8

Description of Deficiency

Section 2.2.1 (Current Land Use) of the TR states:

> *"There is currently one residence (the Taffner homestead) located within the Proposed Project boundary, and the Taffner homestead is currently located where the proposed CPP will be located. AUC will acquire the Taffner property prior to construction and it will not thereafter be used as a residence. The domestic water well located at the Taffner residence will be plugged in accordance with all WDEQ Rules and Regulations and will not be used for consumption once construction begins."*

Basis for Request

The applicant acknowledges that this residence is not compatible with licensed activities and the discussion presumes that AUC will satisfy the above commitment. As such, the application does not address the health and safety implications associated with the co-location of the residence and the proposed CPP. AUC's commitment to acquire the Taffner property and plug the domestic water well prior to construction will be conditioned in the issuance of any NRC license.

Formulation of RAI

Describe how and when AUC will verify to the NRC implementation of its plans regarding the Taffner property.

RAI-8 Response

AUC commits to provide the NRC with documentation of the Taffner property acquisition prior to construction. The commitment has been added to TR Section 2.2.1 as shown below:

"There currently is one residence (the Taffner homestead) located within the Proposed Project boundary (ER Figure 3.1-1), and five residential sites located within the five-mile land use review area outside of the Proposed Project boundary. Based on landowner correspondence, there are currently two occupants at the Taffner homestead and approximately eight occupants currently living in the five residences located outside the project boundary. The Taffner homestead is currently located where the proposed CPP will be located. AUC will acquire the Taffner property prior to CPP construction and it will not thereafter be used as a residence. The domestic water well located at the Taffner residence will be plugged in accordance with all WDEQ Rules and Regulations and will not be used for consumption once construction begins. AUC will provide the NRC with a copy of the property title transfer and/or other contract documents following the acquisition of the Taffner property. In addition, AUC will notify the NRC when the plug and abandonment report for the Taffner domestic well has been filed with the Wyoming State Engineers Office."

RAI- 9

Description of Deficiency

In Section 2.5 of the TR, the applicant describes the nearest mountain ranges and the distance (60-100 miles), and concludes that due to these large distances, neither the Antelope site nor the proposed project site experiences weather effects from the three mountain ranges. In section 2.2.1, the applicant describes the Pumpkin Buttes at a distance of 7.5-14 miles from the proposed site.

Basis for Request

NRC staff cannot determine from the information in the TR if the Pumpkin Buttes have an impact on local weather patterns. SRP Acceptance Criteria 2.5.3(2) states that the applicant should assess the impact of terrain and nearby bodies of water on local meteorology. NRC staff considers buttes as tall natural structures/objects located in relatively flat or rolling hill terrain that may have an impact on local weather patterns. NRC staff has determined that the applicant failed to describe the impact (or lack of impact) of the Pumpkin Buttes, (which are much closer to the site than the nearest mountain ranges) on the terrain and how it may (or may not) affect local meteorology at the proposed site.

Formulation of RAI

Provide a technical assessment that demonstrates how the Pumpkin Buttes affect (or does not affect) the local meteorology (i.e., wind direction and wind speed). The applicant can provide actual research, computer simulation models, or relevant scientific literature search to support its conclusions.

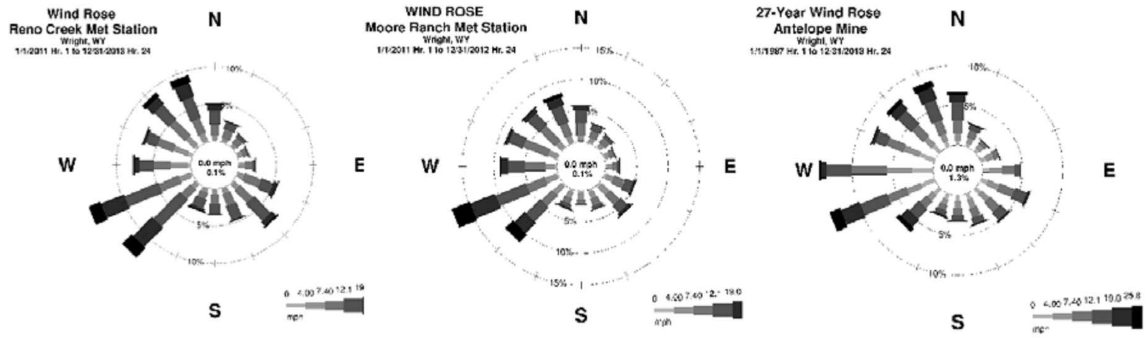
RAI-9 Response

To further support AUC's assessment of local meteorology the following text will be added to the end of TR 2.5.3.7:

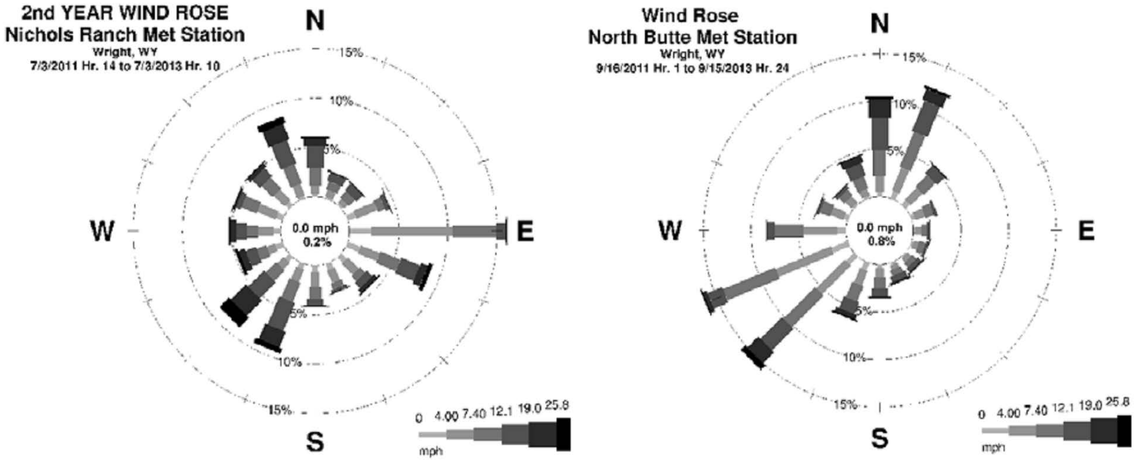
"The nearest significant topographic features are the Pumpkin Buttes, located approximately 10 miles west of Reno Creek, and are approximately 1,000 feet higher in elevation. Given this 50:1 aspect ratio and the relatively small area occupied by the Pumpkin Buttes, Reno Creek is too far away to be influenced meteorologically. This is demonstrated by wind roses generated for various locations in the vicinity of Reno Creek. The Reno Creek wind rose closely resembles the wind rose from the NRC-licensed Moore Ranch ISR Project (SUA-1596) located 15 miles south-southwest of Reno Creek, and roughly resembles the wind rose from Antelope Mine which is located 20 miles southeast of Reno Creek (Figure 2.5-46). All three sites experience the same regional wind pattern. Moore Ranch is approximately the same distance from Pumpkin Buttes as is Reno Creek, but in a more southerly direction.

Conversely, the North Butte ISR Project and the Nichols Ranch ISR Project lie near the southeastern and western slopes, respectively, of North Pumpkin Butte. Each of the wind roses from these sites reflects the localized influence of the Buttes (Figure 2.5-47). The wind roses reflect night-time, downslope drainage, and some blockage or diversion of prevailing winds by the Buttes."

TR Figure 2.5-46



TR Figure 2.5-47



RAI-10

Description of Deficiency

The application states that the mineralization occurs along multiple oxidation-reduction fronts in various interbedded sandstones within the "production zone aquifer" (TR Section 2.6.2.6 page 2.6-15); uranium "intercepts" are variable in thickness ranging from one to 30 feet (TR Section 3.1.1 page 3-3) and the financial surety calculations indicate an average screen thickness (ore body) of 12 feet (Table 2.2 on Attachment 1-3 of Addendum 6-A); the ore body closely resembles roll-front deposits discussed in NUREG-1910 Generic Environmental Impact Statement for In Situ Leach Uranium Milling Facilities (GEIS), which indicate stacked or multiple horizons in a specific sandstone host; in areas in which [sandstones] in the production zone aquifer (PZA) are bifurcated by a thick mudstone, uranium mineralization can be found both above and below the mudstone lens; and, more frequently, the uranium mineralization is found in the lower half of the PZA (TR Section 2.6.2.2.1 page 2.6-9).

Basis for Request

On Figure 2.6A-27, the application presented a cross-sectional view of a typical roll front; however, the application did not include cross-sectional views of the ore body within the production zone aquifer throughout the project area (e.g., Figures 2.6A-18 through -23).

Historically, applications for a source material license contain depictions of the ore bodies' trends in both horizontal and vertical dimensions, in addition to the general information on the "production zone". This information is utilized by staff to determine adequacy of the pre-operation data (pumping test and water quality) for the proposed operations. For example, the vertical distribution of ore bodies will influence staff's evaluation of the suitability of the screened horizon for the perimeter ring wells. For this application, the vertical aspect of the ore bodies is significant with respect to the available water column for operations in areas in which the PZA is not fully saturated.

Section 2.6.1 of the SRP states:

> *"An isopach map of the intended zone of injection or production and associated confining beds should be evaluated. All conclusions regarding the lateral continuity and vertical thickness of the mineralized zone(s), surrounding lithologic units, and confining zones, as based on lithologic logs from core and drill cuttings, geophysical data, remote-sensing measurements, and the results of other appropriate investigations should be reviewed." Emphasis added.*

Formulation of RAI

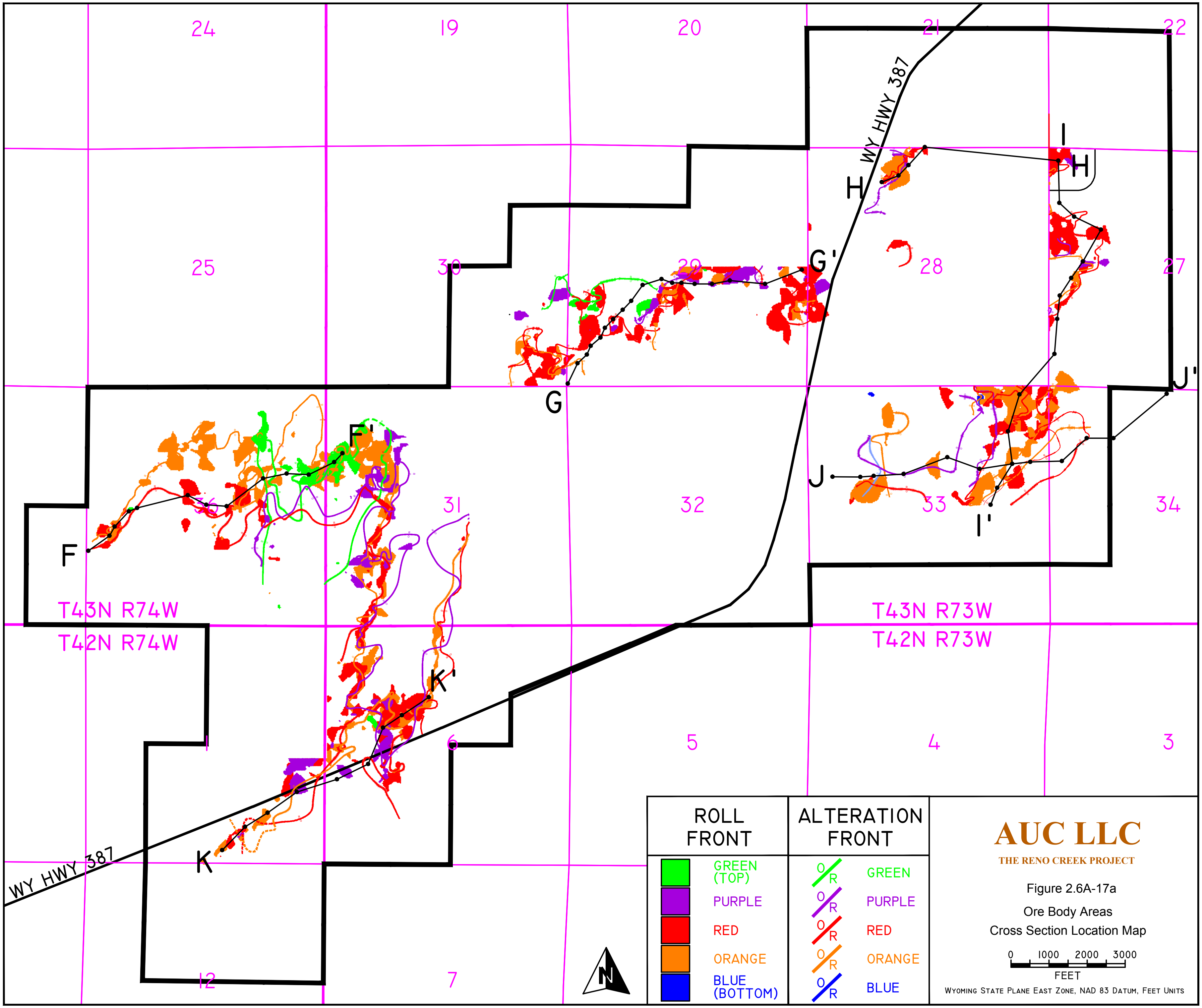
Please depict the vertical location of the mineralized horizon(s) on the cross sections provided in the application. If multiple mineralize zones are identified, please provide map views of the distribution of the individual mineralized zones.

RAI-10 Response

TR Section 2.6.2.2.1 (pg 2.6-9), the third paragraph refers to the vertical positions of ore horizons. AUC has revised figures to add more detail depicting stacked ore trends. These new references are shown below:

"At various localities within the Proposed Project area all horizons from the base to the top of the host sandstone (PZA) can be favorable for uranium deposition. However, economically significant uranium mineralization occurs most frequently in the lower half of the PZA. This relationship and depiction of the ore trends, including oxidation/reduction boundaries is shown on Figure 2.6A-17. Cross sections depicting the vertical stacking of the ore trends are included as Figures 2.6A-18 through 2.6A-23."

Figure 2.6A-17 and Figures 2.6A-18 through 2.6A-23 are shown below:



AUC LLC

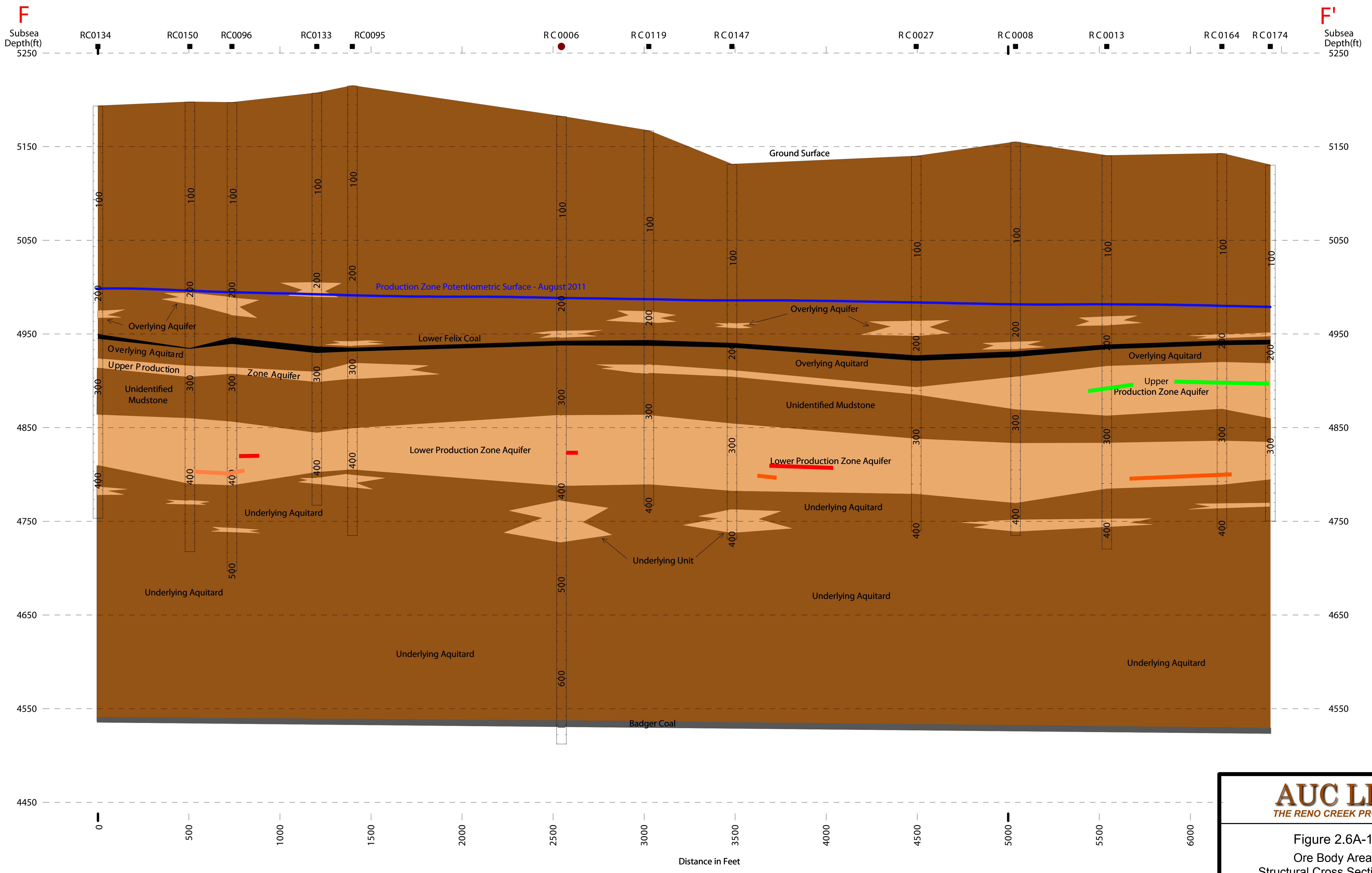
THE RENO CREEK PROJECT

Figure 2.6A-17a

Ore Body Areas

Cross Section Location Map

Wyoming State Plane East Zone, NAD 83 Datum, Feet Units



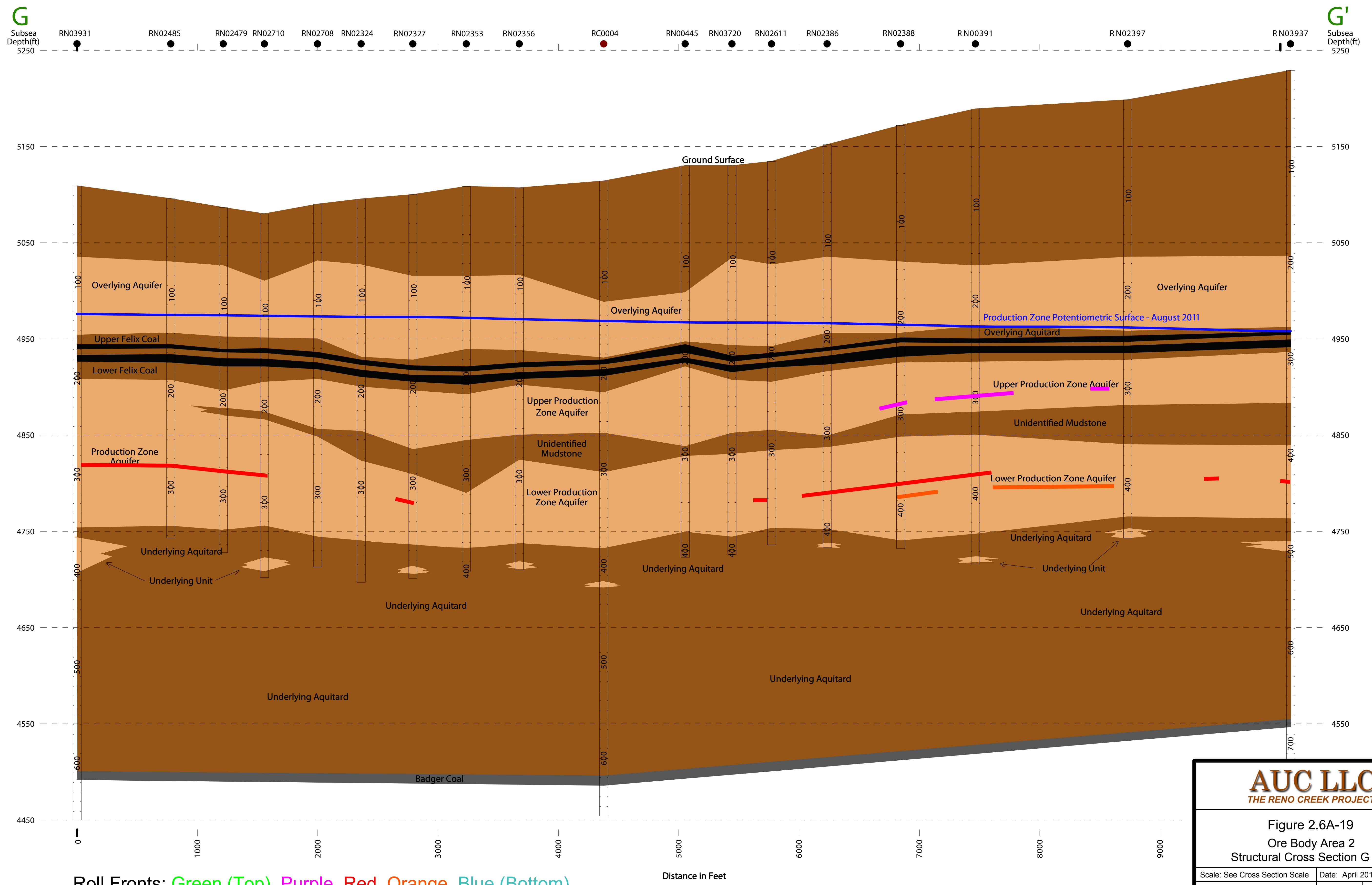
Roll Fronts: Green (Top), Purple, Red, Orange, Blue (Bottom)

AUC LLC
THE RENO CREEK PROJECT

Figure 2.6A-18
Ore Body Area 1
Structural Cross Section F - F’

Scale: See Cross Section Scale	Date: April 2014
AUC_RC_NRC_Fig_2.6A-18.ai	By: KRS / Checked: AAP

Petrotek
10288 West Chatfield Ave., Suite 201
Littleton, Colorado 80127-4239 USA
303-290-9414
www.petrotek.com



Roll Fronts: Green (Top), Purple, Red, Orange, Blue (Bottom)

AUC LLC

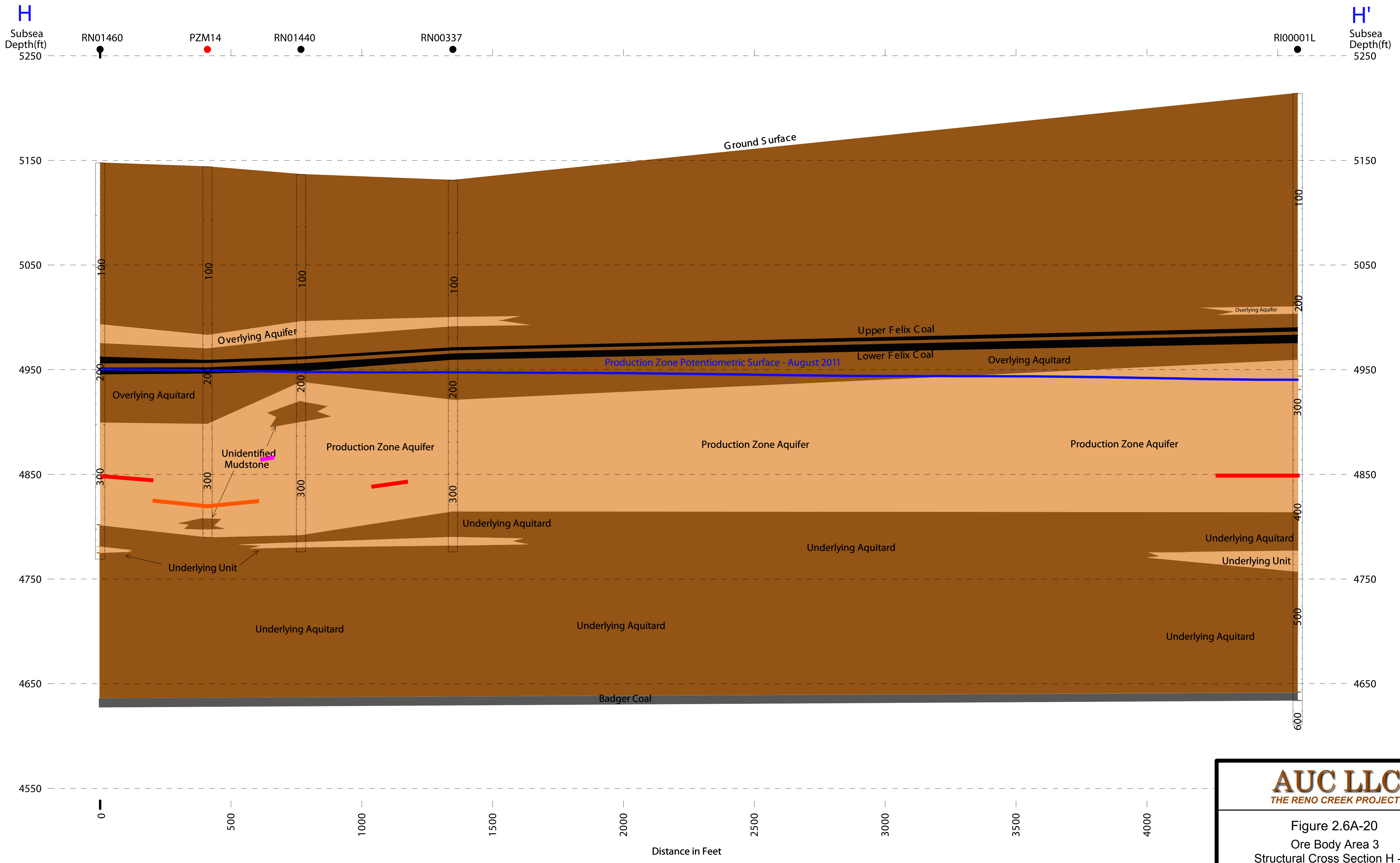
THE RENO CREEK PROJECT

Figure 2.6A-19

Ore Body Area 2
Structural Cross Section G - G’

Scale: See Cross Section Scale	Date: April 2014
AUC_RC_NRC_Fig_2.6A-19.ai	By: KRS Checked: AAP

Petrotek
10288 West Chatfield Ave., Suite 201
Littleton, Colorado 80127-4239 USA
303-290-9414
www.petrotek.com



Roll Fronts: Green (Top), Purple, Red, Orange, Blue (Bottom)

AUC LLC

THE RENO CREEK PROJECT

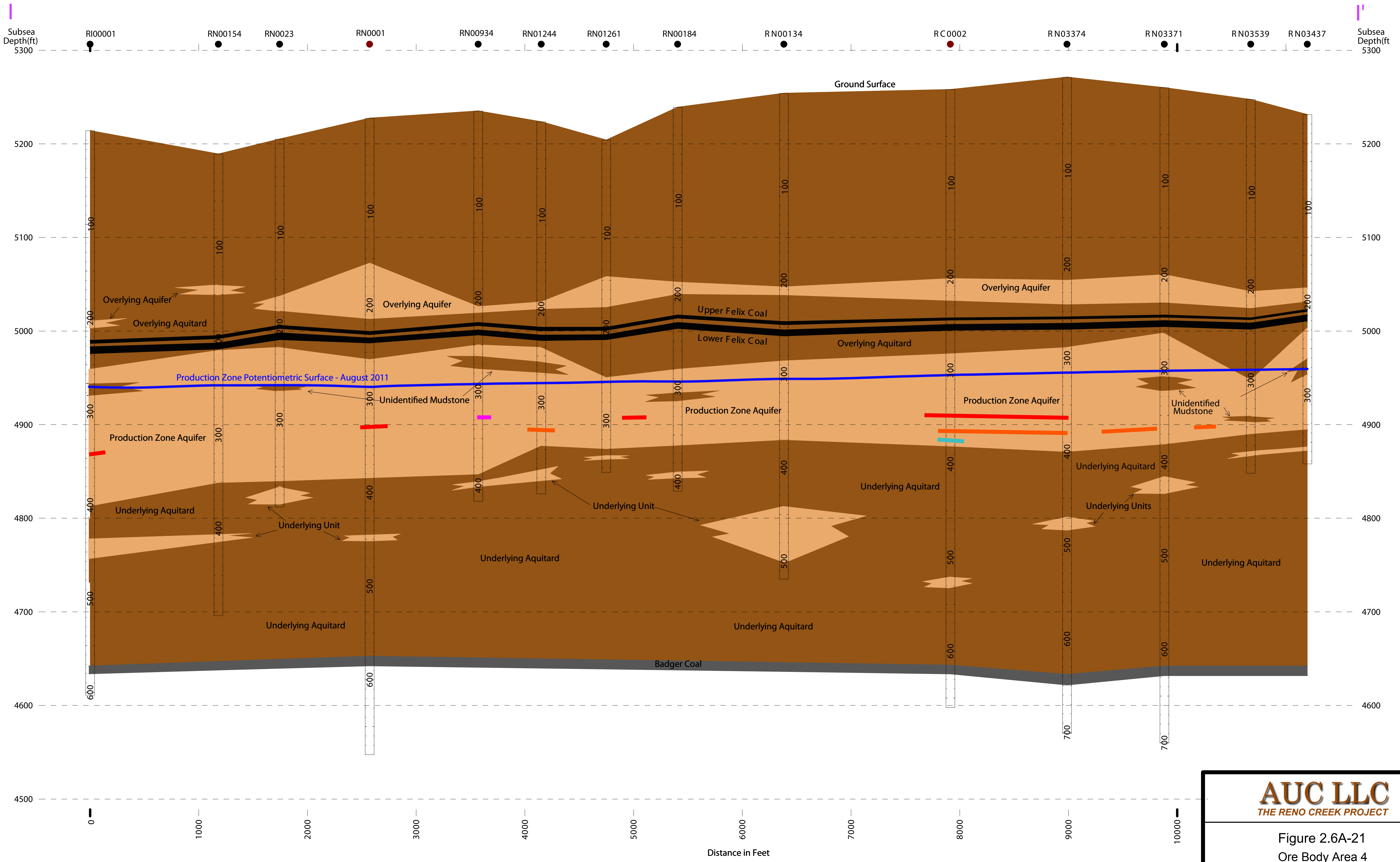
Figure 2.6A-20

Ore Body Area 3

Structural Cross Section H - H'

Scale: See Cross Section Scale	Date: April 2014	
AUC_RC_NRC_Fig_2.6A-20.ai	By: KRS	Checked: AAP

Petrotek
10288 West Chatfield Ave., Suite 201
Littleton, Colorado 80127-4239 USA
303-290-9414
www.petrotek.com



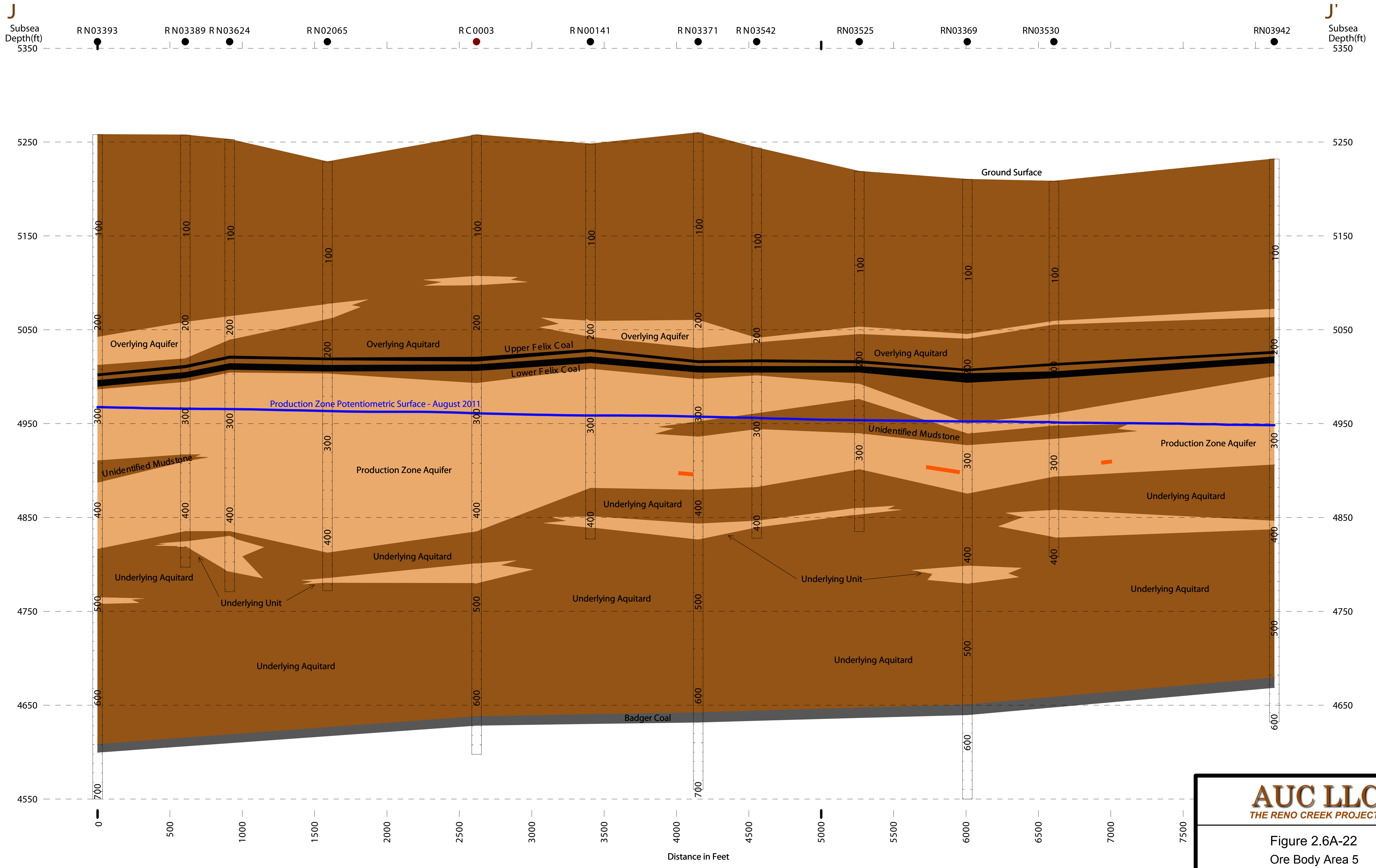
Roll Fronts: Green (Top), Purple, Red, Orange, Blue (Bottom)

AUC LLC
THE RENO CREEK PROJECT

Figure 2.6A-21
Ore Body Area 4
Structural Cross Section I - I'

Scale: See Cross Section Scale	Date: April 2014	
AUC_RC_NRC_Fig_2.6A-21.ai	By: KRS	Checked: AAP

Petrotek
10288 West Chatfield Ave., Suite 201
Littleton, Colorado 80127-4239 USA
303-290-9414
www.petrotek.com



Roll Fronts: Green (Top), Purple, Red, Orange, Blue (Bottom)

AUC LLC

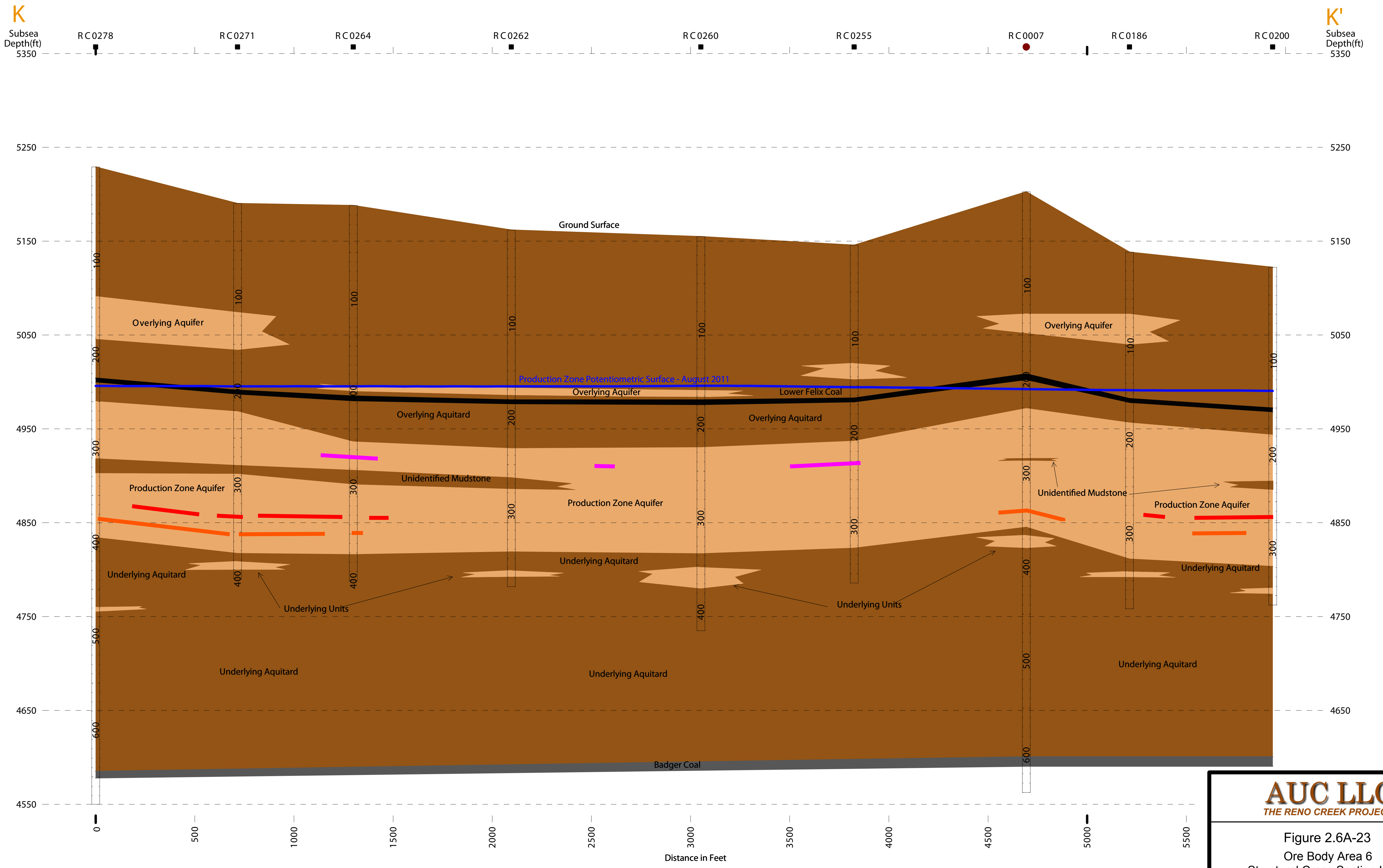
THE RENO CREEK PROJECT

Figure 2.6A-22

Ore Body Area 5
Structural Cross Section J - J'

Scale: See Cross Section Scale	Date: April 2014	
AUC_RC_NRC_Fig_2.6A-22.ai	By: KRS	Checked: AAP

Petrotek
10288 West Chatfield Ave., Suite 201
Littleton, Colorado 80127-4239 USA
303-290-9414
www.petrotek.com



Roll Fronts: Green (Top), Purple, Red, Orange, Blue (Bottom)

AUC LLC
THE RENO CREEK PROJECT

Figure 2.6A-23
Ore Body Area 6
Structural Cross Section K - K'

Scale: See Cross Section Scale	Date: April 2014	
AUC_RC_NRC_Fig_2.6A-23.ai	By: KRS	Checked: AAP

Petrotek
10288 West Chatfield Ave., Suite 201
Littleton, Colorado 80127-4239 USA
303-290-9414
www.petrotek.com

RAI-11

Description of Deficiency

In TR Addendum 2.6-A, the mapping of the potential wellfields (e.g., Figure 2.6A-11) depicts a linear edge to several wellfields that coincide with section lines. During a NRC site visit in September 2013, the applicant acknowledged mineral claims other than those of the applicant exist within the proposed license area boundary. The linear edges in the application figures in general coincide with the general description of the boundary between mineral claims of the applicant and others.

Basis for Request

The application is deficient in that it does not include any description of the extent of mineral claims owned or not owned by the applicant, agreements with the other mineral owners, or techniques or limitations on performing operations near those areas.

Section 2.6.1 of the SRP states:

> *"Data on the geochemistry of the ore zone and the geologic zones immediately surrounding the mineralized zone that will or could be affected by injected lixiviant should be evaluated. Information on unique minerals (including those that might be affected by fluid movement associated with the proposed project, such as bentonite) or paleontologic deposits of particular scientific interest, should also be reviewed. The staff should examine descriptions of any effects that planned operations at the site might have on the future availability of other mineral resources."*

Formulation of RAI

- *Please provide information on the areas in the proposed license area for which the applicant does not have complete control in the subsurface. In those areas, please provide agreements to either monitor or perform corrective actions to ensure that the migration of regulated materials will not occur or be properly mitigated.*
- *Provide information regarding AUC's ability to perform corrective actions on mineral properties held by Uranerz at the locations where AUC will be installing monitor wells?*

RAI-11 Response

AUC has provided the memorandum of reciprocal monitor well agreement with Uranerz Energy Corporation (Uranerz) regarding monitoring the migration of regulated material. This document also provides the legal descriptions of the subsurface mineral lease areas held by Uranerz and adjacent mineral leases held by AUC. This agreement between AUC and Uranerz Energy Corporation permits each party to install monitor ring wells on each other's mining leases allowing controlled monitoring and timing of installation of each party's wellfield wells up to the adjoined mining lease boundary. This agreement is provided as Appendix A of this response package.

Uranerz has mineral rights adjacent to AUC's mineral properties. In order to prevent adverse consequences of adjacent mineral ownership, AUC and Uranerz have signed a Memorandum of Reciprocal Monitor Well Agreement, which grants the right to "…install, operate, plug, reclaim and abandon Monitor Wells" on each parties respective identified properties. This agreement provides for any necessary corrective actions required in conjunction with conducting these activities. There are no other agreements of a similar nature required for AUC's operation of the project. This agreement is provided as Appendix A of this response package.

RAI-12

Description of Deficiency

In TR Section 2.7.1.5 (page 2.7-9), the applicant asserts that "surface-[water] runoff will be directed away" from the plant and associated infrastructure (e.g. backup storage pond)." The foundation of support for the design of diversion channels as recommended by Regulatory Guide 3.11, Revision 3, "Design, Construction, and Inspection of Embankment Retention Systems at Uranium Recovery Facilities", is not discussed.

Basis for Request

The application does not provide an adequate evaluation of the surface-water flow to the surface impoundment.

Section 2.7.1 of the SRP states the application includes:

> *"Descriptions of surface-water features in the site area including type, size, pertinent hydrological or morphological characteristics, and proximity to in situ leach processing plants, well fields, evaporation ponds, or other facilities that might be negatively affected by surface erosion or flooding."*

Furthermore, Section 4.2.3 of the SRP states:

> *"The design, installation, and operation of surface impoundments at the site used to manage 11e.(2) byproduct material meet relevant guidance provided in Regulatory Guide 3.11, Section 1 (NRC, 1977). ... [t]he surface impoundment must have sufficient capacity and must be designed, constructed, maintained, and operated to prevent overtopping resulting from (i) normal or abnormal operations, overfilling, wind and wave actions, rainfall, or run-on;"*

Section 2.2.1 of Regulatory Guide 3.11 states:

> *"If impoundments are designed to contain only direct precipitation that falls into the reservoir area, a single occurrence of the 6 hour probable maximum precipitation (PMP) may be used to determine storage capacity and freeboard requirements. If the tailings retention system has some external drainage area, and hydraulic structures (such as diversion channels) are needed to safely divert the probable maximum flood (PMF), the peak PMF inflows and runoff used to design such structures should be determined in accordance with the suggested flood design criteria in NUREG-1623, "Design of Erosion Protection for Long-Term Stabilization," (Ref. 2)."*

Staff has interpreted the "tailings retention system" reference in Regulatory Guide 3.11 to include all surface impoundments used for storage of byproduct material including liquid byproduct material. ***Formulation of RAI***

Please provide the analysis of the surface-water run-on to the proposed surface impoundment which is proposed for the drainage channel surrounding the "backup pond." For recent applications that include impoundments, calculations and/or drawings to demonstrate compliance with guidance in RG 3.11 are required for staff's evaluation prior to issuance of the license. In this case, staff needs to confirm that the berm upslope of the impoundments is adequate for a diversion of water and/or flow from the upslope areas are accounted for in the freeboard calculations. (Also related to RAI-35)

RAI-12 Response

The flood inundation study presented in Section 2.7.1.5 is used as a basis of siting infrastructure as to minimize flooding risks. The CPP and associated infrastructure are currently planned to be sited on a hill away from major drainages to avoid flooding potential.

Additionally, the response to RAI-35 provides hydraulic calculations to determine the 100-year peak runoff ~~rate. Runoff from the site itself will be addressed during final planning. Specifically, grading plans and detailed design drawings will address the requirements of Regulatory Guide 3.11.~~

No revisions were made to the application as a result of this RAI.

RAI-13

Description of Deficiency

On page 23 in TR Addendum 2.7-D of the application, the applicant reports:

> *"Based on field reports by AUC, it was concluded that well UM3 was irreparably damaged during well completion. After the UM3 well casing was cemented and allowed to cure, the underlying unit was under-reamed to total depth. During the under-reaming, the two blades were bent while reaming through a four to five feet thick hard carbonate layer immediately above the underlying unit. After reaching total depth, the damaged under-reaming blades could not be retracted into the bit. Withdrawal of the bit resulted in gouging and distortion of the inside of the well casing. The well was completed, but as the results of the step test conducted at PZM3 show, the intended underlying unit completion interval was compromised and had direct communication with the PZA. Based on these data, the well was properly plugged and abandoned and replaced with well UM3R."*

In Section 3.1.3.3 of the application (page 3-12), the applicant states:

> *"Any well with evidence of suspected subsurface damage will require an MIT prior to the well being returned to service."*

Basis for Request

Identifying a problem with the integrity of monitoring well UM3 during a step test without evidence of prior testing is inconsistent with the applicant's commitment in Section 3.1.3 to perform tests on wells with suspected damage.

Section 5.2.2 of the SRP states:

> *"The reviewer should determine that the proposed management control program and administrative procedures are sufficient to assure that any activities affecting health, safety, and the environment, including compliance with any license commitments or conditions, will be conducted in accordance with written operating procedures."*

Formulation of RAI

Please describe how commitments made in Section 3.1.3 will be implemented during operations. Also, please verify that information provided in the application is accurate regarding the integrity of damaged wells (e.g., UM3): Refer to Tables 2.7B-8, 2.7B12 (Addendum (2.7-B) and 3 (Addendum 2.7-C); Figures 2.7A-8 and 2.7B-9.

RAI-13 Response

Commitments made in Section 3.1.3 will be implemented during operations as described, with no changes deemed necessary. UM3 was plugged in accordance with State of Wyoming regulations stated below.

AUC has revised the paragraph on page 23 in TR Addendum 2.7-D with new language added shown below:

"Based on field reports by AUC, it was concluded that well UM3 was irreparably damaged during well completion. After the UM3 well casing was cemented and allowed to cure, the underlying unit was under-reamed to total depth. During the under-reaming, the two blades were bent while reaming through a four to five feet thick hard carbonate layer immediately above the underlying unit. After reaching total depth, the damaged under-reaming blades could not be retracted into the bit. Withdrawal of the bit resulted in gouging and distortion of the inside of the well casing, but it was unknown if structural integrity of the well casing was compromised. The UM3 well was completed, but the step test conducted at PZM3 indicated that the well casing across the intended underlying unit completion interval was compromised, and showed direct communication with the PZA. Based on these data, the well was properly plugged and abandoned in accordance with the Wyoming's State Engineer's Office document, "Regulations and Instructions Part III, Water Well Minimum Construction Standards, Chapter 4, Section 4, Water Well Plugging and Abandonment" Revised February 2010, and replaced with well UM3R."

The RAI also requests verification that information provided in the application is accurate regarding the integrity of damaged wells (e.g., UM3). All tables and figures referencing UM3 and UM3R were reviewed for accuracy. The following tables and figures refer to monitoring well UM3 and/or UM3R:

- Addendum 2.7B, Table 2.7B-1: UM3 data was replaced with UM3R data. This table modification can be found in the response to RAI-18.
- Addendum 2.7B, Table 2.7B-6: P&A has been inserted behind the UM3 identification in the first column.
- Addendum 2.7B, Table 2.7B-7: No revisions
- Addendum 2.7B, Table 2.7B-8: Well identification UM3 has been replaced with UM3R and associated data.
- Addendum 2.7B, Table 2.7B-12: Well identification UM3 has been replaced with UM3R

- Addendum 2.7B, Table 2.7B-13: No revisions
- Addendum 2.7B, Table 2.7B-34: No revisions
- Addendum 2.7B, Figure 2.7B-9: Elevation for UM3R has been revised
- Addendum 2.7B, Figure 2.7B-17: Well identification UM3 has been replaced with UM3R including water level depth
- Addendum 2.7B, Figure 2.7B-30: No revisions
- Addendum 2.7A, Figure 2.7A-8: Well identification UM3 has been replaced with UM3R

RAI-14

Description of Deficiency

TR Addendum 2.7-C of the application documents results of a groundwater numeric model used by the applicant for the basis of its proposed design for the wellfield operations. Staff has several comments and questions on the groundwater numeric model which, for convenience, are grouped into three categories as follows: (1) existing model design/simulations; (2) model setup; and (3) model predictions.

(1) Existing Model Design/Simulations: The supplemental data dated July 19, 2013 (ADAMS Accession No ML13213A064) included the electronic version of the ground water modeling input and output files. For the Regional SS and Life-of-Mine Simulations, an error in a water mass balance budget for many stress periods exceed 1.0 percent. Generally, the conventional industry standard for an error is 0.1 to 0.5 percent, but it is reported that errors of 1.0 percent may be acceptable (Hill, 2007).

(2) Model Setup

(a) On Figure 11 in Addendum 2.7-C, the application reports that the groundwater numeric model consists of 24 zones of hydraulic conductivity values with values varying between 0.1 and 6 feet per day. Of the 24 zones, 23 zones approximate a "circular-like" zone centered about the various locations of pumping tests and generally limited to the proposed license area. The modeled area outside of the proposed license area is one zone with a hydraulic conductivity of 1.0 foot per day. The geometry of the circular-like zones is likely an artifact of using pilot point calibration techniques. However, use of this calibration technique with the large number of zones needs to be addressed in light of the fact that the calibration "targets" consisted of only 12 head values. Furthermore, the modeling report did not include any sensitivity analysis on the hydraulic conductivity values, in particular, the single zone surrounding the license area.

(b) The discussions on sensitivity of the groundwater numeric model to storage terms are limited in Addendum 2.7-C of the application. The application states that calibration for two transient simulations (based on drawdown in the partially 10 saturated cells) was more sensitive to specific yield (page 12 of Addendum 2.7-C); however, other than reporting the "calibrated" values the report did not elaborate model sensitivity to specific yield values.

(c) Based on information in Addendum 2.7-C, the groundwater numeric model is based on strata orientation with a uniform northwesterly dip (Page 5). As a result, the general head boundary conditions assigned to cells along the southeastern perimeter model had to be assigned relatively high heads. The high heads result in a "source" component to the groundwater model. The application states that the general head boundaries in that area reflect recharge directly to the ore zone based on the mapped distribution of outcrops of the Felix Coal seam (Page 6). While staff acknowledges that the applicant's model assigns a low contribution to that source and that the Felix Coal seam outcrops are as reported by the applicant (Page 11), staff's concern is that general head boundaries in that area may be an artificial source of water in the model. For example, the area of recharge is actually located within another surface water watershed and the outcrops of the coal seam correlate with incised slope surface forming distant stream channels. As such, direct recharge to the ore zone may not be occurring to the extent of the applicant's conceptual model nor migrate to the location of the proposed license area.

(d) The applicant's model is a one-layer model (Page 11) which limits its predictive capabilities to a 2-dimensional flow regime (i.e., horizontal flow). The application states that a single layer is reasonable because the upper and lower layer represents no-flow boundaries consistent with the applicant's conceptual model for the upper and lower confining units. However, vertical anisotropy to the aquifer, as inferred by the application, cannot be incorporated into a one-layer model and vertical anisotropy would affect specific model predictions (as discussed below under Section (3)).

(e) The transient stress periods for the Life-of-Mine Simulation consist of withdrawals that are based on a "preliminary production unit operational schedule" and the "maximum proposed production …during year seven". While staff acknowledges that the withdrawals reflect proposed production unit constraints, the application did not provide a simulation which took into account the maximum impact of operations (e.g., 3 percent bleed at the maximum 11,000 gpm for the life of the operations).

(3) Model Predictions

(a) Life-of-Mine Simulation - The application predicts drawdown for various stress periods during the life-of-mine simulation. The model simulation predicted the worst case of 35 feet of drawdown during stress period 7 (year 7

of operations) in the area of the aquifer which is only partial saturated with 80 feet of available water column under static conditions (Page 17).

- *(i) The model predictions are based on rectangular model cells; the predictive results do not take into account radial drawdown in the vicinity of a relatively thin diameter well (thin compared to the dimension of the model cell) or inefficiency of a well. The applicant reports that from the pumping tests, well efficiencies on the order of 10 percent may be expected.*
- *(ii) The model is based on wells screened throughout the entire saturated thickness of the aquifer. However, the production wells may be focused on only a portion of the ore aquifer and thus the available water column after the 35 feet of drawdown may be significantly less than 55 feet (80 minus 35 feet).*

(b) Flare Simulation - The application determined based on the model results horizontal flare factors of 1.14 or 1.15 for the fully and partially saturated areas of the aquifer, respectively, and concluded that those values are less than those used in other ISR applications (Page 20); the applicant adopted higher values in the surety calculations (similar to those used by other applicants (e.g., 1.20). In addition, the application states that although not simulated in the model, the vertical flare should be less than the horizontal flare due to the anisotropy. Being a single layer, the model cannot incorporate any anisotropy in the aquifer. Furthermore, because the model incorporates a "fully penetrating" well by design, the model cannot predict flare for a partial penetrating well, which will be the case for all production (injection and recovery) wells.

(c) Excursion Recovery - The application reports that model predictions support the applicant's proposed spacing of the perimeter ring monitoring wells and that the modeling demonstrates timely corrective action should an excursion be observed (Page 19). The duration of the stress period used to demonstrate that the well spacing is adequate was 2 years.

Basis for Request

Based on the information provided in the application, staff is unable to substantiate the applicant's conclusions nor can staff conclude that the applicant's conceptual model is appropriate for the specific setting. As a result, staff developed three specific RAI *comments on the applicant's model.*

Section 2.7.1 of the SRP states:

> *"Characterization of the hydrology at in situ leach uranium extraction facilities must be sufficient to establish potential effects of in situ leach operations on the adjacent surface-water and ground-water resources and the potential effects of surface-water flooding on the in situ leach facility."*

Section 2.7.2 of the SRP further states:

> *"Examine pumping tests, analyses, and/or other measurement techniques used to determine the hydrologic properties of the local aquifers and aquitards that affect or may be affected by the proposed in situ leach activities."*

Section 6.1.2 of the SRP provides guidance on the evaluation of groundwater numerical models:

> *"If numerical ground-water flow or transport modeling is used to support or develop the ground-water restoration plans, examine the descriptions of features, physical phenomena, and the geological, hydrological, and geochemical aspects of the modeled aquifers. The staff should verify that the descriptions are adequate and that the conditions and assumptions used in the modeling are realistic or reasonably conservative and supported by the body of data presented in the descriptions." "Evaluate the sufficiency of data used to support model input parameter values. Data sources may include a combination of techniques such as laboratory experiments, aquifer hydraulic testing and water level measurements in wells, geochemical analyses, or other site-specific field measurements."*
>
> *"Evaluate the technical bases for parameter ranges, probability distributions, or bounding values. The reviewer should determine whether the parameter values are derived from either site-specific data, or an analysis to show assumed parameter values bound data uncertainty in a manner that is not overly optimistic."*
>
> *"Evaluate whether there are aspects of the model where additional data could provide new information that could invalidate the modeling results and significantly affect the ground-water restoration plan. For example, if constant head boundary conditions are used in a numerical ground-water flow model, could additional wells or sampling during a different season result in a significantly different interpretation of model boundary conditions? If so, is a different interpretation of boundary conditions likely to significantly alter model results used*

> *to develop or support the restoration plan?"*
>
> *"Examine the initial conditions and boundary conditions used in any numerical modeling for consistency with available data. The staff should also consider the potential importance of temporal and spatial variations in boundary conditions and source terms used to support the ground-water restoration plan."*
>
> *"Evaluate the applicant's assessment of uncertainty and variability in model parameters. The reviewer should determine whether uncertainty in both temporal and spatial parameter variability is incorporated into or bounded by parameter values."*

Formulation of RAI

(1) Please provide a discussion of the potential uncertainty of the model for stress periods that did not achieve the 1.0 percent threshold.

(2) (a) Please provide an analysis of the model sensitivity to the distribution and number of hydraulic conductivity values used in the model.

(b) Please provide a discussion and sensitivity analysis of the storage coefficient on the model predictive results.

(c) Please provide a discussion on the impact of the boundary conditions in the southeastern perimeter on the long-term model predictions.

(d) Please comment on the limitations and impacts of a single layer model on the predictive results with respect to the field vertical anisotropy to the aquifer.

(e) Please provide a simulation evaluating the impact under the maximum operating conditions requested by this application.

(3) (a) Please provide an evaluation of available water column at a specific well taking into account radial flow to the well, well inefficiency, anticipated well completion elevation in the partially saturated portions of the aquifer.

(b) Please provide further clarification on the limitation of the flare calculations.

(c) Please provide further evaluation of the spacing for the perimeter ring monitoring taking into account the limited flare predicted for the application.

RAI-14(1) Response

AUC has tightened the convergence criteria for the model simulations to reduce the mass balance error for steady state and life-of-mine simulations.

RAI-14(2)(a) Response

AUC has conducted sensitivity analyses on the predominant hydraulic conductivity (K) value outside the permit boundary (1.0 ft/d) at one value above and one value below 1.0 ft/d. Values above and below this K value will be assigned to the large area outside of the permit boundary on the steady state calibration and on the life-of-mine simulations. AUC is providing comparative drawdown data from point locations along the permit boundary that were presented in the original model report to compare the results of varying this K value.

RAI-14(2)(b) Response

Similar to (2)(a), AUC has conducted sensitivity analyses on the storage coefficient utilized in the model for the life-of-mine simulations, in conjunction with the sensitivity analyses conducted on the predominant K values conducted to address (2)(a). Additionally, AUC is providing an additional level of discussion related to the specific yield values utilized in the model based on the NRC request for additional information related to this topic.

RAI-14(2)(c) Response

NRC's primary concern regarding the recharge boundary to the southeast was whether the model simulates what would be expected conceptually regarding the aquifer system and the recharge boundary, and if there are any additional data regarding water level elevation to the east. AUC has added an additional level of discussion regarding the conceptual model of the system, and discuss the impacts of the recharge boundary on the results of the model.

RAI-14(2)(d) Response

RAIs (2)(d) and (3)(b) concerns relate to the vertical anisotropy of the production zone aquifer and vertical flare. NRC requested additional clarification regarding the limitations of flare evaluations presented, and that the horizontal flare presented was based on a single-layer model with a fully penetrating well. Horizontal flare that incorporated a 10:1

(estimate based on core samples) anisotropy and partially penetrating wells injecting the same volume of fluid would be increased, as flowpaths are expected to be longer.

AUC is presenting a smaller-scale multi-layer model to simulate operating conditions in an anisotropic aquifer with partially penetrating wells to evaluate the vertical and horizontal flare within a simulated wellfield. This model simulation is also utilized to address and provide additional discussion regarding the RAI in (3)(c) regarding excursion control and perimeter well spacing.

RAI-14(2)(e) Response

The life-of-mine simulation provided was on the maximum operating conditions at a 1% bleed rate identified in the application.

RAI-14(3)(a) Response

NRC's expressed concern regarding the partially saturated portions of the aquifer was related to whether there is enough water column to control potential excursions. AUC proposes to present the ore bodies mapped in cross section relative to the available head above the ore zone to better address this potential concern. In addition, AUC has provided additional discussion regarding the well efficiencies noted in the partially saturated pumping wells that were installed and tested.

RAI-14(3)(b) Response

See response to (2)(d).

RAI-14(3)(c) Response

AUC has provided more explanation regarding the single-layer model with fully penetrating wells, in comparison to the results expected for actual operating conditions in a partially penetrating wellfield design in an anisotropic aquifer. Additional discussion has been provided to address travel times to the monitor well ring in the 1-layer model versus discrete intervals in an anisotropic model.

RAI-15

Description of Deficiency

In TR Section 2.7.1, the narrative in the application states that the surface water sampling locations consist of stock ponds or in drainages where ponding occurs (Section 2.7.1.9 page 2.7-13). The application states that, in general, surface water in the ponds exhibit typical saline characteristics of [coal bed methane] surface discharge during the summer and fall months and changes during the spring months due to dilution from snow melt or heavy precipitation (Page 2.7-13). The application states that there are significant differences among the various sampling locations with surface water quality at several locations and proffers various source characteristics (Page 2.7-15). For example, the application notes three locations as being dilute, at one location having a composition similar to rainwater. At the other end of the spectrum, several surface water samples being comparable with CBM discharges indicating a chemistry strongly influenced by CBM discharges, CBM discharge waters characterized by relatively high [total dissolved solids], dominantly sodium-bicarbonate water, and the fact that several surface water sampling locations are close to CBM discharges (Page 2.7-16).

The application (Page 2.7-16) also states another potential end member for the surface water quality is a calcium magnesium sulfate rich water, which differs from CBM discharged water in that coal bed methane (CBM) discharges have low sulfate levels, but does not provide any source characterization (i.e., groundwater discharge, surface water runoff). The application states that surface water at one location (SW9) appears to be CBM type water that has undergone some dilution and possible interaction with minerals in the soil and that a lixiviant spill could be distinguished from CBM discharges by concentrations of sulfate (high in lixiviant (aquifer) and low in CBM discharges) and barium (high in CBM discharges and low in the lixiviant (aquifer)).

Basis for Request

The conceptual surface water model presented in the application lacks specificity. For example, it fails to denote which surface water sampling locations are impacted by a permitted CBM discharge, which locations are not impacted but are located close to permitted CBM effluent discharge, and which locations that saline conditions characteristics of CBM discharge are not located close to a permitted CBM discharge.

Section 2.7.1 of the SRP states:

> *"Review surface-water data, including maps that identify nearby lakes, rivers, surface drainage areas, or other surface-water bodies; stream flow data; and the applicant's assessment of the likely consequences of surface-water contamination from in situ leach operations. Verify that the applicant has generally characterized perennial surface-water bodies, such that an assessment of impacts from operations can be made."*

Formulation of RAI

While staff acknowledges that the surface water features are ephemeral and thus difficult to characterize, the description provided in the application is too generalized to provide adequate background. Please provide the following information for each surface water sampling location:

(1) Whether an active CBM discharge is occurring;

(2) Whether the surface-water body is used for livestock water and, if so, is it supplemented with groundwater;

(3) Duration and maximum depth of the water in the surface-water body;

(4) Which of the "end" members (precipitation, CBM discharge, sulfate-rich) are a dominant component, and

(5) Whether or not reaction with soils are likely occurring.

RAI-15(1), (2) and (3) Response

Table 2.7A-14a (shown below) depicts the comparison and relationship of all the surface water samples with respect to their proximity to nearby or upgradient sources of groundwater potentially supplemented by existing CBM wells, livestock wells, or domestic wells. The duration and maximum depth of surface water at any one time for any of the surface water sample locations is dependent upon any supplemental groundwater sources nearby and/or recent precipitation events. Therefore, the duration in these ephemeral streams is based on seasonal precipitation events. The maximum depth of surface water at any one time within the stream channels ranges from 0.0 feet up to 4 feet deep based on the channel cross section, and/or the depth of the private surface impoundments which store the surface water, supplemented by either wells or precipitation runoff.

Table 2.7A-14a: Surface Water Sample Source

ID	Active CBM Outfall	Surface Water Source		
		CBM	Livestock	Domestic
SW1	No	No	No	No
SW2	No	No	No	No
SW3	No	WY0048526,006	No	No
SW4	No	WY0048526	No	No
SW5	No	WY0042340	No	No
SW6	No	WY0042340	No	No
SW7	No	WY0048542	No	No
SW8	No	No	GW9	No
SW9	No	WY0048542,001	No	No
SW10	No	WY0050679	GW5	No
SW11	No	WY0048526,005	No	No
SW12	No	WY0048526,002	No	No
SW13	No	No	No	No
SW14	No	No	GW4	No
SW15	No	No	GW4	No
SW16	No	WY0056251	GW2 GW3	No
SW17	No	WY0056251	No	No
SW18	No	WY0042340,010	No	No
SW19	No	WY0048526,002	No	No
SW21	No	No	GW15	No
SW22	No	WY0048526,003	No	No

** References data in Figure 2.7A-9*

RAI-15(4) and (5) Response

Based upon the cation concentrations, the CBM waters are characterized by more than 80 percent sodium plus potassium, on an equivalent basis. For the anions, the waters have more than 80% bicarbonate and carbonate (HCO_3^- plus CO_3^{-2}). In the near neutral pH range present in these samples, bicarbonate will dominate over carbonate, and so in the following discussion the term bicarbonate will be used to describe the total of bicarbonate and carbonate. In the Piper diagram, the CBM waters plot on the bottom of the quadrilateral. To that end they define their own “end member” composition.

At the opposite end of the quadrilateral is the SW19 composition, which consists of approximately 90% sulfate, and only 10% bicarbonate (equivalent), and contains mainly divalent elements calcium and magnesium. The SW19 defines another “end member”.

The third “end member” represents dilution through precipitation (rain and snow). It is best noted in SW15, which is the most dilute sample in the figure.

Many of the waters included on Figure 2.7A-10 can be described by these three end members based upon their major ion compositions. However, several waters display intermediate compositions that are not readily defined by these simple compositions.

- Waters classified as sodium bicarbonate dominant include SW11, SW3, SW22, WY0048542_003, WY0048542_010, and WY0042340_010. SW22 may have undergone some dilution with precipitation. SW18 has been included in this group, mainly because of the high TDS values, which are typically of the CBM waters. This water also has about 40% sulfate (equivalents). So some reactions with sulfate containing soils (gypsum) or mixing with a more sulfate dominant water have probably occurred.
- Waters dominated by precipitation (rain and snow) are limited to SW15. This is based upon the relatively low TDS concentration in the sample. Bicarbonate is the dominant anion, and this would be expected because of equilibration with carbon dioxide in the atmosphere. Cations show a slight bias towards calcium and magnesium. This indicates some reactions with carbonate minerals such as calcite, dolomite or magnesite.
- SW19 is the other “end member”. That sample is characterized by a calcium magnesium sulfate composition. There are about equal equivalents of magnesium and calcium in this sample. Nearly equal equivalents of calcium and magnesium in surface waters are not common, but reactions with clay minerals in the soils may

explain this relationship. The high TDS concentration suggests that the water has also undergone significant evapoconcentration.

SW9, SW7 and SW14 are characterized by intermediate TDS values. Their compositions are also not readily defined by the sodium carbonate, or calcium sulfate "end members". These waters appear to have more complicated origins than the CBM sources. These waters probably are true surface waters that are not as developed (evaporated) along a reaction path as SW19 has developed:

- SW9 is approximately 50% sodium (on an equivalents basis), and about 50% calcium and magnesium (equivalents). Based upon the low TDS, it probably also contains a significant amount of precipitation, this would also explain the bicarbonate dominance among the anions. It is too dilute to originate from the CBM, sodium bicarbonate dominant waters. It might be a CBM water that has undergone dilution with precipitation, but the relatively high proportion of divalent cations suggests some reactions with carbonate minerals in the soils have taken place.
- SW7 has no dominant anion, it is about 55% bicarbonate and 45% sulfate, which means it is too close to 50/50 to confidently assign a unique anion end member. Cations are dominantly calcium and magnesium. Most likely this is a surface water that originated with rainfall and has undergone some reactions with calcium sulfate (gypsum) and to a lesser extent with carbonates possibly dolomite.
- Based upon the anion proportions, SW14 is about 75% sulfate, but the cations plot close to 47% calcium and magnesium with the remainder sodium (and possibly potassium). The low TDS concentration does not support a simple mixture between the two "end member" sources of CBM water and Ca Mg sulfate dominant. The simplest explanation is that precipitation derived surface water has reacted with minerals in the soils.

Possible reactions between the waters and soils are best examined by starting with the dilute sample SW15. This near rainwater sample could react with carbonates minerals such as calcite or dolomite, and calcium sulfate (Gypsum) in these soils to produce compositions similar to SW7 or possible SW14. With further reactions, and evapoconcentration compositions similar to SW7 could eventually develop into concentrations similar to SW19.

RAI-16

Description of Deficiency

In TR Addendum 2.7B, Figure 2.7B-60, the application plots data for wells PZM-1, 3, 5, 9 &19 on a piper diagram but the tabulated data are not provided. Similarly, several wells (e.g., PZM4, 11, 12 & 13) were used to monitor water levels during pumping tests but the application did not include any water quality data for those wells.

Basis for Request

The applicant failed to include complete data or a rationale for not including the data.

Section 2.7.2 of the SRP states:

> *"Verify that a sufficient number of baseline ground-water samples are collected to provide meaningful statistics, that samples are spaced in time sufficiently to capture temporal variations, and that the chemical constituents and water quality parameters evaluated are sufficient to establish pre-operational water quality, including classes of use."*

Section 2.7.3 of the SRP states:

> *"All significant borehole data should be included in an appendix. Staff should verify that, an adequate number of boreholes is used to support the assertion of hydrogeologic unit continuity, if shown as such in the cross sections."*

Formulation of RAI

Please provide rationale for not sampling several wells (PZM-4, 11, 12 & 13) or not providing the data for several wells (e.g., wells PZM-1, 3, 5, 9 &19), even though data from those wells were included in the piper diagrams.

RAI-16 Response

AUC installed 21 Production Zone Aquifer (PZA) monitoring wells (denoted as PZM Wells) across the proposed Reno Creek Project area to evaluate the groundwater hydrology and collect baseline water quality data. Ten of the 21 PZM Wells were installed within mineralized portions of the PZA and were sampled four times (once per quarter) over a one year duration to establish baseline groundwater quality in the mineralized portion of the PZA. Several of these wells were also used as observation wells for the four regional pump tests conducted by AUC.

WDEQ/LQD Guideline 4 requires that baseline sampling wells be installed at a density of one well per square mile within the proposed project boundary. The area within the proposed boundary encompasses approximately 9.5 square miles thus the 10 baseline wells met this requirement. Guideline 4 does not discuss spatial distribution of the baseline wells; therefore, in collaboration with the WDEQ/LQD and NRC staff, the monitoring well locations were deemed sufficient to characterize the groundwater quality of the PZA.

The remaining 11 wells were installed to act as either pumping or observation wells for the four regional pump tests conducted by AUC. Eight of the 11 wells were sampled. The grouping of the wells in relation to pumping wells and observation wells is shown on Figure 2.7B-6 and discussed in the Regional Hydrologic Test Report located in Addendum 2.7-D.

Piper Diagrams were developed using 15 of the 18 sampled PZM Wells in order to characterize the regional baseline groundwater quality based on anion and cation distributions as discussed in TR Section 2.7.2.10.2. Even though all 18 wells were not used in the development of the Piper Diagrams (Figure 2.7B-60), the wells did cover the spatial extent of the baseline monitoring well program. These data were used to successfully show the continuity of the PZA, without the additional three sampled wells being incorporated in the Piper Diagrams.

Table 2.7B-31a was added to Addendum 2.7B providing the groundwater quality data collected from the eight non-baseline wells. Additionally, Table 2.7B-31b has been included in Addendum 2.7B to show the intended use for all 21 wells installed to characterize the PZA, including which wells were used to develop the Piper Diagrams.

The new tables are shown below:

Table 2.7B-31a: Non-Baseline PZA Monitoring Well Results

Parameter	Units	Lab Detection	PZM1	PZM3	PZM4		PZM5	PZM9	PZM13	PZM19	PZM20	PZM4D
Collection Date			12/15/2010	8/11/2011	12/16/2010	1/27/2011	11/2/2010	12/20/2010	12/27/2011	6/8/2011	3/10/2011	7/7/2011
Field1												
Field pH	s.u.		8.05	8.85	0.00	7.86	7.52	11.45	7.45	9.67	0.00	0.00
Field Conductivity	µmhos/cm		1266	1408	0	630	1773	1220	3606	1279	0	0
Dissolved Oxygen	mg/L		0.92	2.18	0.00	6.00	7.92	0.35	2.46	0.68	0.00	0.00
Field Turbidity	NTU		4.81	0.00	0.00	1.13	9.89	2.86	0.50	4.90	0.00	0.00
Temperature	°C		6.67	21.77	0.00	8.27	14.89	5.93	10.97	18.07	0.00	0.00
ORP	mV		63.5	207.2	0	176.7	362.1	0	232.2	28.1	0	0
Depth to Water	Ft.		291.83	300.71	0.00	148.20	65.73	291.68	0.00	157.51	0.00	0.00
Anions/Cations												
Alkalinity, Total (As CaCO3)	mg/L	5	75	127	144	145	238	80	119	94	98	0
Alkalinity, Bicarbonate as HCO3	mg/L	5	92	155	175	174	291	<5	145	115	120	0
Alkalinty, Carbonate as CO3	mg/L	5	<5	<5	<5	<5	<5	40	<5	<5	<5	0
Chloride	mg/L	1	6	5	3	3	15	0.1	5	4	3	0
Flouride	mg/L	0.1	<0.1	<0.1	<0.1	<0.1	0.6	<0.1	<0.1	<0.1	<0.1	0
Nitrogen, Nitrate-Nitrite (as N)	mg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0
Sulfate	mg/L	1	913	546	329	330	32	754	2400	541	512	0
Calcium	mg/L	1	100	77	61	66	17	113	526	92	89	0
Magnesium	mg/L	1	23	16	13	14	3	5	102	18	16	0
Potassium	mg/L	1	8	10	6	6	9	21	15	9	8	0
Sodium	mg/L	1	321	227	125	128	109	266	325	171	172	0
Nitrogen, Ammonia (As N)	mg/L	0.1	<0.1	2	<0.1	<0.1	0.8	0.3	0.5	<0.1	<0.1	0
Silica as SiO2	mg/L	1	10	11	10	10	13	4	12	10	9	0
General Parameters												
Laboratory pH	s.u.	0.1	8	8.2	7.9	8.3	8.2	10.7	7.9	7.9	8.2	8.7
Electrical Conductivity	µmhos/cm	5	1790	1480	906	916	579	1720	3110	1070	1180	0
Total Dissolved Solids (180)	mg/L	10	1500	1020	640	690	420	1340	3580	950	920	640
Data Quality												
Cation Sum	meq/L	0.01	21.06	15.29	9.74	10.22	6.05	18.19	49.15	13.7	13.37	0
Anion Sum	meq/L	0.01	21.28	14.06	9.8	10	5.86	17.48	52.53	13.25	12.72	0
Cation-Anion Balance (±5%)	%	0.01	0.53	4.2	0.29	1.08	1.56	1.97	3.32	1.67	2.5	0
Solids, Total Dissolved (Calc)	mg/L	10	1430	970	620	630	330	1210	3460	890	860	0
Calculated TDS/TDS Ratio (0.80-1.20)	dec. %	0.01	0	1.05	0	1.1	0	0	1.03	1.07	1.07	0
Metals-Dissolved												
Aluminum	mg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0
Arsenic	mg/L	0.001	0.002	0.006	<0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	0
Barium	mg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0
Boron	mg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0
Cadmium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0
Chromium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0
Copper	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0
Iron	mg/L	0.05	0.07	<0.05	<0.05	<0.05	0.07	<0.05	0.37	<0.05	<0.05	0
Lead	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0
Manganese	mg/L	0.01	0.08	0.06	0.03	0.03	0.06	<0.01	0.42	0.11	0.06	0
Mercury	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0
Molybdenum	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	0
Nickel	mg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0
Selenium	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0
Uranium	mg/L	0.0003	0.0047	0.016	0.0638	0.0819	0.0018	0.003	<0.0003	0.0418	0.0922	0
Vanadium	mg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0
Zinc	mg/L	0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0
Metals-Suspended	mg/L											
Uranium	mg/L	0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	0.0006	<0.0003	0.0004	<0.0003	<0.0003
Metals-Total	mg/L											
Iron	mg/L	0.05	0.31	2.79	0.54	0.13	0.24	0.06	1.11	0.76	0.07	0
Manganese	mg/L	0.01	0.1	0.11	0.03	0.04	0.07	<0.01	0.48	0.12	0.06	0
Radionuclides-Dissolved												
Gross Alpha	pCi/L	4	42	28.9	52.1	78.6	3.4	186	2	35.5	63.9	0
Gross Beta	pCi/L	7	25.3	10	19.6	25.8	6	70.8	7.6	19.3	45.2	0
Lead 210	pCi/L	1	4.8	<1	4.5	3	1.5	5.6	0	1.3	<1	0
Polonium 210	pCi/L	1	2.7	<1	<1	<1	<1	1.3	0	<1	<1	0
Radium 226	pCi/L	0.2	23.5	3.1	2.5	7.9	0.282	107	0.3	1.4	1.3	.7
Radium 228	pCi/L	1	1.5	<1	<1	<1	1.35	1.4	5.2	1.4	<1	0
Thorium 230	pCi/L	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0	<0.2	<0.2	0
Radionuclides-Suspended	pCi/L											
Lead 210	pCi/L	1	5.8	1.5	5	15.4	1.3	8.1	0	<1	<1	0
Polonium 210	pCi/L	1	<1	<1	1.1	<1	<1	<1	0	<1	<1	0
Radium 226	pCi/L	0.2	0.3	<0.2	<0.2	7.9	<0.2	0.7	0	<0.2	<0.2	0
Thorium 230	pCi/L	0.2	0.3	<0.2	<0.2	<0.2	<0.2	<0.2	0	<0.2	<0.2	0
Radionuclides-Total	pCi/L											
Radon 222	pCi/L	50	11900	8460	0	67300	2150	38600	22900	396	2690	0

Table 2.7B-31b: PZA Monitoring Well Information

Monitoring Well ID	Monitoring Well Uses					
	PZA Baseline Monitoring Wells (TR Table 2.7B-31)	Hydrologic Pump Test Wells	PZA Pump Test Observation Wells	Non-Baseline PZA Monitoring Wells Sampled	PZA Monitoring Wells plotted on Piper Diagram (TR Figure 2.7B-60)	PZA Monitoring Wells not plotted on Piper Diagram (TR Figure 2.7B-60)
PZM-1		x		x	x	
PZM-2	x				x	
PZM-3		x		x	x	
PZM-4			x	x		x
PZM-4D		x		x		x
PZM-5		x		x	x	
PZM-6	x		x		x	
PZM-7	x				x	
PZM-8	x		x		x	
PZM-9			x	x	x	
PZM-10	x		x		x	
PZM-11			x			x
PZM-12			x			x
PZM-13			x			x
PZM-14	x		x		x	
PZM-15	x		x		x	
PZM-16	x		x		x	
PZM-17	x		x		x	
PZM-18	x		x		x	
PZM-19			x	x	x	
PZM-20			x	x		x
Total	**10**	**4**	**15**	**8**	**15**	**6**

RAI-17

Description of Deficiency

In TR Addendum 2.7B, Figure 2.7B-65, the application includes a piper diagram for the historical groundwater quality (previous R&D and application) but did not provide any tabulated data for staff to verify.

Basis for Request

Same as RAI 16.

Formulation of RAI

Please provide a summary table of historical groundwater quality used to construct the piper diagram (Figure 2.7B-65).

RAI-17 Response

The following table provides a summary of historical groundwater quality used to construct the piper diagrams presented in Figure 2.7B-65.

WELL	Unit	Date	Water Levels	Ca	Mg	Na	K	Cl	SO4	HCO3	CO3	pH	Conductance	Temp °C	TDS	Hardness as CaCO3	Alkalinity as CaCO3	Al	Fe	Mn	NH3	U	226Ra pCi/L	230Th pCi/L
RI 1	PZA	4/30/1979	4970.3	108		115	10	10	330		12	11.5	1535		792	270	170	0.16	0.02	0.01	0.12	0.004	3.3	0.9
RI 1		5/12/1979	4970.3	88	17	240	11	34	690	5.8	24	9.7	1395		1118	290	16	0.66	0.13	0	0.1	0.25		
RI 1		5/18/1979	4969.8	96		136	9	12	422		5	11.2	1325		700		100	0.17	0.01	0.01	0.15	0.02		
RI 1		6/25/1979	4969.5	87		120	9	14	367				1138		704				0.26	0.08		0.003		
RI 1		7/19/1979	4969.4	88		135	9	10	432	8	14	10	1065		733	220	76		0.19	0.01		0.003	4.2	0.5
RI 1		7/17/1979	4975.6	62		213		16	646	92		9	1228		1000				0	0.05	0	0		
RI 1		6/23/1993	4975.1	79	7	129	4.6	4.6	435	120			1058	11.5	705		98	0				0.02	3.3	
RI 2	PZA	5/14/1978	4976.9	88	25		7	16	670	117	0	8.1	1355		1100	323	35	0	0.04	0.06	0.16	0.006		
RI 2		4/30/1979		108	68	20	9	10	600			7.4	1580		1422	870	280	0.43	0.16	0.09	0.12	0.004	3.5	0.9
RI 2		5/18/1979		249	68	11	8	8	605			7.2	1595		1150	980	342	0	2.3	0.23	0.3	0.0023		
RI 2		6/25/1979		224	63	35	9	0.12	633	254			1495		1190				1.6	0.14		0.002		
RI 2		7/19/1979	4979.5	257	63	77	8	10	765	342	0	7.6	1525		1522	980	280		1.7	0.2		0.001	2	0.5
RI 2		6/24/1993	4979.4	260	63	50	7.5	4.6	770	367	0	7.2	1684	11	1340		301	0	1.6	0.13	0.2	0.0003	1.1	
RI 3	PZA	5/17/1978	4951.03	99	22	218	8	10	710		34	9.4	1220		1150	338	25	0.2	0.34	0.02	0.64	0.24		
RI 3		4/30/1979	4951.2	108	24	155	8	10	504	183		7.9	1325		1028	350	150	0.04	0.02	0.05	0	0.02		0.9
RI 3		5/18/1979	4950.7	96	32	138	7	8	490	176		8	1355		885	370	144	0.01	0.03	0.06	0.17	0.01	8.7	
RI 3		6/25/1979	4956.1	96	27	150	7	10	517	161			1310		942				0.02	0.04		0.02		
RI 3		7/19/1979	4955.7		22	135	9		584	181		7.6	1320		1044	370	148		0.11	0.04		0.008	7.7	0.9
RI 3		6/22/1993	4951	140	26	198	5.8	2.6	761	187	0	7.2	1604	13	1120		153	0	0.14	0.09	0	0.01	9.5	
RI 4	PZA	5/18/1978	4912.7	88	17	210	14	8	700		19	9.7	1410		1124	380	16	0	0.21	0.8	0.1	0.17		
RI 4		8/28/1978	4922.4	60	20	170	22	42	368	244	10	8.2	915		773	230	200	0	0.14	0.05	0	0.09		
RI 4		4/30/1979	4922.5	60	17	155	9	12	290			7.8	1105		780	220	230		0.29	0.54		0.02		
RI 4		5/17/1979	4922.6	66		153	7	12	324	244		8.2			730	212	200		0.32	0.31		0.04		
RI 4		6/25/1979	4922.6	60	15	160	8	14	326	239			1006		722				0.24	0.29		0.03		
RI 4		7/20/1979	4936.9	60	15	170	7	14	370	244		7.8	1045		815	210	185		0.42	0.26		0.03	99	
RI 4		6/22/1993	4937.8	67	39	178	4	30	503	181		7.2	1358	13.5	931		148	0	0.71	0.48	0.06	0.03	32	
RI 5	PZA	4/23/1979	4936.5	96	27	220	8	12	650	134		7.9	1755		1095	351	110		4.1	0.15		0.008		
RI 5		5/11/1979	4936.5	108	20	256	7	12		107	0	7.9	1830		1230	38	88		0.01	0.04		0.01		
RI 5		6/25/1979	4936.5	100	22	245	8	16	715	117			1785		1220				4.5	2.6		0.003		
RI 5		7/20/1979	4936.05	104	22	280	8	14	840	107	0	7.9	1720		1344	350	88		0.14	0.06		0.008	18.5	1.1
RI 5		10/6/1979	4937.9	103	28	332	9	12	950	122	0	7.9	1750		1494	372	100	0	0.14	0.03	0	0		
RI 5		7/8/1982	4938	93		263		20	708	105		7.6	1400		1475				0	0.1	0	0		

WELL	Unit	Date	Water Levels	Ca	Mg	Na	K	Cl	SO4	HCO3	CO3	pH	Conductance	Temp °C	TDS	Hardness as CaCO3	Alkalinity as CaCO3	Al	Fe	Mn	NH3	U	226Ra pCi/L	230Th pCi/L
RI 5		6/29/1993	4937.8	103	22	277	5.1	10.9	826	107	0	6.9	1863	14	1339		87	0				0.006	17.6	
RI 6	PZA	8/28/1978	4844.8	132	29	259	10	14	850	112	0	7.9	1450		1461	450	92	0	0.13	0.09	0	0.18		
RI 6		3/22/1979	4844.8	119	27	213	7	12	755	107	0	8	1610		1536	408	88	0.05	0.42	0.08	0.14	0.08	240	4.8
RI 6		5/15/1979	4844.7	116	29	220	7	12	745	107		7.9	1845		1172	410	88	0.1	1.5	0.14		0.04		
RI 6		6/25/1979	4847.3	120	24	250	8	18		107			1845		1307				0.33	0.05		0.05		
RI 6		7/24/1979	4847.4	120	27	295	8		920	107		7.8	1775		1452	410	88		0	0.06	0	0.02	224	3.4
RI 6		6/29/1993	4847.1	119	25	275	4.8	9.2	909	113	0	6.9	1911	14	1385		92			0.05		0.02	136	
RI 7	PZA	3/22/1979	4955.6	31	7	180	5	24	55	503	0	8.1	895		759	104	412	0.18	0.54	0.04	0	0.04	4.3	0
RI 7		5/15/1979	4955.4	32	7	189	5	20	25	566		8.1	955		570	108	464	0.79	0.94	0.02	0.2	0.004		
RI 7		6/25/1979	4964.5	32	5	190	6	22	26	561		7.9	920		593			0.02	0.08	0.06		0.01		
RI 7		7/24/1979	4963.8	30	7	200	6	18	38	556	0	7.8	900		668	104	456		0.21	0.03		0.002	3.9	0.4
RI 7		6/30/1993		41	9.7	200	3.3	4.8	56	578	0	8.1	963	17	569		474	0.1	0	0.02	0	0.0003	3.9	
RI 13	PZA	3/22/1979	4969.6	151	75	512	14	40	1500	244	0	6.7	2275		1425	685	200	0.18	0.11	0.38	0.9	1.1	0	0
RI 14	PZA	4/23/1979		108	20	270	8	12	514	464	0	7.8	1840		1323	220	380	2.8	0.23	0.22	0	0.009	4.2	0.9
RI 14		5/16/1979		120	20	260	7	10	525	468	0	7.7	1845		1170	380	348	0.9	2.9	0.63	0.14	0.007		
RI 14		6/25/1979		116	20	290	7	10	565	459	0				1302				0.35	0.83		0.02		
RI 24U	OA	7/11/1982	5034.7	118		183		26	519	154		8	1120		960							0.03		
RI 24U		6/22/1993	5065.5	94	12	154	3.4	6.6	233	375	0	7.4	885	13	689		307	0	0	0.16	0.1	0.1	1.6	1.6
RI 24U		8/19/1993	5059.6											11										
RI 25U	OA	6/23/1993	5039.9	260	87	114	7.5	7.3	1004	295	0	7.4	2159	10.5	1795		242	0	0	0.48	0.31	0.1	2.1	
			5035.3											11.7										
RI 28	PZA	7/14/1982	4964.8	92	0	118	0	12	402	214	0	7.7	1080									0.15		
RI 30U	OA	7/13/1982	5027.5	252		55		16	660	288		7.7	1395		1425									
RI 30U		6/24/1993	5030.05	338	84	55	7.6	5.3	1042	328	0	7.2	2079	10.5	1745		269	0	0.1	0.12	0.12	0.002	1.1	
RI 30U		8/19/1993	5031.3											11								0.0003		
RI 38U	OA	7/16/1982	4987.7	146	0	109	0	21	518	150	0	7.6	1320									0.02		

- Units: mg/L
- pH: standard units
- Unit: PZA = Production Zone Aquifer; OA = Overlying Aquifer
- Heavy metals not detected: Ag, Cd, Cr, Cu, Pb, Hg, Mo, Ni, Se, V, Zn
- Conductance as micromhos/cm: this would be unit used at the time most samples were collected
- No underlying aquifers reported

RAI-18

Description of Deficiency

In TR Addendum 2.7B, the application did not include well completion details for well UM3R in Table 2.7B-1.

Basis for Request

Same as RAI 16

Formulation of RAI

Please provide well completion details for well UM3R in Table 2.7B-1.

RAI-18 Response

AUC has updated Table 2.7B-1 to include the well completion details for UM3R. The updated table is shown below:

Well ID	Screened Aquifer Zone	UTM Easting (m)	UTM Northing (m)	TOC Elev (ft amsl)	Ground Surf Elev (ft amsl)	Casing Material	Casing Nominal ID (in)	Casing Nominal OD (in)	Casing Depth (ft)	Annular Seal Material	Grount Weight (lbs/gal)	Top of Filter Pack (ft)	Top of Screen (ft)	Bottom of Screen (ft)	Ream Bit Diameter (in)	Total Ream Depth (ft)	Screen O.D. (in)	Screen type	Screen Diameter (in)	Screen slot size (in)
SM3	Water Table	448983.47	4834242.53	5260.94	5258.24	SCH 40 PVC belled glue joint	4	4.5	50	Cement w/ bentonite	14.3	44	50	80	8.75	80	4.5	Factory Slot PVC	4	0.03
SM5	Water Table	444508.65	4833523.55	5115.90	5114.20	SCH 40 PVC belled glue joint	4	4.5	30	Cement w/ bentonite	14.2	24	30	50	8.75	50	4.5	Factory Slot PVC	4	0.03
SM6	Water Table	443806.22	4833944.88	5183.20	5180.40	SCH 40 PVC belled glue joint	4	4.5	60	Cement w/ bentonite	14.3	54	60	80	8.75	80	4.5	Factory Slot PVC	4	0.03
SM7	Water Table	445099.77	4832403.42	5176.73	5174.23	SCH 40 PVC belled glue joint	4	4.5	55	Cement w/ bentonite	14.2	50	55	75	8.75	78	4.5	Factory Slot PVC	4	0.03
OM1	Overlying	450012.64	4835767.75	5229.94	5227.44	SDR 17 PVC spline and groove	4.5	4.95	190.5	Cement w/ bentonite	14.5	182	191	211	9	211	4.95	Factory Slot PVC	4.5	0.03
OM2	Overlying	449474.19	4834655.12	5258.68	5256.38	SDR 17 PVC spline and groove	4.5	4.95	201	Cement w/ bentonite	14.4	na	201	221	8.75	211	3.5	Factory Slot PVC	3	0.03
OM3	Overlying	448966.40	4834246.63	5262.27	5259.97	SDR 17 PVC spline and groove	4.5	4.95	150	Cement w/ bentonite	14.2	na	150	170	8.75	160	3.5	Factory Slot PVC	3	0.03
OM4	Overlying	446885.57	4835402.26	5118.72	5116.02	SDR 17 PVC spline and groove	4.5	4.95	157	Cement w/ bentonite	14.5	151	157	177	9	180	4.95	Factory Slot PVC	4.5	0.03
OM5	Overlying	444509.29	4833511.60	5115.94	5113.34	SDR 17 PVC spline and groove	4.5	4.95	69	Cement w/ bentonite	14.5	64	69	84	9	84	4.95	Factory Slot PVC	4.5	0.03
OM6	Overlying	443799.99	4833933.40	5185.60	5182.70	SDR 17 PVC spline and groove	4.5	4.95	227	Cement w/ bentonite	14.5	219	227	237	9	238	4.95	Factory Slot PVC	4.5	0.03
OM7	Overlying	445114.05	4832384.84	5176.20	5173.50	SDR 17 PVC spline and groove	4.5	4.95	130	Cement w/ bentonite	14.5	na	130	150	8.75	140	3.5	Factory Slot PVC	3	0.03
OAM4D	Over Aquitard (L. Felix)	446891.37	4835418.40	5121.19	5118.29	SCH 40 PVC belled glue joint	4	4.5	201	Cement w/ bentonite	13.1	198	201	206	8.75	208	4.5	Factory Slot PVC	4	0.03
OAM4S	Over Aquitard (U. Felix)	446875.72	4835417.14	5119.30	5117.10	SCH 40 PVC belled glue joint	4	4.5	191	Cement w/ bentonite	13.1	na	191	194	8.75	196	4.5	Factory Slot PVC	4	0.03
PZM4	U. Production Zone	446880.12	4835407.82	5118.83	5116.03	SDR 17 PVC spline and groove	5	5.563	235	Cement w/ bentonite	14.3	na	235	255	9.875	266	3.5	Factory Slot PVC	3	0.03
PZM1	Production Zone	450020.53	4835774.59	5230.87	5228.77	SDR 17 PVC spline and groove	5	5.563	354	Cement w/ bentonite	14.4	288	354	384	9.875	384	6.078	W.O.P PVC	5	0.03
PZM10	Production Zone	449950.24	4835761.90	5228.64	5225.84	SDR 17 PVC spline and groove	4.5	4.95	300	Cement w/ bentonite	14.5	295	300	320	9	320	4.95	Factory Slot PVC	4.5	0.03
PZM11	Production Zone	448993.33	4834253.77	5257.53	5255.23	SDR 17 PVC spline and groove	4.5	4.95	365	Cement w/ bentonite	14.3	na	365	385	8.75	385	3.5	Factory Slot PVC	3	0.03
PZM12	Production Zone	448959.27	4834227.03	5257.94	5255.44	SDR 17 PVC spline and groove	4.5	4.95	370	Cement w/ bentonite	14.3	na	370	390	8.75	390	3.5	Factory Slot PVC	3	0.03
PZM13	Production Zone	448934.25	4834294.74	5260.51	5258.19	SDR 17 PVC spline and groove	4.5	4.95	357	Cement w/ bentonite	14.3	na	357	377	8.75	377	3.5	Factory Slot PVC	3	0.02
PZM14	Production Zone	448631.93	4836132.02	5146.36	5143.86	SDR 17 PVC spline and groove	4.5	4.95	327	Cement w/ bentonite	14.5	319	327	347	9	347	4.95	Factory Slot PVC	4.5	0.03
PZM15	Production Zone	447426.65	4835456.68	5189.17	5186.77	SDR 17 PVC spline and groove	4.5	4.95	420	Cement w/ bentonite	14.5	403	420	440	9	443	4.95	Factory Slot PVC	4.5	0.03
PZM16	Production Zone	446868.00	4835031.05	5112.56	5109.76	SDR 17 PVC spline and groove	4.5	4.95	295	Cement w/ bentonite	14.5	277	295	315	9	318	4.95	Factory Slot PVC	4.5	0.03
PZM17	Production Zone	446292.35	4834801.05	5104.46	5101.62	SDR 17 PVC spline and groove	4.5	4.95	296	Cement w/ bentonite	14.5	289	296	316	9	319	4.95	Factory Slot PVC	4.5	0.03
PZM18	Production Zone	444551.66	4834153.18	5142.89	5139.99	SDR 17 PVC spline and groove	4.5	4.95	250	Cement w/ bentonite	14.5	243	250	270	9	270	4.95	Factory Slot PVC	4.5	0.03
PZM19	Production Zone	444531.96	4833837.72	5140.41	5137.51	SDR 17 PVC spline and groove	4.5	4.95	312	Cement w/ bentonite	14.4	306	312	332	9	335	4.95	Factory Slot PVC	4.5	0.03
PZM20	Production Zone	444386.76	4833621.39	5138.49	5135.69	SDR 17 PVC spline and groove	5	5.563	312	Cement w/ bentonite	14.5	na	312	332	9.875	312	4.5	Factory Slot PVC	4	0.03
PZM3	Production Zone	448977.53	4834252.22	5261.99	5259.64	SDR 17 PVC spline and groove	5	5.563	372	Cement w/ bentonite	14.3	285	372	412	9.875	415	6.025	W.O.P PVC	5	0.03
PZM5	Production Zone	444500.11	4833519.92	5115.12	5113.22	SDR 17 PVC spline and groove	5	5.563	260	Cement w/ bentonite	14.6	182	260	330	9.875	331	5.75	W.O.P PVC	5	0.03
PZM6	Production Zone	443796.94	4833944.84	5184.59	5181.79	SDR 17 PVC spline and groove	4.5	4.95	335	Cement w/ bentonite	14.5	329	335	355	9.875	359	4.95	Factory Slot PVC	4.5	0.03
PZM7	Production Zone	445114.61	4832395.37	5176.66	5173.76	SDR 17 PVC spline and groove	4.5	4.95	298	Cement w/ bentonite	14.3	na	298	318	8.75	309	3.5	Factory Slot PVC	3	0.03
PZM8	Production Zone	450025.08	4835750.34	5227.18	5224.38	SDR 17 PVC spline and groove	4.5	4.95	305	Cement w/ bentonite	14.5	288	305	340	9	340	4.95	Factory Slot PVC	4.5	0.03
PZM9	Production Zone	450033.27	4835786.67	5230.71	5228.31	SDR 17 PVC spline and groove	4.5	4.95	310	Cement w/ bentonite	14.6	304	310	330	9	330	4.95	Factory Slot PVC	4.5	0.03
PZM2	L. Production Zone	449471.85	4834673.21	5257.39	5255.19	SDR 17 PVC spline and groove	4.5	4.95	350	Cement w/ bentonite	14.4	na	350	370	8.75	360	3.5	Factory Slot PVC	3	0.03
PZM4D	L. Production Zone	446888.05	4835423.13	5120.47	5118.47	SDR 17 PVC spline and groove	4.5	4.95	311	Cement w/ bentonite	14.3	na	311	371	9	325	3.5	W.O.P PVC	3	0.03
UM1	Underlying	450018.14	4835759.96	5228.51	5226.01	SDR 17 PVC spline and groove	4.5	4.95	430	Cement w/ bentonite	14.4	420	430	450	9	450	4.95	Factory Slot PVC	4.5	0.03
UM2	Underlying	449467.36	4834656.74	5259.45	5256.95	SDR 17 PVC spline and groove	4.5	4.95	423	Cement w/ bentonite	14.3	na	423	443	8.75	433	3.5	Factory Slot PVC	3	0.03
UM3R	Underlying	448972.62	4834234.57	5260.88	5258.28	SDR 17 PVC spline and groove	4.5	4.95	459	Cement w/ bentonite	14.3	na	459	479	8.75	480	3.5	Factory Slot PVC	3	0.03
UM4	Underlying	446885.23	4835413.09	5120.17	5117.67	SDR 17 PVC spline and groove	4.5	4.95	410	Cement w/ bentonite	14.5	404	410	430	9	434	4.95	Factory Slot PVC	4.5	0.03
UM5	Underlying	444499.68	4833529.21	5116.67	5113.67	SDR 17 PVC spline and groove	4.5	4.95	424	Cement w/ bentonite	14.4	418	424	444	9	445	4.95	Factory Slot PVC	4.5	0.03
UM6	Underlying	443796.29	4833954.10	5183.46	5181.06	SDR 17 PVC spline and groove	4.5	4.95	415	Cement w/ bentonite	14.5	NA	415	435	9	435	4.95	Factory Slot PVC	4.5	0.03
UM7	Underlying	445114.00	4832405.15	5176.66	5174.06	SDR 17 PVC spline and groove	4.5	4.95	385	Cement w/ bentonite	14.3	na	385	405	8.75	405	3.5	Factory Slot PVC	3	0.03

RAI-19

Description of Deficiency

Section 2.7 of the TR includes:

(1) A summary of water quality at nearby, privately owned, livestock and domestic water supply wells (Table 2.7B-38);

(2) A summary of wells sampled (2.7B-37);

(3) A summary of groundwater rights within a two-mile buffer (Table 2.7B-18); and

(4) A narrative description of water supply wells located within:

  (i) The project (15 groundwater rights including 6 rights cancel, 8 rights for livestock use and 1 right for domestic use),

  (ii) Two miles of the project (29 rights including stock, domestic, miscellaneous and industrial usage), and

  (iii) Three miles of the project (69 rights without any further delineation).

The reported summary of water quality is for 14 locations, 6 locations within the project and 9 locations outside of the project. The reported summary of sampling locations includes 15 locations. The applicant did not provide any discussion of the water quality of the sampled wells in Section 2.7 of the application.

In Section 2.9.8, the applicant summarizes recommendations in Regulatory Guide 4.14 for a monitoring program that consists of one well upgradient and three wells downgradient of the tailings area. The applicant further states that because no tailings impoundments are proposed, the Regulatory Guidance 4.14, Revision 1, "Radiological Effluent and Environmental Monitoring at Uranium Mills", recommendations "ha[ve] been interpreted and adapted by AUC." The applicant then summarizes the detected levels of various radionuclides in Tables 2.9-16 through Table 2.9-21, and the baseline radiological sampling locations in Figure 2.9-1. The reported radiological analytical parameters consist of Radium-226, Polonium-210, Thorium-230, Lead210, uranium and Radon-222. Based on tables in Section 2.9, the number of samples reportedly analyzed for the baseline radiological program varied from 6 to 17 locations and only during the fall of 2010. For Radium-226, the locations include 3 privately owned wells, 9 on-site monitoring wells, 5 locations with the Sample Name not depicted on Figure 2.9-1 or discussed in the narrative.

In Appendix 2.9-A, the applicant includes a sampling and analysis plan which includes groundwater sampling and analysis. Based on the plan, its objective is to describe programs and procedures for obtaining baseline radiological data. For groundwater *sampling, the plan notes recommendations of Regulatory Guide 4.14 to monitor existing domestic, livestock or irrigation wells within two kilometers of the tailings area, and one well upgradient and three wells downgradient of the tailings area. The plan states that the baseline monitoring included wells within a two-kilometer radius of the project boundary and then provides a confusing discussion on the details. For one sentence, "[w]hile there are six wells within the two km sample requirement, these resources will likely be analyzed in the baseline study", staff is interpreting the meaning of this sentence that the six wells refer to those reported in the application for six locations (GW2, GW3, GW6, GW10, GW12 & GW14) and not a commitment for additional six wells. For the next sentence, "[i]n addition to wells within two km outside the Proposed Project area, there are 14 baseline stock/domestic wells sampled", staff is interpreting the meaning of this sentence as the 14 privately owned wells (both inside and outside of the project) as reported in Table 2.7B-38. Finally, the application includes the following sentence "[i]nside of the Proposed Project area, seven monitoring well clusters with a total of 39 wells have been installed for characterizing the up-gradient and down-gradient flow from the locations of the proposed CPP and backup pond", which the staff is interpreting refers to the wells sampled for site characterization in Section 2.7. The plan also states that the analytical parameters consist of uranium (dissolved), Radium-226, gross alpha and gross beta.*

In Section 5.7.8.1 of the application, the applicant states that the all private wells used for drinking water, livestock watering or crop irrigation within two kilometers of the wellfield area boundary will be sampled for baseline values and during operations for parameters identified in Regulatory Guide 4.14 Table 2. The applicant does not provide a listing of wells that meet that criterion or a figure showing the extent of the area.

Basis for Request

The presentation of data for the pre-operational and operational groundwater monitoring program is unclear and appears to be inaccurate due to:

1. *(1) Errors in the tables listed below;*
2. *(2) Conflicting information among various sections of the application;*
3. *(3) Lack of commitments regarding implementation of the environmental monitoring program.*

Staff has identified the following issues:

<u>Summary of Errors</u>

Table 2.7B-37

- *GW8 is listed but the summary data and location are not shown elsewhere.*
- *For GW15, the location lists Range 72 but figure 2.9-1 depicts it in Range 74. Furthermore, Permit P18852P is not listed in Table 2.7B-18.*
- *No location is listed for GW12, GW-14 and GW17; however, the sampling locations were deduced from Figure 2.9-1.*

Tables 2.9-16 through -21

- *The table number is incorrect for several tables (e.g., Table 2.9-16 is listed as Table 2.91)*
- *The table lists the sample names PZM5-PT1, PZM5b, TAF1, TAF2 & PRI1, but the locations are not shown on any figure or descriptions in the application.*

Conflicting Information

As noted in the above summary, the application includes conflicting information in various sections of the application, which, as presently constructed, would not lead to a staff sufficiency finding. For example, the analytical parameters in Appendix 2.9-A lists uranium (dissolved), Radium-226, gross alpha and gross beta whereas Tables 2.9-16 through 2.9-21 list Radium-226 (dissolved and suspended), Polonium-210 (dissolved and suspended), Thorium-230 (dissolved and suspended), Lead-210 (dissolved and suspended), uranium (natural) (dissolved and suspended), and radon (not specified as dissolved), or Regulatory Guide 4.14 Table 2, which the applicant commits to in Section 5.7.8.1 of the application, lists dissolved and suspended natural uranium, Radium-226, Thorium-230, Lead-210 and Polonium-210 (staff notes that the dissolved and suspended components are applicable to each radionuclide). The other conflicting information is that the number of wells identified to be sampled differs among various sections of the application.

Lack of Commitment

While the applicant commits to an operational monitoring program that includes the nearby private wells in Section 5.7.8.1, staff is unsure which wells currently are within two kilometers of the proposed project area fulfills that requirement). Furthermore, staff requires applicant's commitments that all wells meeting the established criteria (i.e., within two kilometers of the proposed project area) are sampled as part of the preoperational monitoring prior to the start of operations.

Inadequate Program

The applicant stated its effluent and environmental program is based on its evaluation of *guidance in Regulatory Guide 4.14. However, the applicant inappropriately combines two types of programs listed in Regulatory Guide 4.14 as a single environmental monitoring program. The first program identified consists of one well upgradient and three wells downgradient of the tailings impoundment. It is defined as a specific groundwater protection detection program designed to monitor a leak from the regulated surface impoundment. This program as identified in Regulatory Guide 4.14 has been superseded by 10 CFR Part 40 Appendix A Criterion 5 (promulgated after Regulatory Guide 4.14). Furthermore, though these regulations discuss "tailings impoundments", staff applies them to all surface impoundments that are designed to contain solid or liquid byproduct material for ISR purposes.*

The second program identified by the applicant is the operational environmental monitoring program which includes the nearby privately owned wells. Based on the recently issued licenses, staff adapts or modifies the recommendations in Regulatory Guide 4.14 of the "2 kilometer of the tailings disposal area" to "2 kilometers of the well perimeter ring" for ISR facilities. The applicant will have to clearly commit to a similar environmental monitoring program.

Formulation of RAI

(a) Please correct errors noted above in the tables and text.

(b) Please correct inconsistencies noted above in the various sections of the application.

(c) Please provide a map depicting the 2-kilometer area (or other proposed area with justification for staff's consideration) for the environmental monitoring program, including all wells that are or could be a water supply, livestock domestic water supply or irrigation well regardless of the state permit use status.

(d) Please provide a summary table of wells sampled for the pre-operational (baseline) environmental monitoring program. If a well was not sampled and located within the distance criteria, please provide the rationale or justification for not sampling the well.

(e) Please provide a description and location of all samples included in the pre-operational environmental monitoring program.

(f) If GW7, GW12 and GW14 are not groundwater use permit numbers identified as P110428W, P165695W or P188488P, respectively, please provide the rationale or justification why those wells are not included in the pre-operational environmental monitoring program.

(g) *Please provide rationale for including only a selected number of wells in the pre-operational environmental monitoring program and only one sampling event for each location.*

(h) *Please provide a commitment that, if all wells in the pre-operational monitoring program have not been sampled, they will be sampled prior to operations.*

(i) *Please provide a summary table of pre-operational environmental monitoring program parameters and rationale for modification from those parameters recommended in Regulatory Guide 4.14 for staff's consideration.*

(j) *Please provide a commitment to perform reviews on an annual basis for new wells that may be installed in the future in the area of the environmental monitoring.*

(k) *Please provide a rationale or justification for continued use of monitoring wells or stock wells (specifically wells for groundwater use permits P2883P and P33284W) if those wells are located in the within an area of influence of a wellfield and the screened horizon spans over more of the ore zone aquifer than the targeted horizon.*

(l) *Please provide design details for and a commitment to install a groundwater protection monitoring program compliant with Criterion 7A of Appendix A, 10 CFR Part 40, for the surface impoundment (backup ponds)*

RAI-19(a) Response

The following tables have been revised as follows:

Table 2.7B-37

- The location of GW8 has been added to Figure 2.9-1 and other applicable figures within the application. The figure in question has been revised per other reviewer comments and is provided in RAI-20.
- The erroneous public land survey (PLS) description for GW15 has been revised to be consistent with its location on Figure 2.9-1.
- The water right attributed to GW15, was incorrectly listed and revised to P127251.0W.
- AUC confirmed water right P11852P was omitted from Table 2.7B-18 and revised accordingly. Figure 2.7B-58 has also been updated to display the water right in question as shown in the RAI-19(c) response.
- The PLS description for GW12, GW-14 and GW17 have been added to the table and are consistent the locations depicted on Figure 2.9-1.

Tables 2.9-16 through-23

AUC recognizes how the conflicting information presented in the tables may have caused confusion. The tables in question presented excerpts from a more comprehensive water resource analytical data set found in Addendum 2.7A and 2.7B. As a result, AUC has elected to remove Tables 2.9-16 through 2.9-23 from TR Section 2.9. Section text and table references have been revised accordingly.

Table 2.7B-37: Stock/Domestic Water Supply Wells

Well ID	WSEO Permit	Total Depth (ft)	Use	Legal Location (Tns-Rng-Sec-¼¼)	1Q	2Q	3Q	4Q
GW1	P2883P	80	Stock	43-73-28-NENW	6/15/2011	8/17/2011	10/19/2011	1/11/2012
GW2	P2882P	205	Stock	43-73-26-SWNW	9/29/2010	8/17/2011	10/19/2011	1/11/2012
GW3	Unknown	Unknown	Stock	43-73-26-NWSE	9/29/2010	8/17/2011	10/19/2011	1/10/2012
GW4	Unknown	Unknown	Stock	43-73-34-NWNW	6/30/2011	8/17/2011	10/19/2011	1/10/2012
GW5	P18841P	300	Stock	43-73-32-SWSW	9/29/2010	8/17/2011	10/19/2011	Not Operating
GW6	P174588W	400	Stock	43-73-30-SWNW	9/29/2010	8/17/2011	10/18/2011	Not Operating
GW7	P110428W	354	Domestic	42-74-1-SENE	9/29/2010	8/18/2011	10/13/2011	1/10/2012
GW8	Unknown	380	Stock	43-73-29-NWSW	9/29/2010	Not Operating	Not Operating	Not Operating
GW9	P33284W	378	Stock	42-73-6-SENW	6/30/2011	8/17/2011	10/18/2011	1/11/2012
GW10	P127147W	276	Stock	42-73-5-NWSW	12/27/2011	3/6/2012	5/8/2012	7/3/2012
GW11	P2881P	90	Stock	43-73-32-NWNE	12/28/2011	Not Operating	5/8/2012	7/3/2012
GW12	P165695W	243	Domestic	43-73-25-SWNW	12/27/2011	3/6/2012	5/8/2012	7/3/2012
GW14	P18848P	200	Domestic	42-73-2-SWNW	12/27/2011	3/6/2012	5/8/2012	7/3/2012
GW15	P127251W	800	Stock	42-74-12-NWSE	12/28/2011	Not Operating	Not Operating	Not Operating
GW17	Unknown	Unknown	Stock	42-74-24-NWNE	12/29/2011	3/6/2012	5/8/2012	7/3/2012

Table 2.7B-18: Non-CBM Groundwater Rights in Proposed Project Area and within 2 Km

Permit Number	Priority Date	Applicant	Facility Name	Status [1]	Uses [1]	Township	Range	Section	QtrQtr	Total Depth	Static Water	Yield	In Project Area
P153958W	9/15/2003	NOLAN & MELISSA JOHNSON	JOHNSON 9101	CAN	DOM	43	73	15	SWSW	500	303	0	N
P110428W	6/10/1998	RICKIE/GALE TAFFNER	TAFFNER #1	GST	DOM,STO	42	74	1	SENE	354	123	10	Y
P19244P	12/31/1953	AUGUST LAUR	LAUR #6	GST	DOM,STO	43	74	25	NESE	180	30	2	N
P72820W	7/8/1986	W.A. MONCRIEF, JR.	MANION 11 1 WSW	CAN	MIS	42	74	11	NWSE	1240	170	0	N
P129340W	9/19/2000	FLOYD C RENO & SON, INC.**W. A. MONC	MANION #11-1 WSW	GSE	MIS	42	74	11	NWSE	0	0	0	N
P59470W	3/1/1982	RUSSELL FORGEY CONSTRUCTION COMPANY	FORGEY #1	CAN	MIS	42	73	6	NENE	0	0	0	Y
P60967W	5/28/1982	RUSSELL FORGEY CONSTRUCTION COMPANY	FORGEY - #1	CAN	MIS	42	73	6	NENE	320	220	0	Y
P45984W	5/16/1978	ROCKY MOUNTAIN ENERGY COMPANY	RENO RANCH ISL P 1	CAN	MIS	43	73	27	NWNW	413	282.27	0	Y
P93136W	9/15/1993	INTERNATIONAL URANIUM (USA) CORP	RI-44	CAN	MIS	43	73	20	SESE	375	175	0	N
P59471W	3/1/1982	RUSSELL FORGEY CONSTRUCTION COMPANY	FORGEY #2	CAN	MIS	43	73	21	SESW	320	220	0	Y
P60143W	3/15/1982	RUSSELL FORGEY CONSTRUCTION COMPANY	FORGEY #3	CAN	MIS	43	73	21	SESW	320	220	0	Y
P60142W	3/15/1982	RUSSEL FORGEY CONSTRUCTION COMPANY	FORGEY #4	CAN	MIS	43	73	21	NWSE	405	220	0	Y
P3827W	12/22/1969	TURNERCREST RANCH CO.	TURNER #1	GST	STO	42	74	13	NWNE	237	130	2	N
P84793W	3/29/1991	FLOYD C. RENO & SON'S INC	COUNTY ROAD #1	GST	STO	42	74	12	NWSE	800	540	8	N
P127251W	7/25/2000	FLOYD C. RENO & SON'S INC.	COUNTY ROAD #1	GST	STO	42	74	12	SWNE	800	380	16	Y
P17460W	12/27/1972	INC. FLOYD C. RENO & SON'S	O'NIEL #4A	GST	STO	42	73	6	SWSE	276	130	15	N
P127147W	7/18/2000	FLOYD C. RENO & SON'S INC.	O'NIEL WELL	GST	STO	42	73	5	NWSW	276	130	12	N
P33284W	5/14/1976	HARRY B. RENO	O'NEIL #1	GST	STO	42	73	6	SENW	254	90	5	Y
P37881W	5/16/1977	PINE TREE RANCH CO.	PINE TREE #11	GST	STO	42	74	3	NENE	185	125	25	N
P19245P	12/31/1953	AUGUST LAUR	LAUR #7	GST	STO	42	74	1	NWNE	120	80	3	Y
P18851P	9/15/1951	INC. FLOYD C. RENO & SON'S	HI WAY	GST	STO	42	73	5	NENW	350	110	7	N
P18841P	7/31/1950	INC. FLOYD C. RENO & SON'S	TUCKER	GST	STO	43	73	32	SWSW	300	100	5	Y
P18852	7/16/1951	INC. FLOYD C. RENO & SON'S	RED WELL	GST	STO	42	74	12	NWSE	350	120	6	
P19241P	12/31/1941	AUGUST LAUR	LAUR #3	GST	STO	43	74	35	NENW	120	90	3	N
P2881P	6/23/1943	ED. R. WILLARD	WILLARD #3	GST	STO	43	73	32	NWNE	90	65	5	Y
P19246W	12/29/1972	AUGUST LAUR	LAUR #8	GST	STO	43	74	26	NWSE	190	110	3	N
P69050W	11/5/1984	LOUISIANA LAND & EXPLORATION CO.**AU	LAUR 1 26	GST	STO	43	74	26	NWSE	730	290	25	N
P26955W	6/13/1974	AUGUST LAUR	LAUR #9	GST	STO	43	73	30	NWSE	174	75	10	Y
P2882P	6/15/1960	ED. R. WILLARD	WILLARD #4	GST	STO	43	73	26	SWNW	205	150	10	N
P174588W	5/4/2006	RICKIE AND GALE TAFFNER	TAFFNER #2	COM	STO	43	73	30	SWNW	0	0	0	N
P2883P	12/31/1960	ED. R. WILLARD	WILLARD #5	GST	STO	43	73	28	NWNE	80	60	5	Y
P2880P	7/26/1940	ED. R. WILLARD	WILLARD #2	GST	STO	43	73	22	SESW	230	210	3	Y

[1] Table Abbreviations Source: WSEO (2012)

DOM:	Domestic	COM:	Completed	STO:	Stock	GSE:	Good Standing - Permitted time limits have been extended
CAN:	Cancelled	GST :	Good Standing	MIS:	Miscellaneous Use		

RAI-19(b) Response

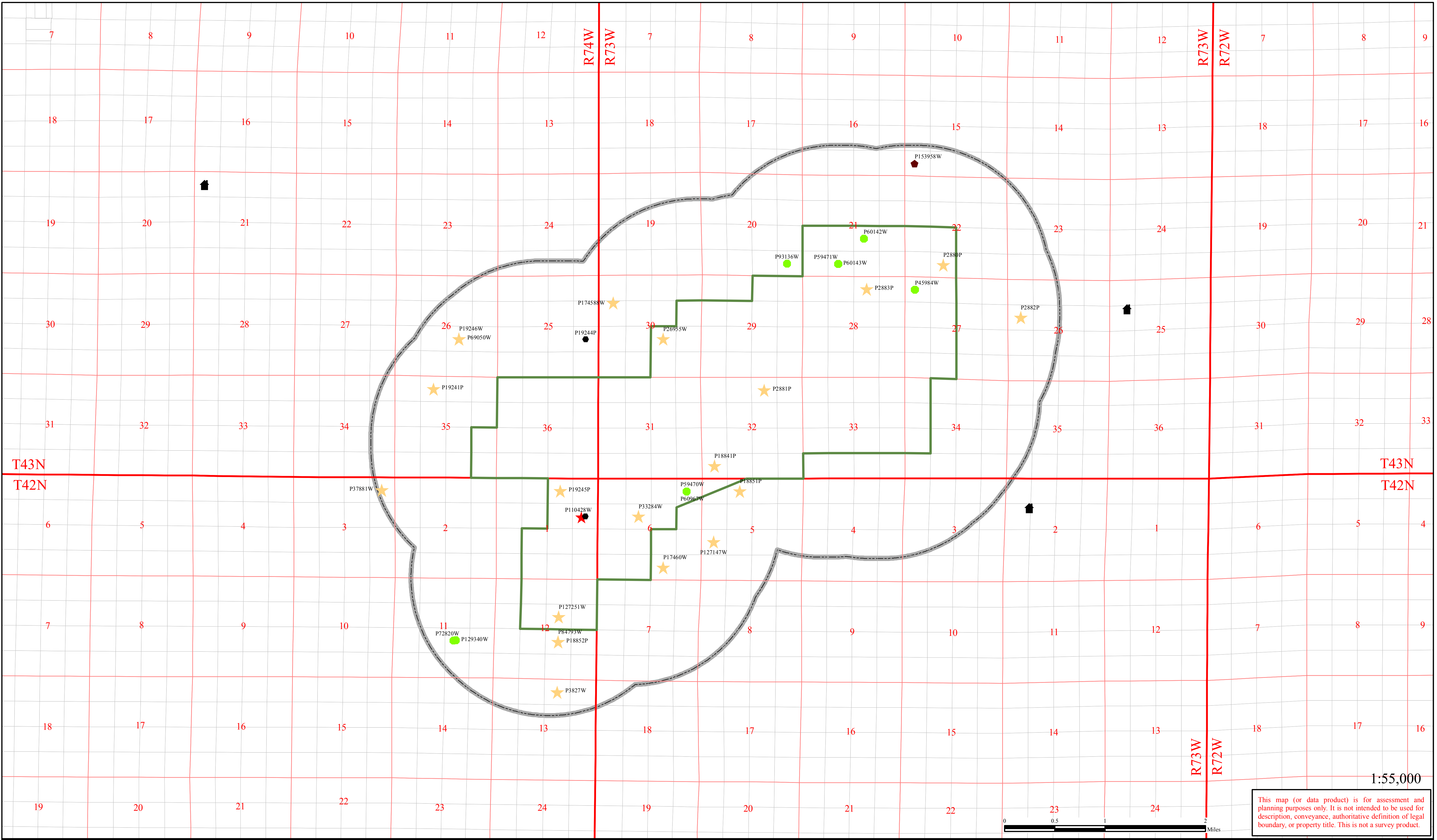
Per RAI-19(a), the conflicting information presented in Tables 2.9-16 through 2.9-23 have been removed from Section 2.9. In addition, Table 3 of Addendum 2.9-A has been revised to be consistent with Regulatory Guide 4.14, NUREG 1569, and the proposed operational monitoring program discussed in Section 5.7.8.1. Other applicable tables have been revised accordingly for consistency. The revised Table 3 is shown below:

Table 3: Analytes and Analytical Methods for Groundwater and Surface Water Samples (Reg. Guide 4.14, Table 1)

Radionuclide	Analytical Method	Reporting Level
U-Nat (dissolved and suspended)	EPA 200.8	0.0003 mg/L
^{226} Ra	SM 7500-Ra B	0.2 pCi/L
^{230} Th	ACW10	0.2 pCi/L
^{210} Pb	OTW01	1 pCi/L
^{210} Polonium	OTW01	1 pCi/L
Gross Alpha	SM 7110B	4 pCi/L
Gross Beta	SM 7110B	7 pCi/L

RAI-19(c) Response

In accordance with 10 CFR Part 40 Appendix A Criterion 5, Figure 2.7B-58 of TR Addendum 2.7-B has been revised to depict all groundwater wells appropriated for stock, domestic, miscellaneous, and industrial usage within the 2 km (1.25 mi) environmental monitoring program area. Additionally, it has been updated to display the previously omitted location of water right P11852P (GW8). The revised TR Figure 2.7B-58 is shown below.



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.

Path: O:\WY_Projects\2010-100_AUC_Reno_Creek\Project_MXD\Submittal\RAI_NRC_r1\Groundwater Rights NonCBM SEO Wells within Two Miles.mxd

PREPARED FOR

AUC LLC
LAKEWOOD, CO

PROPOSED RENO CREEK PROJECT
CAMPBELL COUNTY, WY

TREC, Inc.
Engineering & Environmental Management

900 Werner Court
Suite 150
Casper, WY 82601
Phone (307) 265-0696
Fax (307) 265-2498
www.treccorp.com

Legend

- Proposed Reno Creek Project Boundary
- Monitoring Well Ring Two Kilometer Buffer
- ★ Central Processing Plant
- Residence

Wells Within Two Kilometers of Monitoring Well Rings (excluding CBM)

Uses

- ⬟ Domestic
- ● Domestic; Stock
- ■ Industrial; Miscellaneous
- ● Miscellaneous
- ★ Stock

DRAWN BY: RHK
CHECKED BY: RMD
APPROVED BY: JEY

Groundwater Rights (excluding CBM, Oil and Gas) within Two Kilometers of the Proposed Reno Creek Project Area Wellfield Monitoring Well Rings

REV #	DESCRIPTION	BY	DATE
0	Draft	RHK	09/02/11
1	Final	RHK	12/14/11
2	Revision	EGS	05/13/14

FIGURE 2.7B-58

RAI-19(d) Response

Two new stock wells have been identified within the two km (1.25 mi) environmental monitoring program area; however, were not included in the pre-operational environmental sampling as they are new wells with priority dates post pre-operational sampling. In addition, well P19245 is a longstanding stock well but was excluded from the pre-operational sampling as it was not known to exist until discovered during the paleontological survey. AUC commits to sampling these wells and will designate them GW18, GW19, and GW20 to remain sequential to the current monitoring program sampling designations.

Per the reviewer's request, a table providing a summary of the wells sampled for the pre-operational environmental program is provided below. Several observation wells were not sampled for baseline water quality as they were the designated for hydrologic testing and not baseline water quality sampling:

Summary of Wells Sampled for Pre-operational Environmental Program

Well ID	Screened Aquifer Zone	¼ ¼	Section	Township (N	Range (W)	Easting (ft)	Northing (ft)	Sampled (Y/N)
Monitor Wells								
SM3	Water Table	SWNE	33	43	73	532838.06	1151629.11	Y
SM5	Water Table	NESE	36	43	74	518156.96	1149240.01	Y
SM6	Water Table	SENW	36	43	74	515848.91	1150618.12	Y
SM7	Water Table	SWNW	6	42	73	520104.35	1145567.77	Y
OM1	Overlying	SWNW	27	43	73	536205.64	1156641.51	Y
OM2	Overlying	NENE	33	43	73	534445.82	1152986.40	Y
OM3	Overlying	SWNE	33	43	73	532782.00	1151642.45	Y
OM4	Overlying	NESW	29	43	73	525945.35	1155421.38	Y
OM5	Overlying	NESE	36	43	74	518159.15	1149200.78	Y
OM6	Overlying	SENW	36	43	74	515828.53	1150580.40	Y
OM7	Overlying	SWNW	6	42	73	520151.32	1145506.89	Y
OAM4D	Over Aquitard (L. Felix)	NESW	29	43	73	525964.26	1155474.58	Dry
OAM4S	Over Aquitard (U. Felix)	NESW	29	43	73	525912.91	1155470.34	Dry
PZM1	Production Zone	SWNW	27	43	73	536231.46	1156664.19	Y
PZM2	. Production Zone	NENE	33	43	73	534438.03	1153045.75	Y
PZM3	Production Zone	SWNE	33	43	73	532818.49	1151661.06	Y
PZM4	U. Production Zone	NESW	29	43	73	525927.41	1155439.78	Observation Well/ Y
PZM4D	L. Production Zone	NESW	29	43	73	525953.33	1155490.08	Y
PZM5	Production Zone	NESE	36	43	74	518128.94	1149228.23	Y
PZM6	Production Zone	SENW	36	43	74	515818.44	1150617.93	Y
PZM7	Production Zone	SWNW	6	42	73	520153.09	1145541.43	Y
PZM8	Production Zone	SWNW	27	43	73	536246.59	1156584.44	Y
PZM9	Production Zone	SWNW	27	43	73	536273.19	1156703.91	Y
PZM10	Production Zone	SWNW	27	43	73	536000.88	1156621.87	Y
PZM11	Production Zone	SWNE	33	43	73	532870.33	1151666.25	N
PZM12	Production Zone	SWNE	33	43	73	532758.72	1151578.27	N
PZM13	Production Zone	SWNE	33	43	73	532676.16	1151800.32	N
PZM14	Production Zone	NENW	28	43	73	531671.88	1157827.88	Y
PZM15	Production Zone	NWSE	29	43	73	527720.74	1155603.53	Y
PZM16	Production Zone	SESW	29	43	73	525890.13	1154202.99	Y
PZM17	Production Zone	SESE	30	43	73	524002.55	1153444.37	Y
PZM18	Production Zone	SENE	36	43	74	518293.95	1151306.65	Y
PZM19	Production Zone	NESE	36	43	74	518231.37	1150271.42	Y
PZM20	Production Zone	NESE	36	43	74	517756.27	1149560.50	Y
PZM4D	L. Production Zone	NESW	29	43	73	525953.33	1155490.08	
UM1	Underlying	SWNW	27	43	73	536223.73	1156615.97	Y
UM2	Underlying	NENE	33	43	73	534423.42	1152991.67	Y
UM3	Underlying	SWNE	33	43	73	532808.63	1151631.71	Y
UM4	Underlying	NESW	29	43	73	525944.18	1155456.91	Y
UM5	Underlying	NESE	36	43	74	518127.47	1149258.52	Y
UM6	Underlying	SENW	36	43	74	515816.26	1150648.33	Y
UM7	Underlying	SWNW	6	42	73	520151.01	1145573.53	Y
Water Supply Wells within 2 km of the Well Perimeter Ring[1]								
GW1	Water Table	NENW	28	43	73	531967.53	1158238.67	Y
GW2	Overlying	SWNW	26	43	73	541607.73	1156201.80	Y
GW3	Unknown	NWSE	26	43	73	543144.24	1155239.93	Y
GW4	Unknown	NWNW	34	43	73	536019.24	1151982.00	Y
GW5	Production Zone	SWSW	32	43	73	524622.22	1148304.20	Y
GW6	Underlying	SWNW	30	43	73	519828.48	1157045.64	Y
GW7	Production Zone	SENE	1	42	74	518128.40	1145746.97	Y

Well ID	Screened Aquifer Zone	¼ ¼	Section	Township (N	Range (W)	Easting (ft)	Northing (ft)	Sampled (Y/N)
GW8	Underlying	NWSW	29	43	73	524967.67	1155069.61	Y
GW9	Production Zone	SENW	6	42	73	520641.85	1146169.50	Y
GW10	Production Zone	NWSW	5	42	73	524622.68	1144234.31	Y
GW11	Overlying	NWNE	32	43	73	527562.00	1152490.55	Y
GW12	Unknown	SWNW	25	43	73	546802.01	1156786.92	Y
GW14	Unknown	SENW	2	42	73	541701.87	1146400.48	Y
GW15	Unknown	SENE	12	42	74	517535.92	1140170.44	Y
GW17	Unknown	NWNW	24	42	74	516098.55	1131297.46	Y
GW18*	Overlying	NWNE	12	42	74	516946.51	1147137.38	N
GW19*	Unknown	NWSE	31	43	73	521878.37	1149741.26	N
GW20*	Unknown	SWSW	28	43	73	531025.35	1153533.63	N

[1] Screened aquifer zone is estimated based on best information available

* New wells added to the environmental sampling program with water rights as follows:

GW18: P19425 GW19: P201311W GW20: Unknown

RAI-19(e) Response

Figure 2.9-1 provides a sample type and location for all pre-operational baseline samples located within the proposed project's environmental monitoring program area. The figure in question has been revised per other NRC comments and is provided in RAI-20.

RAI-19(f) Response

As previously shown in RAI-19(a), GW7, GW12, and GW 14 are groundwater use permit numbers identified as P110428W, P165695W, and P18848P respectively.

RAI-19(g) Response

AUC installed 21 Production Zone Aquifer (PZA) monitoring wells (denoted as PZM Wells) across the proposed Reno Creek Project area to evaluate the groundwater hydrology and collect baseline water quality data. Ten of the 21 PZM Wells were installed within mineralized portions of the PZA and were sampled four times (once per quarter) over a one year duration to establish baseline groundwater quality in the mineralized portion of the PZA. Several of these wells were also used as observation wells for the four regional pump tests conducted by AUC.

WDEQ/LQD Guideline 4 requires that baseline sampling wells be installed at a density of one well per square mile within the proposed project boundary. The area within the proposed boundary encompasses approximately 9.5 square miles thus the 10 baseline wells met this requirement. Guideline 4 does not discuss spatial distribution of the baseline wells; therefore, in collaboration with the WDEQ/LQD and NRC staff, the monitoring well locations were deemed sufficient to characterize the groundwater quality of the PZA.

The remaining 11 wells were installed to act as either pumping or observation wells for the four regional pump tests conducted by AUC. Eight of the 11 wells were sampled. The grouping of the wells in relation to pumping wells and observation wells is shown on Figure 2.7B-6 and discussed in the Regional Hydrologic Test Report located in Addendum 2.7-D. The table presented in response to RAI-19(d) provides a summary of wells sampled for the pre-operational environmental program.

RAI-19(h) Response

AUC commits to pre-operational baseline sampling of wells GW 18, GW 19 and GW20 in the pre-operational monitoring program prior to operations. See RAI-19(d) for summary of the wells included in the pre-operational environmental program.

RAI-19(i) Response

A summary table of pre-operational baseline environmental monitoring program parameters are provided in the table below:

Program Element	Location	Radionuclides Analyzed	Sampling Frequency	Number of Sampling Locations
Water				
Surface Water	Onsite water impoundments or natural drainage systems that contain surface runoff from a precipitation event	Dissolved and suspended uranium, Ra-226, Th-230, Pb-210, Po-210, gross alpha, gross beta	Quarterly (as available)	21 locations (as available)
Groundwater-Monitor Wells	Up-gradient and down gradient from CPP	Dissolved uranium, Ra-226, Th-230, PB-210, Po-210, gross alpha, gross beta	Quarterly	28 locations
Groundwater-Existing Groundwater Wells	Private wells within 2 km (1.25 mi) of project area	Dissolved and suspended uranium, Ra-226, Th-230, Pb-210, Po-210, gross alpha, gross beta	Quarterly (as available)	15 locations
Soil and Sediment				
Soil (Surface and Sub-surface)	Particulate in air locations and other locations with the highest predicted concentrations	All samples for Ra-226, 10% of samples natural uranium, Th-230, and Pb-210	Once	108 locations
Sediment	Onsite water impoundments or natural drainage systems that contain surface runoff from a precipitation event	Uranium, Ra-226, Th-230, and Pb-210	Twice (following spring runoff and late summer following period of extended low flow)	21 locations (collected at surface water locations)
Air				
Particulates	Locations with the highest predicted concentrations, nearest residences and control location	Uranium, Ra-226, Th-230, and Pb-210	Quarterly composites (started with weekly samples graduating to monthly)	9 locations
Radon	Particulate in air locations and other areas of interest	Rn-222	Continuous via Track-Etch units-quarterly exchange and analysis	9 locations
Direct Radiation	Particulate in air locations and other areas of interest	Continuous via TLD	Quarterly	9 locations
Vegetation, Food, and Fish				
Vegetation (1)	Grazing areas and other locations with the highest predicted concentrations	Uranium, Ra-226, Th-230, Pb-210, and Po-210	Three times during grazing season	To be sampled
Food (1)	Crops, livestock, etc. Raised with 3 km of the project area	Uranium, Ra-226, Th-230, Pb-210, and Po-210	Once	To be sampled

Fish (2)	From lakes, rivers, and streams within the environs of the site	Uranium, Ra-226, Th-230, Pb-210, and Po-210	Twice	N/A

(1) In accordance with the provisions of NRC Regulatory Guide 4.14, Footnote (o) to Table 2: "*vegetation and forage sampling need be carried out only if dose calculations indicate that the ingestion pathway from grazing animals is a potentially significant exposure pathway...*" defined as a pathway which would expose an individual to a dose in excess of 5% of the applicable radiation protection standard.

(2) None of the surface water features in the Proposed Project area support aquatic life due to the ephemeral nature of those waters.

RAI-19(j) Response

Section 7.1.5.2 of the ER provides a commitment to sample all wells within 2 km (1.25 mi) of the proposed project area. AUC has added the following commitment to this section for further clarification of the environmental monitoring program:

"All private wells used for drinking water, livestock watering or crop irrigation within 2 km (1.25 mi) of the perimeter ring monitoring wells for all wellfields undergoing recovery operations or restoration will be sampled on a quarterly basis during operations, given the owner's consent. AUC will perform annual reviews for all nearby groundwater wells installed within 2 km of any production area to identify construction details of new wells or new use of existing wells. Groundwater samples will be analyzed for dissolved and suspended U-nat, ^{226}Ra, ^{230}Th, ^{210}Pb and ^{210}Po (Regulatory Guide 4.14 Table 2) with results reported to the NRC and landowners. Details of the sites are discussed in ER Section 3.4 and depicted in TR Addendum 2.7-B."

RAI-19(k) Response

AUC has investigated three stock wells potentially screened within the PZA to determine if new stock wells will need to be developed:

1. GW7 (P110428): Is the only domestic supply well in the Proposed Project area and is completed to the PZA at this location. AUC will acquire the Taffner property prior to construction and it will not thereafter be used as a residence. The well will be plugged and abandoned prior to initiating uranium recovery operations.

2. GW9 (P33284): AUC, with the approval of the land/well owner, has plugged and abandoned the well in accordance with Wyoming State Engineer's Office, Ground Water Division, Regulations and Instructions -Part III, Water Well Minimum Construction Standards, 2011. A letter stating AUC and well owner approval to plug and abandon the O'Neal #1 can be found in Addendum D12-G. These abandonment actions met the applicable inspection, monitoring, and administrative reporting requirements to assure adequate protection of USDs. AUC cooperated with the Wyoming State Engineer's Office to obtain approval of all applicable well abandonment documents. AUC has provided a copy of O'Neal #1 Abandonment Notice to further demonstrate completion of this action in Addendum D12-H.

3. GW5 (P1884P): The well is located approximately 2,300 feet outside the closest proposed aquifer exemption area as well as in an area where currently there is no known

mineralization. Therefore, AUC will not plug and abandon the well and will adhere to the private well operational monitoring plan.

AUC reviewed P2883P and determined that the well will not be impacted by operations. The well has a documented 80 foot total depth thus completed above the production zone aquifer.

RAI-19(l) Response

Sections 4.3.5.1 and 4.3.5.2 of the TR provide preliminary design details related to the backup pond(s) liner and proposed leak detection systems. AUC recognizes a detailed pond design plan must be submitted and approved before a license will be issued. AUC has completed geotechnical test borings for the proposed pond locations and is currently developing a pond design plan.

A commitment to install a groundwater protection monitoring program has been added to Section 4.3.5.1:

"AUC commits to install a groundwater monitoring program compliant with Criterion 7A of Appendix A, 10 CFR Part 40. The storage pond design will utilize a double liner system with an intervening leak detection system. Backup pond liners and the leak detection system will also meet the requirements of NRC Regulatory Guide 3.11."

RAI-20

Description of Deficiency

In Section 2.9 of the TR, the applicant stated that the locations of the air particulate and air radon monitoring stations are located in Figure 2.9-1 of the Technical Report (AUC, 2012).

Basis for Request

NRC staff noted that the locations of the pre-operational soil (and direct radiation measurements) are not collected around the center of the mill operations (or central processing facility) in Figure 2.9-1. The location of the central processing facility is considered to be the origin of the coordinates and the bases for the location of air particulate, air radon, soil, and direct radiation measurements. Regulatory Guide 4.14, Table 1, recommend surface and subsurface soil samples taken at various intervals from the center of the milling area. Also, SRP Acceptance Criteria 2.9.2(1), which references Regulatory Guide 4.14, Section 1.1, states that three locations at or near the site boundaries in different sectors that have the highest predicted concentrations of airborne particulates, and preoperational sampling should be the same as operational locations. This guidance affects air particulate, air radon, soil, and direct radiation pathways for both pre-operational and operational programs.

NRC staff reviewed Figure 2.9-1 and determined that the pre-operational soil sampling locations are not conducted from the center of the central processing facility. Thus the proposed air particulate, air radon, soil, and direct radiation measurements are not in the proper sampling locations. The central processing facility, as shown in Figure 2.9-1, is located at a different location. NRC staff has determined that the origin of the location of the central processing facility in Figure 2.9-1 impacts the location of the air particulate sampling locations shown in Figure 2.9-1, as well as air radon, soil, and direct radiation during operations. The applicant needs to conduct pre-operational soil sampling from the origin of the location of the central processing facility, as shown in Figure 2.9-1, and develop air particulate sampling locations, based on wind rose data collected during pre-operations from this point of origin. Pre-operational soil samples need to be collected at various intervals from the center of the milling area consistent with Regulatory Guide 4.14 or if the applicant proposes other locations, the applicant must provide its rationale for staff's consideration.

Formulation of RAI

(a) Describe and commit to a soil sampling regimen consistent with Regulatory Guide 4.14 for surface and subsurface soils, or propose an alternative method with rationale for Staff's consideration. Commit to 12 consecutive months of pre-operational air particulate, air radon, soil, and direct radiation data collection regimen consistent with Regulatory Guide 4.14, prior to operations, or propose an alternative data collection regimen with rationale for staff's consideration.

(b) AUC indicated in the RAI response to RAI 20 that they revised the air sampling stations and established some new air sampling stations and kept some previous air sampling stations. Provide the rationale for the new stations. Show how the AUC onsite meteorological monitoring program comports with Regulatory Guide 4.14.

(c) Please provide an explanation for the inconsistencies of the air radon monitoring data collected for AM# 4-2 during the third and four quarters of 2012 and AM# 6-2 in the second quarter of 2013 relative to the other data.

(d) In Table 2.9-6, what is "RL" and also where are the uncertainties for Uranium.

(e) In Table 2.9-12 thru 2.9-15, define "ND"

(f) Any reason why the subsurface soil data for Ra-226 in Table 2.9-5 are separated from the subsurface soils data in Table 2.9-6?

RAI-20(a) Response

AUC has completed additional soil sampling and 16 consecutive additional months of pre-operational air particulate, radon and gamma monitoring, at a revised set of locations consistent with Regulatory Guide 4.14 and the proposed CPP location.

AUC's CPP location as given in the application was finalized after the soil sampling for radiological materials had been conducted, and reported in TR Figure 2.9-1. Subsequent to the submission of the application, AUC sampled around the operative CPP location and a revised Figure 2.9-1 (shown below) has been inserted into TR Sec. 2.9 showing changes associated with the relocated CPP.

AUC completed additional soil sampling in 2013, consistent with Regulatory Guide 4.14, for surface and subsurface soils. The pattern of soil sampling locations is shown in revised Figure 2.9-1. Revised Tables 2.9-4 and 2.9-5 present summary statistics for the surface and subsurface soil sampling data. Revised Table 2.9-6 presents radionuclide soil concentration data for the surface and subsurface samples. These tables have been inserted into TR

Section 2.9.

In July, 2012, AUC moved three of its five air sampler locations and began a new air particulate, radon and integrated gamma monitoring program based on the new CPP location. Monitoring was performed at all 5 locations (including those not moved) during the new program. The revised monitoring locations were selected based on wind rose data from AUC's onsite meteorological monitoring program and the new CPP location, and are consistent with Regulatory Guide 4.14. Monitoring was completed in November, 2013; a total of 16 months. Air particulate sample analysis results for the new monitoring program are presented in revised Tables 2.9-12 through 2.9-15, which have been inserted into TR Section 2.9. Radon-222 integrated monitoring via high-sensitivity Landauer Radtrak devices, paired with same-batch Landauer-stored devices, has been performed at the revised location set over the same period. Results are presented in revised Table 2.9-11, inserted into TR Section 2.9. Integrated gamma monitoring, using Landauer X-9 high-sensitivity OSL dosimeters, has been similarly performed, with results presented in revised Table 2.9-10, also inserted into TR Section 2.9.

AUC commits to performing air particulate, radon and gamma monitoring using the same revised set of monitoring locations (as depicted in revised Figure 2.9-1) during licensed operations at the Reno Creek facility. The revised text and tables have been inserted into TR Section 2.9 within the application and are all shown below:

"2.9.3 Soil Sampling

In addition to soil sampling performed for to develop radiation vs. soil radionuclide correlations, additional soil sampling was conducted according to recommendations set forth in Regulatory Guide 4.14. (The data reported here are for a new set of radials laid out with the proposed CPP location as pattern center, as shown in revised Figure 2.9-1.) The NRC guidance suggests five cm sampling depths for surface soils, supplemented with a limited set of samples taken to depths up to one meter. The Guide specifies that all soil samples should be analyzed for 226Ra, with ten percent (including at least one of the one meter sample sets) analyzed for natural uranium, Th-230, and Pb-210. Additionally, soil samples should be collected at air particulate sampling stations, and analyzed for Ra-226, natural uranium, Th-230 and Pb-210. Figure 2.9-1 presents the sample locations. Table 2.9-3 summarizes analytical methods and target reporting limits. Addendum 2.9-A presents the Standard Operating Procedures and the Sampling and Analysis Plan used during all sampling events."

2.9.3.1 Soil Sampling

2.9.3.1.1 Surface Soil Sampling Methods

The surface soil sampling layout was a radial grid based on Regulatory Guide 4.14 recommendations. Soil samples were collected along transects in eight compass directions from the proposed processing plant location, at 300 meter intervals, as illustrated in Figure 2.9-1. In addition, surface soil samples were collected at five air particulate monitoring stations. Sample ID information was recorded in a field log book, with GPS coordinates taken at each sampling point. Samples were sent to IML, along with chain of custody forms. At IML, samples were dried, crushed, ground and homogenized, prior to analysis (after 21 day equilibration specific to the Ra-226 analyses)."

2.9.3.1.2 Subsurface Soil Sampling Methods

Depth profile sampling locations in the vicinity of the proposed CPP were selected based on RG 4.14 recommendations. Samples were taken at the center, and at 750 meters north, south, east and west of the potential CPP location. At each location, samples were collected at 0.33 meter increments to a depth of one meter, and were submitted to IML for analysis per RG 4.14 specifications."

2.9.3.2 Surface Soil Sampling Results

The Ra-226 soil concentration results are consistent with regional natural background Ra-226 concentrations. Summary statistics for surface soil samples are provided in Table 2.9-4.

2.9.3.3 Subsurface Soil Sampling Results

Summary statistics for the subsurface samples analyzed for Ra-226 are provided in Table 2.9-5. Results for the subsurface sample analyzed for Pb-210, Th-230 and natural uranium are provided in Table 2.9-6. Average Ra-226 concentrations were within the region's natural background range. There were no apparent trends in soil concentration with depth.

2.9.3.4 Conclusions

Baseline radiological soil sampling and analysis was performed in accordance with Regulatory Guide 4.14 recommendations. No unusual results or trends were noted."

2.9.5 Ambient Gamma Dose and Radon Monitoring

Continuous passive monitoring of ambient gamma radiation integrated dose and Rn-222 air concentrations within the Proposed Project site was performed for 12 months, from

7/9/2012 – 7/2/2013. These new data replace the results presented in the original technical report, and reflect results from the revised set of monitoring locations. Regulatory Guide 4.14 calls for 12 consecutive months of quarterly monitoring (NRC, 1980).

Devices for monitoring quarterly gamma dose, and Rn-222 concentrations in air, were provided by Landauer Inc. and housed at the air particulate monitoring stations in Landauer's weather-protected housings. The revised monitoring locations were selected based on Regulatory Guide 4.14 guidance, updated site-specific meteorological data, and the new central processing plant location. These locations are shown in Figure 2.9-1.

2.9.5.1 Ambient Gamma Dose and Radon Monitoring Methods

2.9.5.1.1 Procedure

Passive monitoring of gamma dose at the site was conducted using high-sensitivity optically-stimulated luminescent environmental dosimeters (OSLs) supplied by Landauer. The badges were received quarterly in Fort Collins CO, transported to the site monitoring locations, installed and retained in place at the site for approximately one quarter, retrieved and returned by mail, per the protocol provided by the Landauer laboratory. The badges were then read by Landauer and data transmitted to AUC staff. A correction for the time spent at the site vs. the total time spent in transit, at the site, and during return for readout, was applied to the gross Landauer integrated exposure data. Minimum detectable dose level, as provided by Landauer for this badge type, was 0.1 mrem., including results corrected for installed time in the field, are reported in Table 2.9-10. Monitoring was continuous during the entire period covered by the reported data. The receipt, installation, retrieval and return procedure was implemented without observed discrepancies during all four quarters. No anomalies with respect to procedure implementation or the laboratory readout process were reported by Landauer.

The results shown in Table 2.9-10 are reasonably consistent from quarter to quarter, and are also comparable to the integrated doses anticipated for this site (based on independent readings observed with portable instrumentation). Data differences among locations and quarters are small, but are also reasonably consistent - they may or may not reflect actual differences."

2.9.5.2 Ambient Radon Monitoring Methods

Passive monitoring of average Rn-222 air concentrations at the Proposed Project site was conducted with Radtrak® alpha-track Rn-222 detectors, supplied by Landauer Inc. These detectors were placed at the revised set of air particulate monitoring stations with locations based on the new central processing plant site. They are protected from weather and animal disturbance using field containers provided by Landauer (Figure 2.9-19). The radon detectors are supplied by the vendor in sealed packages to minimize exposure prior to the beginning of the field monitoring period. Upon completion of the monitoring period, Landauer film-foil sealing stickers are applied to the detector openings to prevent further exposure during transit back to the vendor.

2.9.5.2.1 Results

The radon concentration data reported by Landauer are presented in Table 2.9-11. This new information, when compared to older but similarly-developed radon data presented in the original TR section, shows fewer results that are below Radtrak detection limits. Landauer modified its detector-background determination methods, and other aspects of the Radtrak monitoring system, prior to initiation of this new 12-month monitoring period. Some improvement in the newer data set's internal consistency is apparent, perhaps as a result. However, inspection of Table 2.9-11 still shows several results that are significantly higher or lower than expected. The reasons for these apparent inconsistencies remain unclear."

2.9.6 Air Particulate Monitoring

Continuous monitoring of air particulate radionuclides was performed for twelve consecutive months, per regulatory guide specifications. Air particulate sampling station locations were modified conforming to RG 4.14 guidance. Selection of the revised locations included consideration of the new location of the Proposed Project facilities, updated met data, proximate residences, access, and future operations. Locations of the air particulate monitoring stations are shown in Figure 2.9-1.

2.9.6.1 Air Particulate Monitoring Methods

The air particulate monitoring program was conducted using solar powered stations employing Model DF-40L digital air samplers from F&J Specialty Products, Inc. (Figure 2.9-20). These samplers employ electronic air flow control, and SD card nonvolatile memory storing all important parameters. The samplers draw approximately 30 liters per minute through 4" glass fiber filters. The calibration records can be found in Addendum 2.9-B. The six current air sampler locations are shown in Figure 2.9-21.

Air sampling was continuous. Filters were exchanged monthly and composited quarterly. Use of larger, 4" filter media rather than 47 mm filters, and extension of the filter exchange interval from weekly to monthly, was pre-approved by the NRC's Steve Cohen, subject to a successful in-field testing program. A copy of a written report titled, "*Proposed Modification to Regulatory Guide 4.14 Pre-Operational Air-Sampling Guidance*," prepared by Dr. Meyer to summarize the field test protocol, is included in TR Addendum 2.9-C.

As noted, filters from each station are composited quarterly and laboratory analyzed to calculate quarterly average radionuclide air concentrations. Analyses are performed by IML for Ra-226, natural uranium, Th-230, and Pb-210.

2.9.6.2 Air Particulate Sampling Results

Results are provided in Tables 2.9-12 through 2.9-15. Variations in quarterly concentrations over time and location are evident, but all values are low and no unusual trends are evident."

Table 2.9-4: Summary Statistics for Radial Surface Soil Samples

Surface Sample Type	Mean	Standard Deviation	Median	Maximum	Minimum	Number of Samples
^{226}Ra (pCi/g)						
Radial	1.0	0.3	1.0	2.4	0.5	41
PAS	1.1	0.5	1.0	1.8	0.5	5
CPP	1.0	0.2	1.1	1.2	0.6	8
All Samples	1.0	0.3	1.0	2.4	0.5	54
U-Nat (mg/Kg)						
Radial	0.7	0.1	0.8	0.8	0.6	5
PAS	0.7	N/A	0.7	0.7	0.7	1
CPP	1.1	N/A	1.1	1.1	1.1	1
All Samples	0.8	0.2	0.8	1.1	0.6	7
^{210}Pb (pCi/g)						
Radial	2.2	1.6	1.5	4.8	1.0	5
PAS	2.3	N/A	2.3	2.3	2.3	1
CPP	1.4	N/A	1.4	1.4	1.4	1
All Samples	2.1	1.4	1.5	4.8	1.0	7
^{230}Th (pCi/g)						
Radial	0.8	0.2	0.8	1.0	0.6	5
PAS	0.7	N/A	0.7	0.7	0.7	1
CPP	0.5	N/A	0.5	0.5	0.5	1
All Samples	0.7	0.2	0.7	1.0	0.5	7

Table 2.9-5: Summary Statistics for Radial Subsurface Soil Samples

Subsurface Sample Depth Interval (cm)	Mean	Standard Deviation	Median	Maximum	Minimum	Number of Samples
^{226}Ra (pCi/g)						
0-33	1.3	0.7	1.2	2.4	0.6	5
33-66	1.3	0.2	1.4	1.5	1.1	5
66-100	1.1	0.3	1.0	1.6	0.8	5
All Depths	1.2	0.4	1.2	2.4	0.6	15

Table 2.9-6: Subsurface Soil Sample Results

Sample ID	Depth Interval (cm)	Uranium		^{210}Lead			^{230}Thorium		
		Conc. (pCi/g)	RL (pCi/g)	Conc. (pCi/g)	Precision +/- (pCi/g)	RL (pCi/g)	Conc. (pCi/g)	Precision +/- (pCi/g)	RL (pCi/g)
C	0-33	0.7	0.2	1.5	0.4	1.0	0.7	0.2	0.2
	33-66	1.4	0.2	1.2	0.5	1.0	0.9	0.2	0.2
	66-100	1.5	0.2	1.3	0.6	1.0	0.6	0.2	0.2

Table 2.9-10: Ambient Gamma Dose Rates: Results Summary

Passive Monitoring Station ID	OSL Issue Date	Field Installation Date	Field Retrieval Date	OSL Process Date	Landauer's Gross Result (mrem)	Field Dose (mrem)	Field Dose Rate (mrem/day)	Field Dose Rate (mrem/hour)	Quarterly Dose (mrem)
3rd Quarter 2012									
AM1	7/1/2012	7/9/2012	10/5/2012	10/22/2012	36.4	28.3	0.32	0.013	29.3
AM2	7/1/2012	7/9/2012	10/5/2012	10/22/2012	39.1	30.4	0.35	0.014	31.5
AM4-2	7/1/2012	7/9/2012	10/5/2012	10/22/2012	40.3	31.4	0.36	0.015	32.5
AM5-2	7/1/2012	7/9/2012	10/5/2012	10/22/2012	40.9	31.9	0.36	0.015	32.9
AM6-2	7/1/2012	7/9/2012	10/5/2012	10/22/2012	40.9	31.9	0.36	0.015	32.9
4th Quarter 2012									
AM1	10/1/2012	10/5/2012	1/8/2013	1/22/2013	36.1	30.3	0.32	0.013	29.1
AM2	10/1/2012	10/5/2012	1/8/2013	1/22/2013	39.8	33.5	0.35	0.015	32.1
AM4-2	10/1/2012	10/5/2012	1/8/2013	1/22/2013	41.3	34.7	0.37	0.015	33.3
AM5-2	10/1/2012	10/5/2012	1/8/2013	1/22/2013	39.9	33.5	0.35	0.015	32.1
AM6-2	10/1/2012	10/5/2012	1/8/2013	1/22/2013	41.5	34.9	0.37	0.015	33.4
1st Quarter 2013									
AM1	1/1/2013	1/8/2013	4/3/2013	4/9/2013	34.3	29.8	0.35	0.015	31.9
AM2	1/1/2013	1/8/2013	4/3/2013	4/9/2013	35.5	30.8	0.36	0.015	33.0
AM4-2	1/1/2013	1/8/2013	4/3/2013	4/9/2013	35.8	31.1	0.37	0.015	33.2
AM5-2	1/1/2013	1/8/2013	4/3/2013	4/9/2013	35.4	30.7	0.36	0.015	32.9
AM6-2	1/1/2013	1/8/2013	4/3/2013	4/9/2013	34.1	29.6	0.35	0.014	31.7
2nd Quarter 2013									
AM1	4/1/2013	4/3/2013	7/2/2013	7/13/2013	34.3	30.0	0.33	0.014	30.3
AM2	4/1/2013	4/3/2013	7/2/2013	7/13/2013	36.1	31.5	0.35	0.015	31.9
AM4-2	4/1/2013	4/3/2013	7/2/2013	7/13/2013	38.8	33.9	0.38	0.016	34.3
AM5-2	4/1/2013	4/3/2013	7/2/2013	7/13/2013	37.7	32.9	0.37	0.015	33.3
AM6-2	4/1/2013	4/3/2013	7/2/2013	7/13/2013	35.8	31.3	0.35	0.014	31.6

Table 2.9-11: Radon Concentrations in Air

Monitoring Station ID	Start Date	End Date	Exposure (pCi/L-days)	Avg Radon Concentration (pCi/L)
Q3 2012				
AM 1	7/9/2012	10/5/2012	33.7	0.4
AM 2	7/9/2012	10/5/2012	29.0	0.3
AM 4-2	7/9/2012	10/5/2012	<6.0	<0.07
AM 5-2	7/9/2012	10/5/2012	25.1	0.3
AM 6-2	7/9/2012	10/5/2012	18.7	0.2
Q4 2012				
AM 1	10/5/2012	1/8/2013	9.8	0.1
AM 2	10/5/2012	1/8/2013	6.2	0.1
AM 4-2	10/5/2012	1/8/2013	<6.0	<0.06
AM 5-2	10/5/2012	1/8/2013	94.7	1.0
AM 6-2	10/5/2012	1/8/2013	91.9	1.0
Q1 2013				
AM 1	1/8/2013	4/3/2013	80.0	0.90
AM 2	1/8/2013	4/3/2013	78.4	0.90
AM 4-2	1/8/2013	4/3/2013	66.6	0.80
AM 5-2	1/8/2013	4/3/2013	75.0	0.90
AM 6-2	1/8/2013	4/3/2013	72.6	0.80
Q2 2013				
AM 1	4/3/2013	7/2/2013	65.4	0.70
AM 2	4/3/2013	7/2/2013	62.6	0.70
AM 4-2	4/3/2013	7/2/2013	60.9	0.70
AM 5-2	4/3/2013	7/2/2013	61.5	0.70
AM 6-2	4/3/2013	7/2/2013	<6.0	<0.07

Table 2.9-12: Air Particulate Monitoring Results: Quarter 1

Air Station ID	Collection-Date	Air Volume Sampled (L)	Air Volume Sampled (mL)	Analyte	Filter Conc. (pCi/filter)	Reporting Limit (pCi/filter)	Concentration (µCi/mL)	Reporting Limit (uCi/mL)
AM 1	9/28/2012	4.38E+06	4.38.E+09	^{210}Pb	105	2	2.4E-14	2.0.E-15
		4.38E+06	4.38.E+09	^{226}Ra	ND	0.3	ND	1.0E-16
		4.38E+06	4.38.E+09	^{230}Th	ND	0.2	ND	1.0E-16
		4.38E+06	4.38.E+09	U-Nat	ND	0.3	ND	1.0E-16
AM 2	9/28/2012	3.28E+06	3.28.E+09	^{210}Pb	77	2	2.3E-14	2.0.E-15
		3.28E+06	3.28.E+09	^{226}Ra	ND	0.3	ND	1.0E-16
		3.28E+06	3.28.E+09	^{230}Th	ND	0.2	ND	1.0E-16
		3.28E+06	3.28.E+09	U-Nat	ND	0.3	ND	1.0E-16
AM 4-2	9/28/2012	3.76E+06	3.76.E+09	^{210}Pb	75	2	2.0E-14	2.0.E-15
		3.76E+06	3.76.E+09	^{226}Ra	0.3	0.3	ND	1.0E-16
		3.76E+06	3.76.E+09	^{230}Th	ND	0.2	ND	1.0E-16
		3.76E+06	3.76.E+09	U-Nat	ND	0.3	ND	1.0E-16
AM 5-2	9/28/2012	3.76E+06	3.76.E+09	^{210}Pb	79	2	2.1E-14	2.0.E-15
		3.76E+06	3.76.E+09	^{226}Ra	0.4	0.3	ND	1.0E-16
		3.76E+06	3.76.E+09	^{230}Th	ND	0.2	ND	1.0E-16
		3.76E+06	3.76.E+09	U-Nat	ND	0.3	ND	1.0E-16
AM 6-2	9/28/2012	3.69E+06	3.69.E+09	^{210}Pb	68.5	2	1.9E-14	2.0.E-15
		3.69E+06	3.69.E+09	^{226}Ra	0.3	0.3	ND	1.0E-16
		3.69E+06	3.69.E+09	^{230}Th	ND	0.2	ND	1.0E-16
		3.69E+06	3.69.E+09	U-Nat	ND	0.3	ND	1.0E-16

Table 2.9-13: Air Particulate Monitoring Results: Quarter 2

Air Station ID	Collection-Date	Air Volume Sampled (L)	Air Volume Sampled (mL)	Analyte	Filter Conc. (pCi/filter)	Reporting Limit (pCi/filter)	Concentration (µCi/mL)	Reporting Limit (uCi/mL)
AM 1	12/28/2012	4.18E+06	4.18.E+09	^{210}Pb	90.1	2	2.2E-14	2.0.E-15
		4.18E+06	4.18.E+09	^{226}Ra	0.3	0.3	ND	1.0E-16
		4.18E+06	4.18.E+09	^{230}Th	0.3	0.2	ND	1.0E-16
		4.18E+06	4.18.E+09	U-Nat	ND	0.3	ND	1.0E-16
AM 2	12/28/2012	3.88E+06	3.88.E+09	^{210}Pb	89.6	2	2.3E-14	2.0.E-15
		3.88E+06	3.88.E+09	^{226}Ra	ND	0.3	ND	1.0E-16
		3.88E+06	3.88.E+09	^{230}Th	ND	0.2	ND	1.0E-16
		3.88E+06	3.88.E+09	U-Nat	ND	0.3	ND	1.0E-16
AM 4-2	12/28/2012	4.35E+06	4.35.E+09	^{210}Pb	86.3	2	2.0E-14	2.0.E-15
		4.10E+06	4.10.E+09	^{226}Ra	ND	0.3	ND	1.0E-16
		4.10E+06	4.10.E+09	^{230}Th	ND	0.2	ND	1.0E-16
		4.10E+06	4.10.E+09	U-Nat	ND	0.3	ND	1.0E-16
AM 5-2	12/28/2012	4.41E+06	4.41.E+09	^{210}Pb	112	2	2.5E-14	2.0.E-15
		4.41E+06	4.41.E+09	^{226}Ra	ND	0.3	ND	1.0E-16
		4.41E+06	4.41.E+09	^{230}Th	ND	0.2	ND	1.0E-16
		4.41E+06	4.41.E+09	U-Nat	0.3	0.3	ND	1.0E-16
AM 6-2	12/28/2012	4.32E+06	4.32.E+09	^{210}Pb	81.8	2	1.9E-14	2.0.E-15
		4.32E+06	4.32.E+09	^{226}Ra	0.3	0.3	ND	1.0E-16
		4.32E+06	4.32.E+09	^{230}Th	ND	0.2	ND	1.0E-16
		4.32E+06	4.32.E+09	U-Nat	ND	0.3	ND	1.0E-16

Table 2.9-14: Air Particulate Monitoring Results: Quarter 3

Air Station ID	Collection-Date	Air Volume Sampled (L)	Air Volume Sampled (mL)	Analyte	Filter Conc. (pCi/filter)	Reporting Limit (pCi/filter)	Concentration (µCi/mL)	Reporting Limit (uCi/mL)
AM 1	3/29/2013	4.64E+06	4.64.E+09	^{210}Pb	77.3	2	1.7E-14	2.0.E-15
		4.64E+06	4.64.E+09	^{226}Ra	0.3	0.3	ND	1.0E-16
		4.64E+06	4.64.E+09	^{230}Th	0.7	0.2	1.4E-16	1.0E-16
		4.64E+06	4.64.E+09	U-Nat	0.6	0.3	1.3E-16	1.0E-16
AM 2	3/29/2013	3.90E+06	3.90.E+09	^{210}Pb	75.0	2	1.9E-14	2.0.E-15
		3.90E+06	3.90.E+09	^{226}Ra	0.3	0.3	ND	1.0E-16
		3.90E+06	3.90.E+09	^{230}Th	0.5	0.2	1.4E-16	1.0E-16
		3.90E+06	3.90.E+09	U-Nat	0.6	0.3	1.5E-16	1.0E-16
AM 4-2	3/29/2013	4.33E+06	4.33.E+09	^{210}Pb	40.2	2	9.3E-15	2.0.E-15
		4.33E+06	4.33.E+09	^{226}Ra	ND	0.3	ND	1.0E-16
		4.33E+06	4.33.E+09	^{230}Th	0.4	0.2	ND	1.0E-16
		4.33E+06	4.33.E+09	U-Nat	0.4	0.3	ND	1.0E-16
AM 5-2	3/29/2013	4.40E+06	4.40.E+09	^{210}Pb	46.6	2	1.1E-14	2.0.E-15
		4.40E+06	4.40.E+09	^{226}Ra	0.4	0.3	ND	1.0E-16
		4.40E+06	4.40.E+09	^{230}Th	0.3	0.2	ND	1.0E-16
		4.40E+06	4.40.E+09	U-Nat	0.7	0.3	1.5E-16	1.0E-16
AM 6-2	3/29/2013	4.27E+06	4.27.E+09	^{210}Pb	69.5	2	1.6E-14	2.0.E-15
		4.27E+06	4.27.E+09	^{226}Ra	0.4	0.3	ND	1.0E-16
		4.27E+06	4.27.E+09	^{230}Th	0.7	0.2	1.6E-16	1.0E-16
		4.27E+06	4.27.E+09	U-Nat	0.6	0.3	1.4E-16	1.0E-16

Table 2.9-15: Air Particulate Monitoring Results: Quarter 4

Air Station ID	Collection-Date	Air Volume Sampled (L)	Air Volume Sampled (mL)	Analyte	Filter Conc. (pCi/filter)	Reporting Limit (pCi/filter)	Concentration (µCi/mL)	Reporting Limit (uCi/mL)
AM 1	6/28/2013	4.82E+06	4.82.E+09	^{210}Pb	72.4	2	1.5E-14	2.0E-15
		4.82E+06	4.82.E+09	^{226}Ra	0.8	0.3	1.6E-16	1.0E-16
		4.82E+06	4.82.E+09	^{230}Th	0.8	0.2	1.6E-16	1.0E-16
		4.82E+06	4.82.E+09	U-Nat	0.6	0.3	1.3E-16	1.0E-16
AM 2	6/28/2013	3.74E+06	3.74.E+09	^{210}Pb	76.9	2	2.1E-14	2.0.E-15
		3.74E+06	3.74.E+09	^{226}Ra	0.8	0.3	2.2E-16	1.0E-16
		3.74E+06	3.74.E+09	^{230}Th	0.3	0.2	ND	1.0E-16
		3.74E+06	3.74.E+09	U-Nat	0.6	0.3	1.6E-16	1.0E-16
AM 4-2	6/28/2013	4.39E+06	4.39.E+09	^{210}Pb	68.9	2	1.6E-14	2.0.E-15
		4.39E+06	4.39.E+09	^{226}Ra	1.2	0.3	2.7E-16	1.0E-16
		4.39E+06	4.39.E+09	^{230}Th	0.5	0.2	1.1E-16	1.0E-16
		4.39E+06	4.39.E+09	U-Nat	0.9	0.3	2.1E-16	1.0E-16
AM 5-2	6/28/2013	4.43E+06	4.43.E+09	^{210}Pb	72.4	2	1.6E-14	2.0.E-15
		4.43E+06	4.43.E+09	^{226}Ra	0.9	0.3	2.0E-16	1.0E-16
		4.43E+06	4.43.E+09	^{230}Th	1.1	0.2	2.5E-16	1.0E-16
		4.43E+06	4.43.E+09	U-Nat	0.8	0.3	1.9E-16	1.0E-16
AM 6-2	6/28/2013	4.38E+06	4.38.E+09	^{210}Pb	45.0	2	1.0E-14	2.0.E-15
		4.38E+06	4.38.E+09	^{226}Ra	0.6	0.3	1.3E-16	1.0E-16
		4.38E+06	4.38.E+09	^{230}Th	0.4	0.2	ND	1.0E-16
		4.38E+06	4.38.E+09	U-Nat	0.3	0.3	ND	1.0E-16

PROPOSED RENO CREEK PROJECT
CAMPBELL COUNTY, WYOMING

Figure 2.9-1
Baseline Radiological Sampling Locations

REV #	BY	DATE	DESCRIPTION
1	RHK	01/19/2012	Approved
2	RHK	06/15/2012	Revised Project Boundary
3	DCW	05/02/2014	Revised Soil Sample Locations
4	JTW	12/16/2014	Revised Air Monitor Locations

Prepared For:

AUC LLC
LAKEWOOD, COLORADO

Prepared By:

TREC, Inc.
Engineering & Environmental Management

900 Werner Court
Suite 150
Casper, WY, 82601

Phone (307)265-0696
Fax (307)265-2498
www.treccorp.com

Contour Interval = 10 feet

0 0.2 0.4 0.8 Miles

0 1,400 2,800 5,600 Feet

N W E S

NAD 1983 StatePlane Wyoming East FIPS 4901 Feet | 1:17,000

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.

Legend

- ● Groundwater Well Sample Location
- ▲ Surface Water & Sediment Sample Location
- ▲ Stock Well Sample Location
- ▲ Soil Sample Location
- ● Air Particulate Monitor Location
- ▲ Vegetation Sample Location
- ◆ Meteorological Station
- ■ Soil Correlation Plot Location
- ▭ Proposed Reno Creek Project Boundary
- Ephemeral Stream
- Ore Body

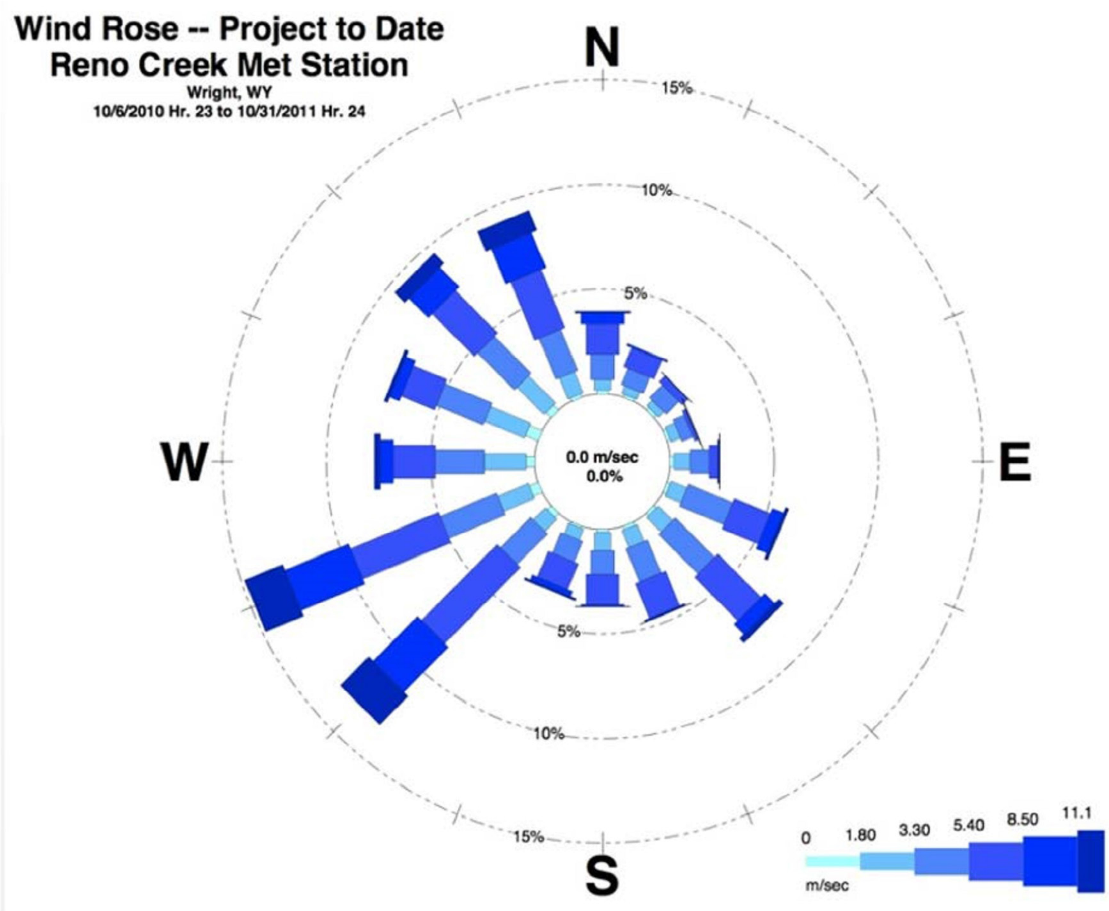
Road Classification

- Major Road (Paved)
- Minor Road (Unpaved)

RAI-20(b) Response

AUC originally sited the pre-operational air sampling stations based on meteorological data from nearby meteorological stations (such as the Antelope Mine, WY) and discussions concerning potential locations of the CPP. Area wind speed and direction information indicated that winds from the southwest were likely to be predominant at the Reno Creek site. These air sampling stations were used to collect an initial 12 months of data beginning in the Fall of 2010. These initial air sampling stations were identified as AM#1 through AM#6, and are shown on TR Figure 2.9-1.

AUC installed a meteorological station on the Reno Creek Project site, which began collecting data in October of 2010. The onsite meteorological station was established at approximately the same time as the initial set of air sampling stations became operational. The meteorological station data was compiled and produced the figure shown below, which is a reproduction of ER Figure 3.6-24: Reno Creek Project Windrose.

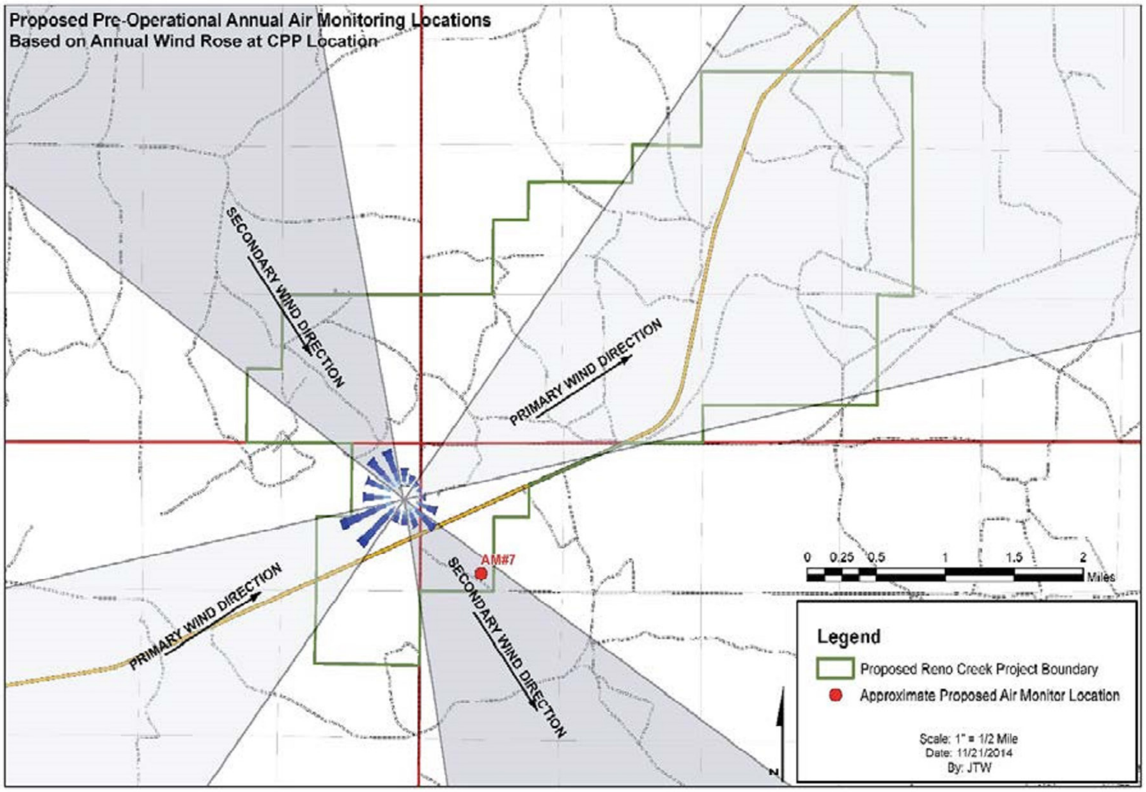


In July, 2012, AUC moved three of its five air sampling stations (AM#4, AM#5 and AM#6) to new locations and began a new air particulate, radon, soil and integrated gamma sampling program. The revised monitoring locations were selected based on wind rose data from AUC's onsite meteorological monitoring program and the proposed CPP location. Monitoring continued at all 5 of the air sampling stations into November, 2013; a total of 16 months.

Those air sampling stations ID's were modified to indicate their new locations. Air sampling station AM#4, after more than a year of operation, was re-positioned to location AM#4-2, on the site boundary and close to the CPP in the prevailing wind direction. Air sampling station AM#5, after more than a year of operation, was re-positioned to location AM#5-2, on the site boundary and near a potential new residential structure (that structure is no longer planned for construction). Air sampling station AM#6, after more than a year of operation, was re-positioned to location AM#6-2, offsite and upwind of the planned CPP, to develop pre-operational site background data. Air sampling station AM#3, after more than a year of initial operation, was no longer required and was sidelined as a backup system. The locations of the re-positioned air sampling stations are shown on a revised Figure 2.9-1, which was submitted with the June 2014 TR RAI Response Package.

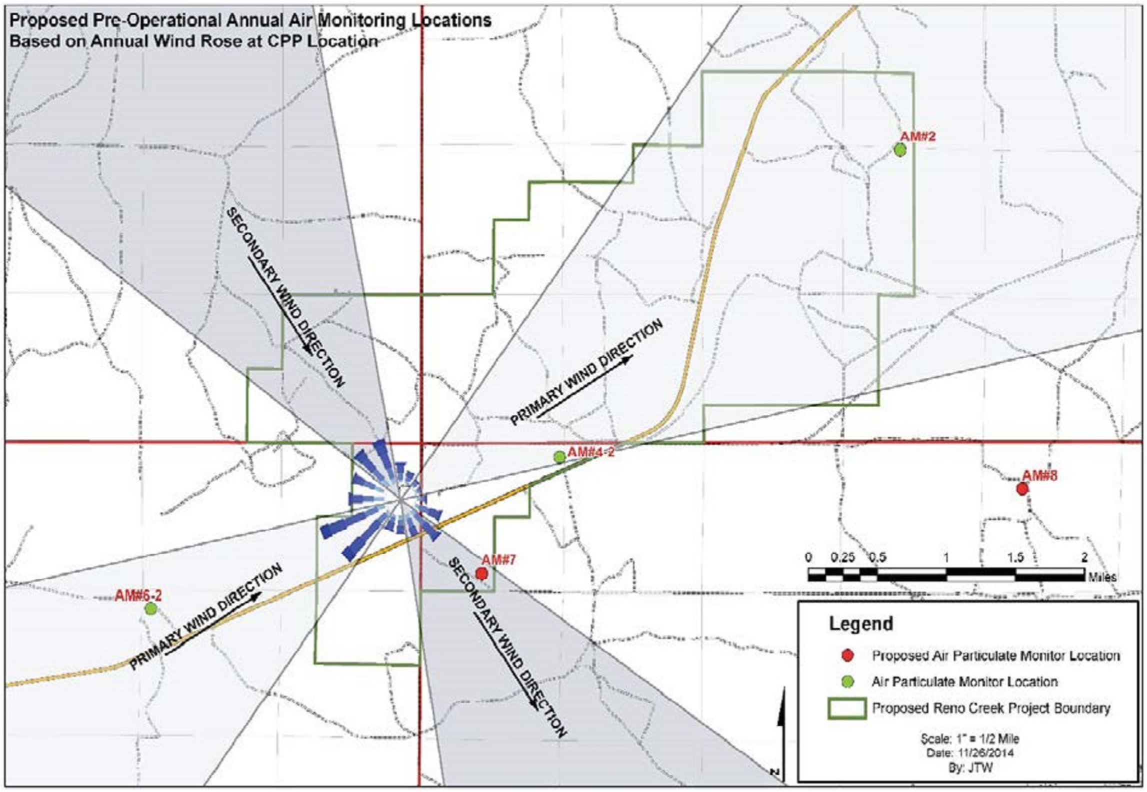
Subsequently, NRC staff requested that AUC review the locations of the air sampling stations to ensure that the new locations conform to Regulatory Guide 4.14, Table 2, Operational Radiological Monitoring Program for Uranium Mills. Specifically the reviewer requested that AUC make sure that three of the air sampling stations are located at or near the site boundaries in different sectors that have the highest predicted concentrations of radioactive materials. Regulatory Guide 4.14 requires that these locations take into account not only the prevailing wind direction, but also the distance from the source (CPP). In order to fulfill this requirement, one of the air sampling stations could be located in a sector with a less dominant wind direction but closer to the source point.

AUC has reviewed the current air sampling stations locations and has determined that air sampling station AM#5-2 is not in a location that meets the above listed requirements from Regulatory Guide 4.14. Therefore, AUC proposes relocating this air sampling station to a location southeast of the CPP in Section 6 of T42N, R73W near the proposed Project Boundary. The sampler will be renamed AM#7. The proposed approximate location of AM#7 is shown on the figure below. This location is in the vicinity of the highest dose predicted by the preoperational MILDOS model results, included as TR Addendum 7-A of the application.



Also, during AUC's review of the locations of the air sampling stations, AUC determined that AM#1 located at the Leavitt Ranch Hand House (MILDOS Figure 3, Modeled Receptor and Production Unit Centroid Locations) is not positioned at the nearest residence. AUC recognizes that the term "nearest" as specified in footnote (b) to Table 2 in Regulatory Guide 4.14 means the location with the highest predicted airborne radionuclide concentrations during milling operations. The MILDOS report shows that the Leavitt Ranch House, also shown on Figure 3, receives a higher predicted dose than any other residence throughout the project life. Therefore, to be in compliance with Regulatory Guide 4.14, Table 2, AUC proposes relocating air sampling station AM#1 to the vicinity of the Leavitt Ranch House. It will be renamed AM#8. AUC will begin collecting 12 months of pre-operational data from these two new sampling locations. AUC will submit the data to NRC after compilation.

The figure below shows the proposed final air sampling locations that will have been used for pre-operational air sample data collection and will continue to be used to collect data at the same locations during operations.



Air sampling station AM#6-2 is the control (background) station and AM#8 air sampling station will become the nearest residence station. In addition to air particulate sampling, these stations will include monitoring for direct radiation and radon, and soil sampling as specified in Regulatory Guide 4.14. AUC has revised TR Figure 2.9-1 to include the proposed approximate locations of AM#7 and AM#8.

The following text will be added to TR Section 2.9.5:

"AUC reviewed the air sampling stations locations and determined that air sampling station AM#5-2 was not in a location that meets the listed requirements from Regulatory Guide 4.14. Therefore, AUC relocated this air sampling station to a location southeast of the CPP in Section 6 of T42N, R73W near the proposed Project Boundary; it has been renamed AM#7. The location of AM#7 is shown on TR Figure 2.9-1. This location is in the vicinity of the highest dose predicted by the preoperational MILDOS model, output included as TR Addendum 7-A of the SML application. During AUC's review of the locations of the air sampling stations, AUC determined that AM#1 located at the Leavitt Ranch Hand House (MILDOS Figure 3, Modeled Receptor and Production Unit Centroid Locations) was not positioned at the nearest residence as defined by Regulatory Guide 4.14, Table 2, the residence of highest predicted dose. The MILDOS report shows that the Leavitt Ranch House receives the highest predicted dose of any residence throughout the project life. Therefore, to be in compliance with Regulatory Guide 4.14, Table 2, AUC relocated air sampling station AM#1 to the Leavitt Ranch House; it has been renamed AM#8.

RAI-20(c) Response

During AUC's pre-operational radiological baseline monitoring program AUC staff noticed an anomalous reading in a data set returned by Landauer for Radtraks deployed at Reno Creek air sampling stations. The anomaly involved a negative result (a less-than-zero radon concentration indicated within the data details). AUC's discussions with Landauer staff determined that, on occasion, routine subtraction of Landauer's unexposed, background radon detector concentration results could lead to such a reading. Further discussion identified the potential source of the problem: the polymer detector element is subject to surface defect variability from the supplier from batch to batch. The number of such defects that, after etching, present themselves as alpha tracks and are thus counted as radon decay progeny alpha particle interactions is small. But, that small number can be relatively large when compared to the small number of actual alpha particle tracks seen in detectors returned from onsite monitoring stations. When Landauer's stored, unexposed background detector results are subtracted from such field samples, occasionally the unexposed detectors' count totals may exceed the totals from a field sample.

Compounding the problem was the background sample protocol in use by Landauer, involving the averaging of results from the unexposed, background detectors across several batches of the sensitive polymer. An unusually high rate of surface imperfections in one of these batches, when averaged with other unexposed detector data, could increase the likelihood that the subtracted, background values could exceed the total count seen on a field detector exposed to very low radon concentrations.

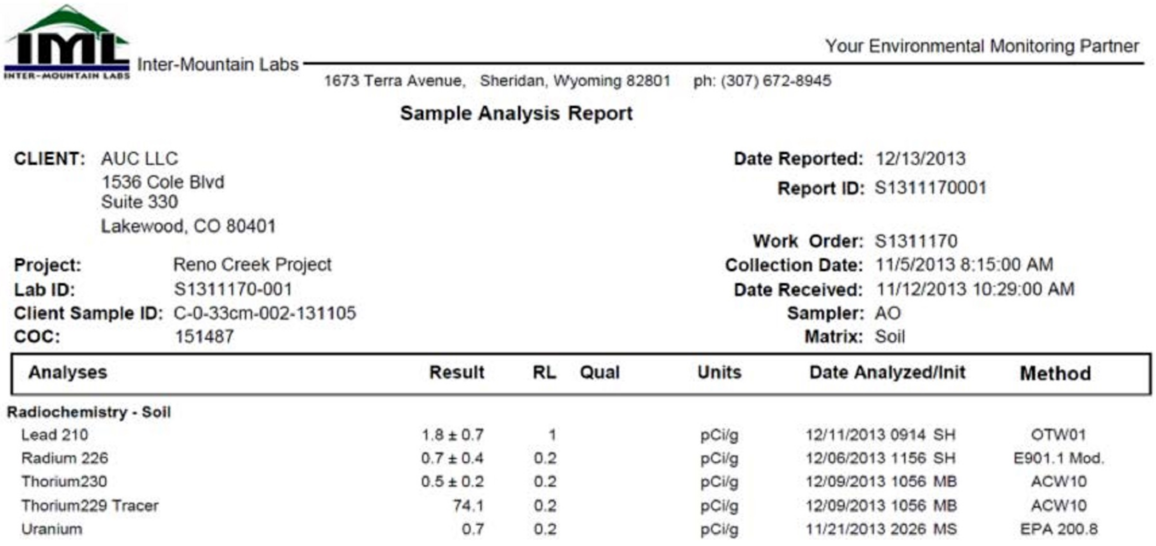
As a result of these findings, AUC instructed Landauer to prepare and ship monitors to AUC in groups that correspond to batches of polymer, so that the background subtraction process occurs only within the manufacturer's same batch of polymer. Under this revised sampling method, AUC has not observed any "negative" Radon detections; the quality and accuracy of the Radon measurements has been enhanced.

At a recent US NRC workshop held in Bethesda, Landauer staff noted that past errors in reported radon concentrations using Radtrak devices may have been related to seal leakage in the radon-proof bags used to store and ship unexposed Radtrak detectors. AUC will only employ Radtrak detectors packaged according to Landauer's resulting, revised sealing process. This modified process includes vacuum packaging, such that seal leakage can be easily observed as expanded storage bags, at the point of customer deployment or when Landauer retrieves stored background samples. This process will reduce measurement errors associated with radon tracks inadvertently accumulated during storage and or shipment.

While it is not possible, after the fact, to definitely identify the cause(s) of the three noted anomalous readings noted per this RAI, it may be that the three noted low values reported for AM#4-2 and AM#6-2 are related to certain of the issues noted above.

RAI-20(d) Response

In Table 2.9-6, "RL" represents Reporting Limit. There are no uncertainties reported for the uranium analysis, per method EPA 200.8. See screenshot below:



Inter-Mountain Labs — Your Environmental Monitoring Partner
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: AUC LLC
1536 Cole Blvd
Suite 330
Lakewood, CO 80401

Date Reported: 12/13/2013
Report ID: S1311170001
Work Order: S1311170
Collection Date: 11/5/2013 8:15:00 AM
Date Received: 11/12/2013 10:29:00 AM
Sampler: AO
Matrix: Soil

Project: Reno Creek Project
Lab ID: S1311170-001
Client Sample ID: C-0-33cm-002-131105
COC: 151487

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Radiochemistry - Soil						
Lead 210	1.8 ± 0.7	1		pCi/g	12/11/2013 0914 SH	OTW01
Radium 226	0.7 ± 0.4	0.2		pCi/g	12/06/2013 1156 SH	E901.1 Mod.
Thorium230	0.5 ± 0.2	0.2		pCi/g	12/09/2013 1056 MB	ACW10
Thorium229 Tracer	74.1	0.2		pCi/g	12/09/2013 1056 MB	ACW10
Uranium	0.7	0.2		pCi/g	11/21/2013 2026 MS	EPA 200.8

RAI-20(d) Response

In Table 2.9-12 through 2.9-15, "ND" represents Non-Detect as the laboratory only reports results that are equal or exceed the reporting limit.

RAI-20(e) Response

Table 2.9-5 provides summary statistics for all of the subsurface Ra-226 results, and not individual results. Five subsurface sample sets were submitted for Ra-226 analysis, per Reg. Guide 4.14 guidance. Because only the Center subsurface sample was submitted for full radionuclide suite analysis (per Reg. Guide 4.14 guidance), those results were placed in separate Table 2.9-6.

RAI-21

Description of Deficiency

In Section 2.9 of the TR, the applicant stated that it conducted pre-operational continuous air sampling and filters were collected weekly initially, but extended filter replacement collection to a monthly frequency in 2011. The applicant indicated that the change in filter replacement was due to cost efficiency and safety for personnel working in sometimes harsh site conditions. The applicant indicated that the filter size was increased to four inches from 47 millimeters and provided a technical basis in Addendum 2.9-C.

Basis for Request

The applicant has not adequately demonstrated that the changing of the sampling frequency from weekly to monthly will not adversely impact accuracy of results due to dust loading. Regulatory Guide 4.14 states that the sample collection frequency should be a weekly filter change or more frequently as required by dust loading. NRC has determined that dust loading can adversely affect the activity on the filter as certain radioactive particles (i.e., alpha and beta) on the filter can be absorbed by the dust prior to reaching the detector. If dust loading is present on an air filter, the amount of dust should be accounted for to correct for the true activity on the filter. NRC staff reviewed TR Addendum 2.9-C and determined that the applicant did not provide any data or discuss the impact (or lack of impact) of dust loading on a 47 millimeter filter collected over one week versus dust loading on a 4 inch (101.6 millimeter) filter collected over one month. More specifically, the applicant did not discuss the type of analysis when evaluating the dust loading on the filter. A stand-alone statement by itself indicating that a 4 inch filter over a 30 day collection period compared to a 47 millimeter filter with a collection period of one week is not sufficient to demonstrate the benefits of using a 4 inch filter paper over a 30-day period.

Formulation of RAI

Provide additional information regarding merits of using a large filter at a longer frequency using dust loading data or a similar study performed by another entity, and its relation to accuracy of the analytical counting method that will be used to determine filter activity. Furthermore, explain how the dust loading on the filter at the proposed sampling frequency impacts counting efficiency and accuracy of results.

RAI-21 Response

The Proposed Project converted from one week air particulate sampling intervals to four week intervals beginning in 2011. The modification was made after discussions with the

NRC to determine that validation of the protocol described here would result in data acceptable for licensed facility use. To ensure that filter dust loading per unit area would not be increased, causing potential air flow rate reduction, the size of the filter media was quadrupled. Air volume flow rates were not changed, so the total dust mass per unit time entering a filter would remain the same. Therefore, dust loading per unit filter area would be the same as for the smaller, 47 mm filters.

The accuracy of the laboratory analytical method is unchanged: All filters collected from a sampler during each three month period are composited and analyzed using the same Method employed for the 47 mm filters. The procedure used by the contract laboratory IML may be summarized as follows:

- Analytical Method - SW846 3950B
- Hot nitric acid digest for 8 hours
- Method variation: The volume of nitric acid is increased to cover the 4" filter (vs. a 47 mm filter). Hydrochloric acid addition is omitted as unnecessary to achieve dissolution.
- All the material on the filter is dissolved; small portions of the filter matrix itself may remain.
- Standard QA/QC practices are applied and recorded.

Per the IML laboratory manager, counting efficiency and accuracy of the laboratory results are not impacted.

The purpose of the exchange interval increase was to simplify the air particulate sampling process, reducing field time for local staff who may be subjected to extreme weather conditions in Wyoming. Reducing the number of filters handled during a 3-month collection period also increases time efficiencies and reduces the potential for handling, storage and analysis errors.

The change from a weekly- to a monthly-exchange process included a validation period. This involved a stepped approach, moving from 1- to 2- to 4-week filter exchange intervals over a period of several months, to watch for unexpected effects. The solar-powered air samplers were examined weekly during this period; instantaneous flow rates and weekly totals were recorded. The resulting data are shown in the attached plots. Air flow rate, as measured by the air sampler pump, was used as a proxy for dust load on a filter. Air flow rate over time (total volume) is the variable of interest in determining minimum detectable radionuclide activity.

The air particulate filter diameter was increased from 47 mm to four inches. The four-inch filter's particle collection area is more than four times the 47 mm filter's surface area. The system's air volume flow rate remained constant at about 30 liters per minute. Dust mass entering the filter is directly proportional to the air volume flow rate: Increasing the sampling period by a factor of four and increasing the filter area by a similar factor ensures that dust loading per unit area should remain constant. Data to verify the results of this logic are presented below.

Dr. Robert Meyer, AUC Reno Creek Project Radiation Safety Officer, carefully reviewed the full air sampler data set on which this study is based, and deleted readings determined to be of no value to this specific study of the filter exchange interval's effect on flow rate. Data removed involved startup weeks, periods during which particular air samplers functioned erratically or were being repaired, and similar issues. For example, air sampler AM-2 showed significant variability during much of the period; its data are not evaluated here. The data set presented here includes all data appropriate to this specific study; nothing was deliberately removed that would bias this study's result.

It should also be noted that, although some air sampler mechanical/electrical problems are evident in the complete data set, in all cases sufficient total air volumes were collected over each 3-month quarter of interest to meet the MDA requirements specified in Regulatory Guide 4.14.

The F&J air sampler pumps used in these systems are computer-controlled, adjusting power to the motor, up to the pump's limit, to maintain flow rate. Therefore, flow rate is maintained in the neighborhood of 30-35 liters per minute, even if some dust loading restriction at the filter occurs. However, the ability of these pumps to maintain flow rate is quite limited: the systems are operating near their maximum flow rate even with clean filters. This is because the pumps were originally selected for their very low power requirements (about 11 watts), allowing them to be used in continuously-operating solar-powered samplers. The pumps have only a small margin of excess flow rate capability. The data presented here would be expected to show significant flow reductions exceeding the capacity of the pumps to compensate if dust loading were a problem. Such reductions would become increasingly apparent toward the end of an extended sampling period.

This study is based on inspection of the following plots showing the weekly instantaneous flow rates for each sampler. Those flow rates would show decreases during a sample collection interval if dust loading were a problem. Gradual decreases in flow rates over the two- and four-week sampling periods are not evident in the data plots.

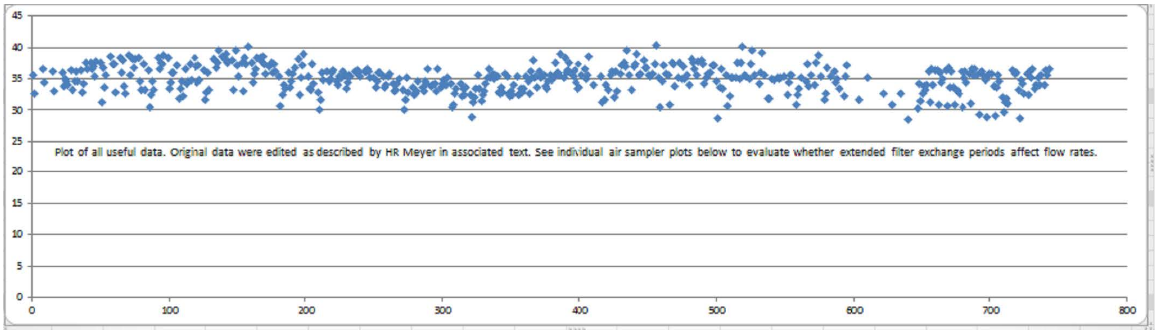
Two of the data plots are annotated to help illustrate this observation. The plots are marked to indicate when each sampling period ended (when one-, two- or four-week sampling intervals ended with filter exchanges). Each annotated plot begins with a period of 1-week sampling intervals, then moves to two-, then four-week intervals as annotated. Dr. Meyer has not annotated all of the data plots presented below, but has examined them all and finds no downward trends that terminate at a filter replacement.

Therefore, extending the air particulate filter exchange period from one week to four weeks, using four-inch filters and no change in the sampler's volume flow rate setting, does not result in significant reductions in volume flow rate. Dust loading over four week periods is not found to be a factor affecting the air particulate sampling results.

The following plots present the data evaluated for this study. Data sufficient to draw conclusions were available by fall, 2012; this analysis focuses on those data. Data collection continued through fall, 2013 but those results are not analyzed here. Some samplers ran for extended periods, others for shorter periods, depending on variables including access restrictions and sampler location changes. The first plot, immediately below, presents all useable data for all samplers. The remaining plots present data for individual air samplers.

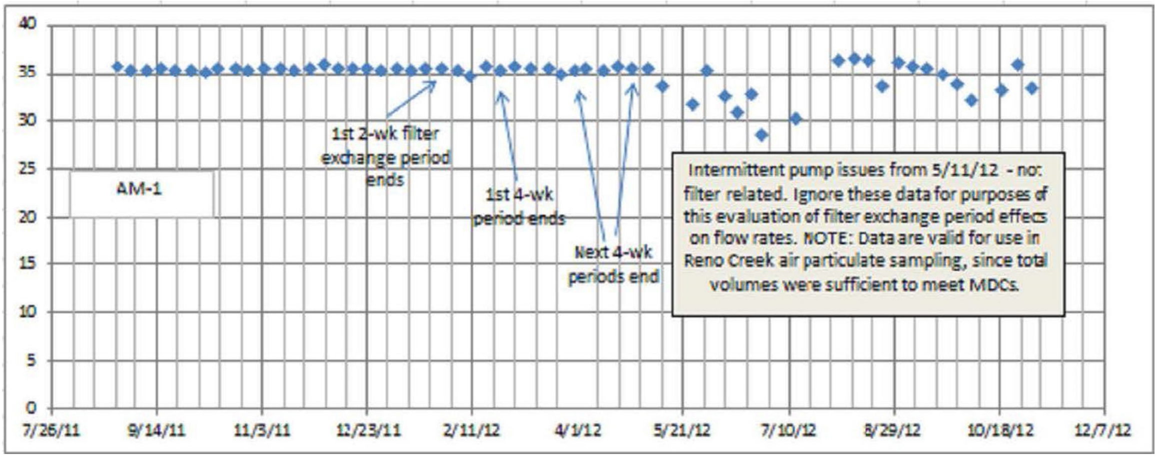
.

Evaluated data – All air samplers



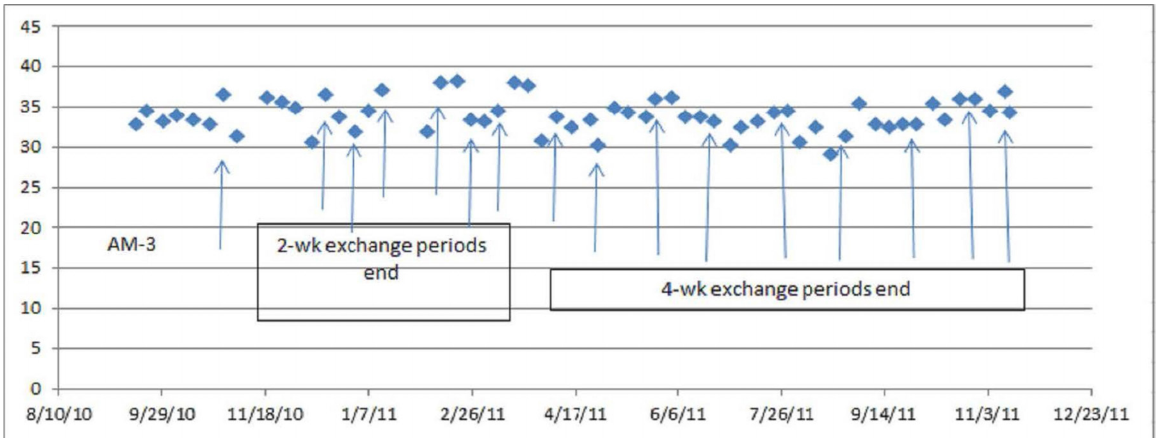
Plot of all useful data. Original data were edited as described by HR Meyer in associated text. See individual air sampler plots below to evaluate whether extended filter exchange periods affect flow rates.

Air Sampler AM-1

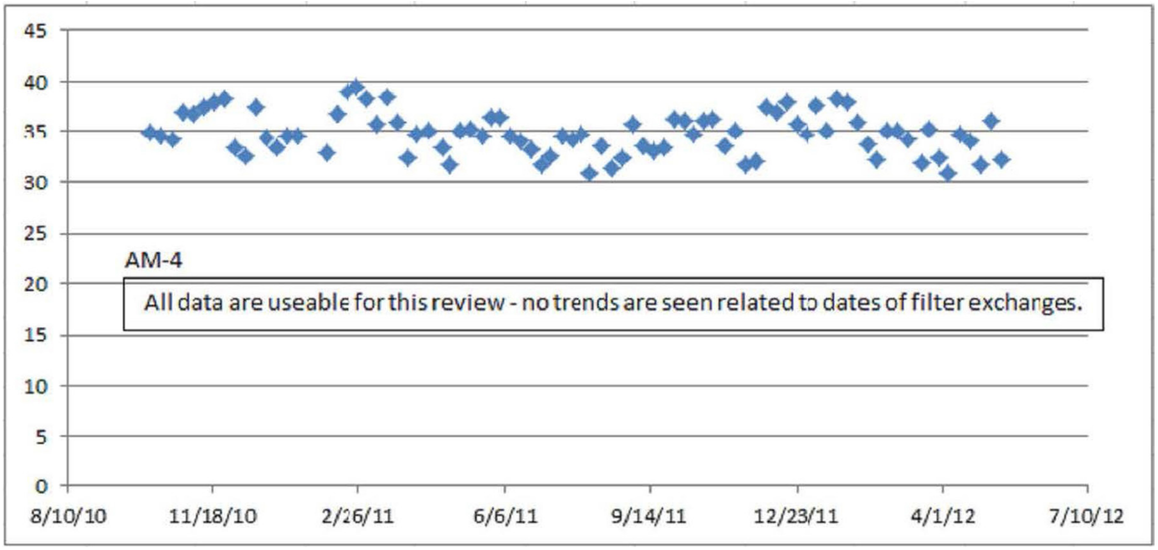


Intermittent pump issues from 5/11/12 - not filter related. Ignore these data for purposes of this evaluation of filter exchange period effects on flow rates. NOTE: Data are valid for use in Reno Creek air particulate sampling, since total volumes were sufficient to meet MDCs.

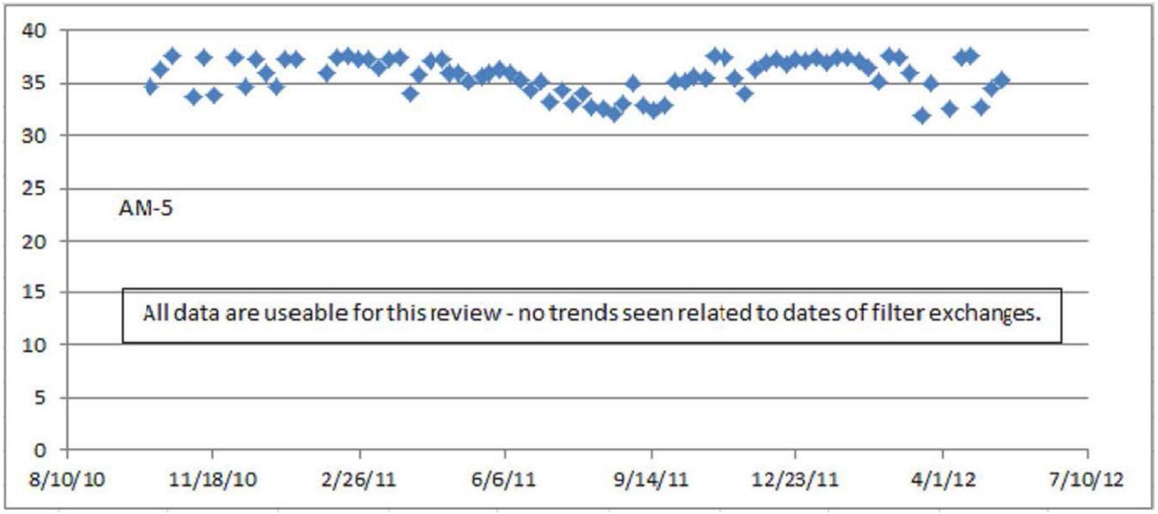
Air Sampler AM-3



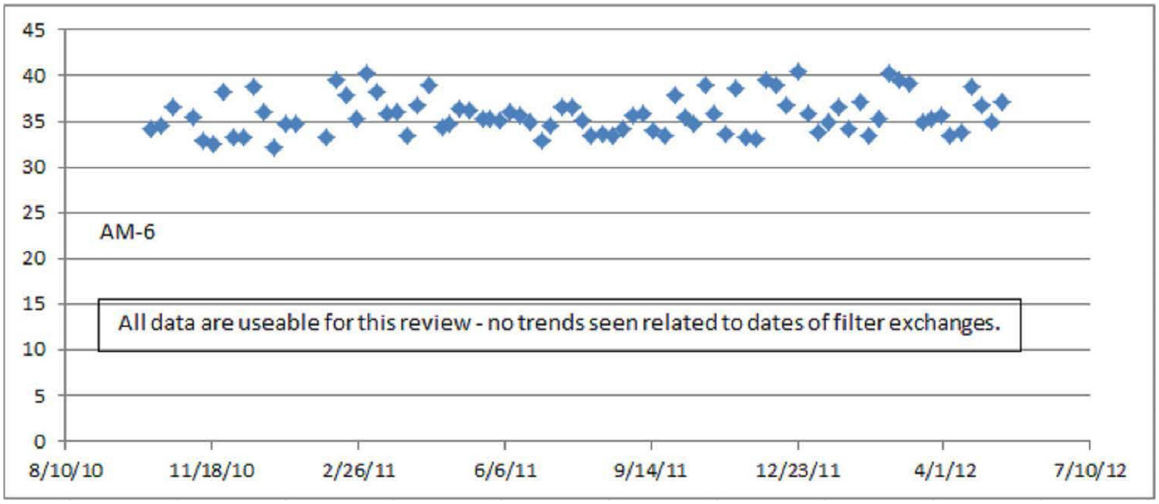
Air Sampler AM-4



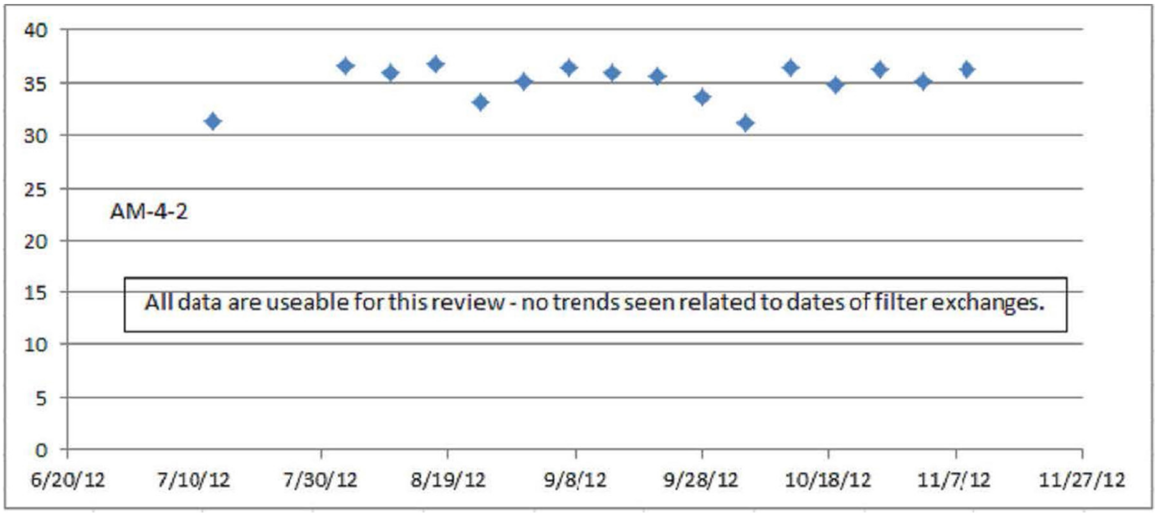
Air Sampler AM-5



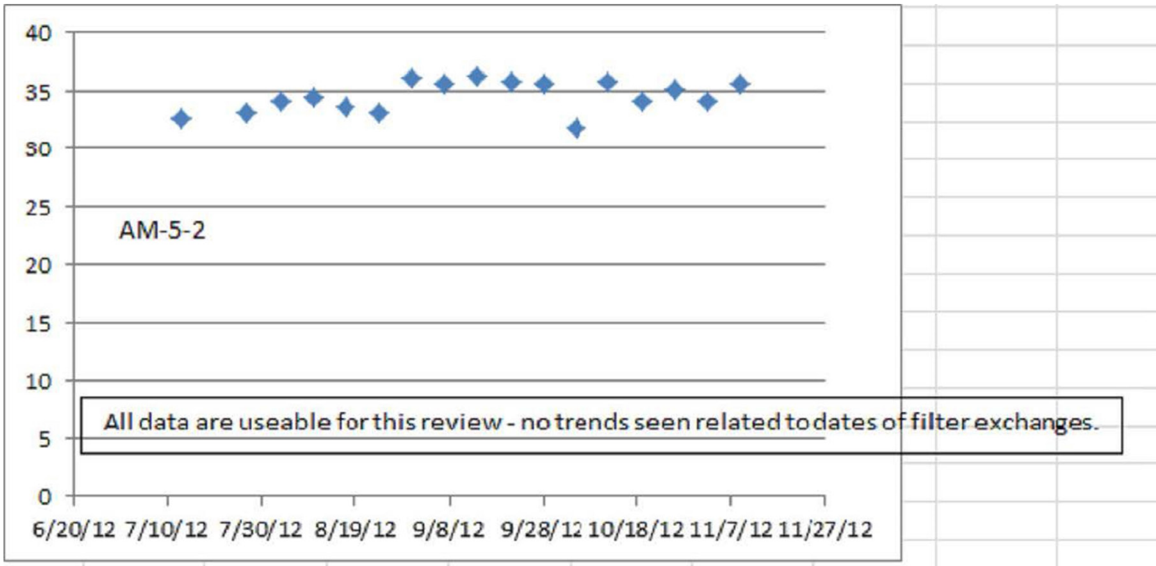
Air Sampler AM-6



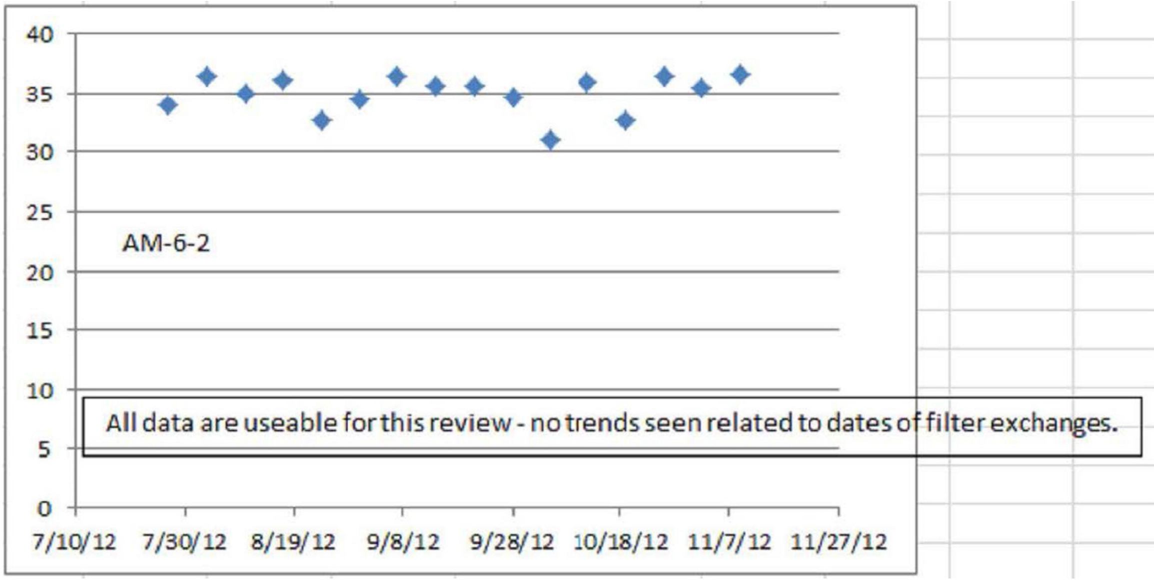
Air Sampler AM-4-2



Air Sampler AM-5-2



Air Sampler AM-6-2



All data are useable for this review - no trends seen related to dates of filter exchanges.

RAI-22

Description of Deficiency

In TR Section 2.9.8.1, the applicant proposes and used the "low-flow" sampling methodology during collection of background groundwater samples for the pre-operational monitoring program. The applicant further states that the wells were sampled (for the pre-operational monitoring program) using "EPA-approved" low-flow procedures, including use of a low-flow purge rate of 0.1 liters per minute and in-line monitoring of stabilization parameters. Although not directly stated, in Section 5.7.8 of the application, the applicant suggests that low-flow purging techniques may be used for sampling of groundwater for the subsequent groundwater protection detection monitoring program(s).

Basis for Request

The applicant fails to include references for the "EPA-approved" procedures. Staff cannot make assumptions about the reference documents to which the applicant is referring (e.g., EPA Regional Offices' Standard Operating Procedure (e.g., EPA Region 1 SOP-GW-001) as the application does not include a proper reference. The applicant provides a SOP-5 "Ground Water Sampling (Low-Flow)" in Appendix 2.9-A of the application. Although the applicant provides general concepts in its Standard Operating Procedures (SOP) that are consistent with guidance in the above referenced EPA SOP, the applicant is silent on how several applicable implementation procedures (e.g., low stress), including that low-flow sampling, may not be appropriate for low-yielding wells, and that more appropriate sampling procedures for low-yielding wells other than the "low-flow" methodology are found in other guidance documents (e.g., EPA 542-S-02-001) and should be used as applicable.

In addition, groundwater sampling methodologies at existing ISR facilities are not the "low-flow" method but hybrid methods consisting of purging one or more well volumes followed by stabilization of selected parameters. However, the applicant has applied its proposed methodology to the pre-operation site characterization monitoring program for the application. Based upon staff's review of the ground water quality reported for various sampling locations in the application, staff identified a significant variability in field-measured pH and temperature levels for the groundwater, which indicates insufficient well completion and/or sampling methodologies.

Section 2.7.3 of the SRP states:

> *"The applicant should show that water samples were collected by acceptable sampling procedures, such as American Society for Testing and Materials D4448 (American Society for Testing and Materials, 1992)."*

Formulation of RAI

Based on the above, please provide clarifications for the following:

(a) Please provide well completion report and/or boring log for all monitoring wells. If the completion report and/or boring log does not document well completion activity, please provide that information in a separate submittal.

(b) Please justify the use of "low-flow" sampling methodology for a low-yielding well especially for: (1) purge volumes approximately equal the volume of water removed from the well; and (2) effects on trace metal levels (in particular uranium) at well UM3R where the first sampling event used non-low-flow techniques and the last three events used low-flow techniques.

(c) Please comment on the significant variability of reported field-measured pH levels at several wells with emphasis on suitability of the sample as representative of the aquifer.

(d) Please comment on the variability of reported temperatures for all samples, which appear to correlate with the ambient temperatures at the time of sampling with emphasis on the suitability of the sample as representative of the aquifer.

(e) Please provide the methodology for wells sampled for the pre-operational monitoring program but were not sampled using low flow techniques.

(f) The RAI stated that several boring logs did not document well completion activity. The main thrust was well development. Table 2.7B-1 presents well completion details but does not document well development. Well Completion report for OM-3 (Page 2.7D Appendix E-11) does contain development info but well completion for SM-3 (Page 2.7D Appendix E-10) does not. Where is the information that the wells were developed? This is an open issue due to the fact that AUC did not state that the wells used for site characterization were properly developed prior to sampling.

(g) The RAI requested justification for the low-flow sampling methodology. The applicant provided a justification that the "traditional" method likely contributed sediment to the first sampling at UM3R thus resulting in higher uranium concentrations and that water within the well screen is an approximation to that in

the aquifer due to lack of advective flow in a low conductivity formation. These arguments are insufficient and will be discussed.

(h) *John Saxton (Hydro). Verbal from 10/8/2014 NRC Public Meeting:*

(1) *NRC requested AUC to determine if deeper sandstone units are present below the Underlying Unit (UM-prefix wells) and to determine if these deeper sandstone units potentially communicate with the Production Zone Aquifer (PZA).*

(2) *Provide an estimate of long term yield for the Underlying Unit to verify the this unit does not meet the definition of an aquifer according to 10 CFR Part 40, Appendix A.*

RAI-22(a) Response

Well completion reports are provided in Appendix E of Regional Hydraulic Test Report (Addendum 2.7-C) and Table 2.7B-1 presents the well completion details in tabular form.

AUC found that Addendum 2.7-C cover page is erroneously labeled as “Groundwater Model Report” and has been revised to read “Regional Hydraulic Test Report”.

RAI-22(b) Response

The traditional approach to sampling low-yielding wells is evacuation of the well by bailing or pumping and then sampling upon adequate recovery. This sampling methodology poses several concerns:

- Possible dewatering of the screen can result in agitation, aeration and oxidation of formation water, therefore potentially causing the precipitation of solids and resulting in nonrepresentative samples.
- High pumping rates can stress the formation and mobilize any sediment settled in the bottom of the well or formation resulting in increased sample turbidity and gross overestimation of certain analyses, particular metals. Many of these solids are artifactual (e.g. well construction) or immobile under natural conditions resulting in nonrepresentative samples. This is potentially the source of the uranium concentration variability between the first sampling event that used traditional sampling methods opposed to low-flow methods used for the following three sampling events.

- The time required for recovery sufficient to produce the necessary sample volume may be excessive, affecting sample chemistry through prolonged exposure to the atmosphere.
- Purging below the top of the well screen may cause "jetting" or cascading into the screen as the well recovers, affecting the concentration of the analytes through the precipitation of dissolved metals.

AUC employed dedicated bladder pumps capable of operating at very low discharge rates (less than 100 mL/min) to control drawdown and avoid disturbing the water column or stirring up sediment within the well. This low-flow or minimum purge method sampled the water within the well screen without purging any stagnant water above the screen. This produces samples without increased turbidity and with minimal alteration of the sample chemistry. Although there is only a limited exchange of water in the screen with the surrounding formation, avoiding the alteration caused by the issues mentioned above makes low-flow or minimum purge sampling the better alternative. In effect, since advection is not a major factor in the transport of contaminants in the subsurface in very low hydraulic conductivity formations, the water within the well screen is an approximation of the water chemistry in the surrounding formation or sand pack through the process of diffusion.

<u>RAI-22(c) and (d) Response</u>

The suitability of the sample as representative of the aquifer should not be based on one or two stabilization parameters. While temperature and pH are important for data interpretation purposes, they are actually quite insensitive in distinguishing between formation and stagnant casing water. It should also be noted that turbidity is a very conservative parameter in terms of stabilization. Other parameters are more significant when establishing that a well has stabilized and the groundwater is representative of the aquifer:

1. Pump Intake Placement- Placement of the pump intake within the screened interval results in representative water quality of the adjacent target formation.
2. Flow rate/drawdown- the goal is minimal drawdown during purging indicating that water pumped from the well is derived directly from the target formation and not from the stagnant water above the screened zone.
3. Conductivity and dissolved oxygen- The inverse relationship between these parameters are what is typical of stabilization. As dissolved oxygen goes down there are more metal ions in solution thus causing electrical conductivity to go up.

Once these parameters have stabilized it is a good indication of stabilization and initiation of sample collection.

RAI-22(e) Response

The sole preoperational baseline monitoring well sampled using traditional sampling methods was UM3R. As noted by the reviewer, this was isolated to the first sampling event for this monitor well.

Most traditional approaches to groundwater sampling are based on the assumption that all water that resides in the well is stagnant and does not represent the chemistry of the water in the formation. Thus, the objective is to remove all stagnant water and induce fresh formation water to enter the well so it can be collected as a sample. This was accomplished by purging three well volumes using an electric submersible pump. The volume of water required to be purged was calculated by using a casing volume per foot factor for the well. The measurements of record for the sampling event, pH, specific conductance, dissolved oxygen, temperature, and turbidity were measured and recorded, during collection of the sample from the recovered volume.

RAI-22(f) Response

The following has been added as the last two paragraphs of TR Section 2.7.2.10.2

"Following well completion, each of the regional baseline monitor wells was developed by air lifting, swabbing, bailing, jetting or a combination of one or more of these techniques. The purpose for developing a well is to provide good communication between the well and formation by removing drilling fluids and fine materials that may have become imbedded in the formation adjacent to the well completion interval during well installation.

The field parameters AUC monitored during development activities were specific conductance, pH and temperature. A monitor well was not deemed to be fully developed until the field parameters had stabilized at representative formation values."

RAI-22(g) Response

Pump Placement

Field studies and numerical models (Varljen, 2006) have shown that, regardless of the pump intake position within the well screen, sample results should be comparable and will represent a flow-weighted average concentration of target analytes. Although, caution should be taken not to position the pump at the top of the screen to avoid drawing in stagnant water from storage in the casing above. Similarly, if the pump is placed too low in the screened zone, mobilization and entrainment of settled solids at the bottom of the well can occur.

In a low yielding well where water levels can be below the top of the screen, the pump is not placed in the middle of the well screen itself but the middle of the targeted saturated zone. The key objective is to make sure that pump operation is not lost during purging and the pump is placed lower in the screened interval as opposed to higher to maintain submersion of the pump.

AUC's well construction methods allow for proper placement of groundwater sampling pumps within the well screened interval to accommodate low-flow sampling techniques.

Volumes and Rates

Prior to groundwater sampling events, the sampling team established the following volumes and rates:

- Volume of the pump and discharge tubing to calculate minimum purge volumes;
- Optimum pump discharge rate to minimize mobilization of solids and stabilize drawdown; and
- Time required to evacuate one volume of the flow-through cell to establish the frequency of the measurements to confirm independent water quality parameter measurements are acquired.

For wells in which dedicated pumps are used, chemical indicator parameters typically stabilize shortly after the volume of the pump and discharge tubing has been purged. Wells that use non-dedicated pumps, the effects of pump installation on the water column typically require longer purging times before chemical parameters stabilize.

References

Varljen, M. D., M. J. Barcelona, J. Obereiner & D. B. Kaminski, (2006). Numerical simulations to assess the monitoring zone achieved during low-flow purging and sampling. Ground Water Monitoring and Remediation, 25, 44-52.

RAI-22(h)(1) Response

AUC has used the following cross sections to determine if sandstone units above the Badger Coal and below the Underlying Unit are present and in communication with the PZA:

- TR Addendum 2.6-A_B_C Figures 2.6A-12;
- TR Addendum 2.6-A_B_C Figure 2.6A-16; and
- TR Addendum 2.6-A_B_C Figures 2.6A-18 through 2.6A-23.

AUC has mapped sandstone units lying within the aquitard below the PZA on the cross sections. The first underlying sandstone unit below the PZA has been designated the Underlying Unit. As seen on the cross sections other deeper potential sandstones are also present (as interpreted from electric logs). However, AUC's lithologic logs (geologist's descriptions of drill cuttings) of the deep stratigraphic holes at the proposed project often did not confirm the presence of a sandstone. Therefore AUC concludes that potential sandstones below the Underlying Unit and above the Badger Coal are discontinuous, silty, and poorly developed.

The distance between the bottom of the PZA and the top of the Underlying Unit is highly variable due to the vertical position of the Underlying Units within the underlying aquitard. Aquitard thicknesses between the base of the PZA and the top of the Underlying Unit sands range from approximately 12 to 104 feet, based on a series of stratigraphic drill holes installed prior to drilling the pump test wells in each of the monitor well clusters.

The aquitard that immediately underlies the PZA has a measured vertical permeability of 0.00058 md (TR Section 2.6.2.4). This permeability prevents communication between the PZA and any sandstone units lying within the aquitard. To verify that conclusion, AUC proposed a Pump Test Plan to test for communication between the PZA and the first underlying sandstone in the aquitard at multiple locations. NRC reviewed and approved the Pump Test Plan.

Multi-well pump testing conducted in accordance with the plan was reported in Petrotek's Reno Creek Project Regional Hydrologic Test Report (TR Addendum 2.7-D_E). The pump tests demonstrated that the underlying sandstones are not in hydrologic communication with the PZA, and do not meet the characteristics or NRC's definition of an aquifer.

The distance from the base of the various Underlying Units and potential sandstone units lying above the Badger Coal ranges from 46 feet to 156 feet based on the cross sections referenced above. Therefore AUC reasonably concludes that if 12 to 104 feet of aquitard between the PZA and the Underlying Unit is sufficient to prevent communication, then it would not be possible for communication to occur with the deeper sand units lying above the Badger Coal.

RAI-22(h)(2) Response

In TR Section 2.7.2.3 of the License Application, the Underlying Unit (UM-prefix wells) at the Reno Creek Project is described and based on the results of testing conducted at four Underlying Unit wells, it is stated that this interval does not meet the NRC definition of an aquifer within the Proposed Permit Area, due to the low well yields and hydraulic conductivities evaluated at these wells.

Additional information was requested by the NRC regarding the long-term well yields that could be expected based on the results of hydrologic investigations conducted in the Underlying Unit to support the conclusion that this interval does not qualify as an aquifer. The following summarizes the results of testing, and provides additional information related to expected estimates of well yield at the four tested wells in the Underlying Unit. The results of testing conducted in this interval are detailed further in TR Section 2.7.2.7.

Based on the hydrographs of water levels observed during pumping within the Underlying Unit, much of the groundwater withdrawn during these tests was from wellbore storage with minimal input from the screened intervals. Thus, these tests were short in duration, as drawdown quickly reached values of 100 feet or more, and the tests were terminated as water levels reached near the level of the pumps. Water level changes during these short duration tests were observed as a unit slope, indicating the predominance of wellbore storage that is reflected in these water level declines.

Transmissivity (T) estimates were calculated based on the water level recovery data and are detailed in TR Section 2.7.2.7. Recovery in these wells was very slow and transmissivity values based on these recovery data were very low, as expected based on the predominance of wellbore storage and slow water level recovery observed during testing. The following table summarizes the calculated T values at each well location, where the saturated thickness of the Underlying Unit ranges between 14 to 18 feet. Based on these data for T, well yields based on a maximum drawdown of 100 feet were predicted based on a forward predictive model according to Theis (1935) for a 24-hour (short term) and a 1-week (sustained) pumping scenario. Well yields were evaluated for these two scenarios at a maximum predicted drawdown of 100 feet, which reflects an assumed depth at which the water level will fall to the level of a pump.

The Theis forward modeling was conducted utilizing the aquifer testing program AQTESOLV (HydroSOLVE, 2014). This evaluation predicts drawdown based on input aquifer parameters (T, storativity, and aquifer thickness) and an assumed pumping rate and duration. Transmissivity input values are based on the estimates of T from the recovery water level data evaluated at all wells. The value of storativity, which could not be evaluated during the single-well testing, was assigned a value of 5 x 10^{-4}, which is a reasonable estimate based on testing conducting in the overlying Production Zone Aquifer. The assumed pumping durations were 24-hours and 1-week. The program calculated the maximum pumping rates for each well to reach the 100 feet of drawdown within the specified time period, which are reported in the table below.

Well	**Transmissivity (ft^2/d)**	**Saturated Thickness (ft)**	**24-Hour Theis Prediction– Pump Rate to 100 ft of drawdown**	**1-Week Theis Prediction– Pump Rate to 100 ft of drawdown**
UM1	0.1	17	0.11 gpm	0.08 gpm
UM3R	0.07	14	0.08 gpm	0.06 gpm
UM4	0.22	17	0.21 gpm	0.16 gpm
UM5	0.44	18	0.38 gpm	0.30 gpm

Based on the estimates of transmissivity evaluated from single-well pump tests in the Underlying Unit, drawdowns in the wells are predicted to reach 100 feet in 24-hours at pumping rates between 0.08 gpm to 0.38 gpm, and are predicted to reach 100 feet after a week of pumping at rates between 0.06 to 0.30 gpm.

These estimates overstate the long-term or sustainable yield in the Underlying Unit, which would be even lower due to the slow recovery observed in these wells. Estimated sustained long-term yields of these wells would likely range from less than 0.06 gpm to approximately 0.3 gpm. These volumes do not qualify the Underlying Unit as an aquifer. Hydrologic testing, as well as drilling and logging data that indicate the Underlying Unit is discontinuous and has limited thickness, indicate that the Underlying Unit is not capable of transmitting sufficient volumes of water to qualify as an aquifer according to 40 CFR Part 40, Appendix A.

References

HydroSOLVE, 2014. AQTESOLV, version 4.50, developed by Glenn M. Duffield, HydroSOLVE, Inc.

Theis, C.V., 1935. The lowering of the piezometer surface and the rate and discharge of a well using ground-water storage. Transactions, American Geophysical Union, 16:519-24.

RAI-23

Description of Deficiency

In Section 2.9.10 of the TR, the applicant stated that vegetation grab samples were collected at sampling locations as identified in Figure 2.9-1 of the TR and the results are provided in Table 2.9-24 of the TR.

Basis for Request

The applicant did not provide vegetation samples and results at least three times in three different sectors during the grazing season. Regulatory Guide 4.14 recommends that forage vegetation should be sampled at least three times during the grazing season in grazing areas in three different sectors that will have the highest predicted air particulate concentrations due to milling operations.

Formulation of RAI

The applicant needs to collect vegetation samples at least three times during the grazing season in grazing areas in three different sectors that will have the highest predicted air particulate concentrations due to operations or provide a rationale for an alternative sampling regime for the staff's consideration.

RAI-23 Response

~~AUC commits to collecting vegetation samples at least three times during the grazing season in grazing areas in three different sectors that will have the highest predicted air particulate concentrations due to operations.~~

~~AUC will collect the vegetation samples prior to preconstruction activities. The following text confirming this commitment has been inserted into Section 2.9.10 of the TR:~~

~~"AUC commits to collecting vegetation samples prior to preconstruction activities at least three times during the grazing season in grazing areas in three different sectors that will have the highest predicted air particulate concentrations due to operations."~~

In consultation with NRC through public meetings, AUC began collecting the required vegetation samples. Two of the required three rounds of vegetation samples were collected during the grazing season in October and November of 2014. The sample locations were picked to satisfy the Regulatory Guide 4.14 requirement that the vegetation samples be collected in three different sectors that will have the highest predicted air particulate concentrations due to CPP operations. AUC will submit the sampling procedure along with a map of the sample locations to NRC staff as the data from the first two rounds of sampling become available. AUC plans on collecting the third round of vegetation samples when the grazing season begins in 2015. The samples were and will be analyzed as required in Table 1of Regulatory Guide 4.14.

RAI-24

Description of Deficiency

In Section 2.9.10 of the TR, the applicant stated that vegetation grab samples were collected at sampling location as identified in Figure 2.9-1 of the TR and the results are provided in Table 2.9-24 of the TR.

Basis for Request

NRC staff reviewed the vegetation sampling locations (RC-RAD-1, RC-RAD-2, and RC-RAD-3) in Figure 2.9-1 of the TR and determined that these vegetation sampling locations are not in three different sectors that will have the highest predicted air particulate concentrations during operations. Regulatory Guide 4.14 states that forage vegetation should be sampled at least three times during the grazing season in grazing areas in three different sectors that will have the highest predicted air particulate concentrations due to milling operations.

Formulation of RAI

The applicant needs to demonstrate that the vegetation sampling locations (RC-RAD-1, RCRAD-2, and RC-RAD-3) are located in three different sectors, or collect vegetation samples in three different sectors that will have the highest predicted air particulate concentrations due to operations or describe and justify an alternate sampling regimen for staff's consideration. The applicant should provide maps with sectors to differentiate the different sectors and sampling locations.

RAI-24 Response

~~AUC will include air particulate concentrations due to operations associated with the proposed CPP location as a parameter when selecting the vegetation sample locations discussed in RAI-23. AUC commits to performing this sampling prior to preconstruction activities, and will provide, prior to sampling, maps to differentiate the different sectors and sampling locations. Sector selection will be based on the most up-to-date meteorological data set available at that time. Text confirming this commitment has been inserted into the opening paragraph of Section 2.9.10 of the TR which now reads:~~

~~"Regulatory Guide 4.14 calls for three forage vegetation sampling events during the grazing season, in grazing areas at the site in three different sectors likely to have the highest airborne radionuclude concentrations associated with operations (NRC, 1980). AUC commits to performing this sampling prior to preconstruction activities and, prior to~~

~~sampling, will provide to NRC the maps to differentiate the different sectors and sampling locations. Sector selection will be based on the most up-to-date meteorological data set available at that time."~~

Regulatory Guide 4.14 calls for three forage vegetation sampling events during the grazing season, in grazing areas at the site in three different sectors likely to have the highest airborne radionuclide concentrations associated with operations (NRC, 1980). Rather than use the results from sampling locations RC-AD-1, RCRAD-2, and RC-RAD-3 AUC has decided to use alternate sampling locations to perform the vegetation sampling. Maps to differentiate the different sectors and sampling locations will be provided to NRC staff.

RAI-25

Description of Deficiency

In Section 2.2.1 of the TR, the applicant stated that within the proposed project area, existing land uses include: oil and gas production, CBM production, transportation, livestock grazing, and wildlife habitat.

Basis for Request

The applicant did not provide any discussion or data for the collection of food samples, including livestock. Regulatory Guide 4.14 states that at least three samples should be collected at time of harvest or slaughter or removal of animals from grazing for each type of crop (including vegetable gardens) or livestock raised within three kilometers of the mill site.

Formulation of RAI

Provide an adequate technical justification for not collecting food samples (i.e., crop, livestock, etc.) during the harvest or slaughter within 3 kilometers of the proposed site, or commit to collect three samples once during the harvest or slaughter for each type of crop or livestock as indicated above prior to construction of the site, or propose an alternate sampling regime with rationale for staff's consideration.

RAI-25 Response

~~As noted in RG 4.14 (Sec. 1.1.3), at least three samples should be collected at time of harvest or slaughter or removal of animals from grazing for each type of crop (including vegetable gardens) or livestock raised within three kilometers of the mill site. AUC has added the following new section to TR Sec. 2.9.10.5 which now reads:~~

~~"AUC commits to collecting tissue samples (livestock, etc. as specified in Regulatory Guide 4.14) once during the slaughter of livestock, prior to construction of the site. There were no observed crops within or adjacent to the proposed project so harvesting of crops will not be required. AUC commits to performing this sample collection prior to commencement of preconstruction activities onsite."~~

AUC will collect three samples weighing 4 kg each, of frozen ground beef for laboratory analysis to meet Reg. Guide 4.14 preoperational radionuclide MDA requirements. A local rancher that owns grazing land adjacent to the proposed CPP site will be providing the beef samples to AUC from a slaughtering event in December 2014.

There are no crops grown within 3 kilometers of the proposed CPP location, therefore AUC will not perform crop sampling.

RAI-26

Description of Deficiency

In Section 2.9.9 of the TR, the applicant stated that surface water sampling at four sampling locations (SW 3, SW 11, SW 16, and SW 18) are shown in Figure 2.9-1 of the TR, and Table 2.9-22 and Table 2.9-23 of the TR. The applicant stated that the surface water sampling included perennial streams, and ephemeral stream drainage channels where surface waters are present at least part of the year.

Basis for Request

The applicant did not collect monthly surface water sampling at four sampling locations. Regulatory Guide 4.14 states that samples should be collected at least monthly from streams, rivers, any other surface waters or drainage systems crossing the site boundary, and any offsite surface waters that may be subject to drainage from potentially contaminated areas or from a tailings impoundment failure. Any stream beds that are dry part of the year should be sampled when water is flowing. Samples should be collected at the site boundary or at a location immediately downstream of the area of potential influence. NRC staff reviewed the surface water sampling results provided by the applicant in Table 2.9-22 and Table 2.9-23 and noted that the results reflected only the month of September 2010. NRC staff determined that the collection of surface water samples for the month of September 2010 does not constitute monthly surface water samples, nor did the applicant provide sufficient information for not collecting monthly surface water samples (i.e., stream beds were dry except for the month of September). NRC staff also reviewed Figure 2.5-9 in the TR and noted that sufficient precipitation occurred during month 5. Figure 2.5-9 does not provide any key or legend that suggests or infers that month 5 is September.

Formulation of RAI

a) *Provide monthly surface water samples consistent with Regulatory Guide 4.14 or provide justification for only collecting surface water samples during the month of September for staff's consideration. Clarify figures by use of legend or description. Specifically, define the measure of month 5.*

b) *A review of the surface water data shows that the applicant did not analyze for dissolved and suspended solids for Unat. RG 4.14 recommends dissolved and suspended solids for Unat for surface water. Applicant needs to provide data for dissolved and suspended solids for Unat for surface water or provide results if they are available.*

RAI-26(a) Response

The information stated in 2.9.9 regarding the sampling of perennial stream was provided in error. As noted in the second sentence of Section 5.7.8.2:

"The Proposed Project area does not contain perennial streams and all surface water features are ephemeral and only contain natural runoff during heavy rainfall and snowmelt events."

The contradictory nature of the statements between TR Section 2.9.9 and TR Section 5.7.8.2 has been corrected. Section 2.9.9 now reads:

"AUC conducted baseline surface water sampling at four sampling locations beginning in September 2010. Surface water sampling locations are shown in Figure 2.9-1. This sampling included ephemeral stream drainage channels where surface waters are present at least part of the year. These locations are widely distributed across the site, including locations roughly upstream and downstream from proposed facility locations. All surface water features are ephemeral in nature, and are subject to high winds and high evaporation rates, therefore the majority of these are not available for seasonal monitoring."

Per response RAI-19(a), Tables 2.9-22 and 2.9-23 presented excerpts from a more comprehensive water resource analytical data set found in Addendum 2.7A and 2.7B. As a result, AUC has elected to remove Tables 2.9-16 through 2.9-23 from TR Section 2.9.

RAI-26(b) Response

AUC reviewed the definitions of the terms "Natural uranium" and "Uranium" found in the Glossary provided on the NRC website. Natural uranium, referred to as U-nat in Regulatory Guide 4.14, is defined as:

"Uranium containing the relative concentrations of isotopes found in nature (0.7 percent uranium-235, 99.3 percent uranium-238, and a trace amount of uranium-234 by mass). In terms of radioactivity, however, natural uranium contains approximately 2.2 percent uranium-235, 48.6 percent uranium-238, and 49.2 percent uranium-234. Natural uranium can be used as fuel in nuclear reactors."

Uranium is defined as:

"A radioactive element with the atomic number 92 and, as found in natural ores, an atomic weight of approximately 238. The two principal natural isotopes are uranium-235 (which comprises 0.7 percent of natural uranium), which is fissile, and uranium-238 (99.3 percent of natural uranium), which is fissionable by fast neutrons and is fertile, meaning that it becomes fissile after absorbing one neutron. Natural uranium also includes a minute amount of uranium-234."

Based on these definitions it is apparent that the terms Uranium and Natural Uranium/U-nat are synonymous and can be used interchangeably in text and in references to laboratory reports presenting concentration data.

AUC has reviewed the laboratory analytical method used for the determination of the concentrations of dissolved and suspended uranium in surface water samples. The laboratory used EPA Method 200.8, Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma – Mass Spectrometry (ICPMS). This method determines the chemical concentration of uranium in waters which is the natural uranium concentration (U-nat). As discussed, the terms U-nat and Uranium are interchangeable. Therefore, AUC has provided concentration data for dissolved and suspended U-nat from surface water samples as reported in Table 2.7A-13: Surface Water Monitoring Results under the parameter listed as "Uranium".

RAI-27

Description of Deficiency

In Section 2.9 of the TR, the applicant references Figure 2.9-1 for the Baseline Radiological Sampling Location. In Figure 2.9-1, the applicant identified the Proposed Reno Creek Project Boundary in the legend. In the applicant's Glossary on page G-4, the applicant defines the Proposed Project Area as the area proposed for construction, operation, groundwater restoration, and decommissioning of an ISR uranium recovery facility.

Basis for Request

The applicant needs to define the site boundary consistent with 10 Part CFR Part 20. According to 10 CFR 20.1003, the Site Boundary is defined as that line beyond which the land or property is not owned, leased, or otherwise controlled by the licensee. During the review, NRC staff noted that a public road runs through the Proposed Reno Creek Project Boundary. This leads to the question, does the applicant have control over that public road and lands that are not controlled areas as defined by 10 CFR 20.1003. NRC staff cannot determine from the applicant's definition of the Proposed Reno Creek Project Boundary if it is the same as the site boundary or if the Proposed Reno Creek Project Boundary definition is different from the NRC 10 CFR Part 20.1003 definition of site boundary.

Formulation of RAI

Clearly define the site boundary and controlled area using 10 CFR 20.1003. Explain any difference between the site boundary and the proposed Reno Creek Project Boundary. Identify the controlled area within the site boundary.

RAI-27 Response

The Proposed Project Boundary is the external peripheral of all lands within the geographic extent as illustrated in TR Figure 5-2. The public road right-of-ways are not included within the lands to be controlled and is therefore consistent with 10 CFR 20.1003. In addition, other than public road right-of-ways, access to lands within the proposed project boundary will be controlled by AUC through existing surface access agreements with all landowners, and where active operations are planned AUC has control of all mineral leases. For further clarification, AUC has added the following text to the definition of Proposed Project Area in the glossary:

“**Proposed Project Area:** the area proposed for the construction, operation, groundwater restoration, and decommissioning of an ISR uranium recovery facility. This includes all lands owned, leased, or otherwise controlled by the licensee.”

AUC has also added the following definition to the glossary to differentiate between the Proposed Project Area and the Proposed Project Boundary:

“**Proposed Project Boundary:** the peripheral extent of the Proposed Project Area based primarily on the Township and Range grid system. The boundary is used primarily in characterizing the site conditions and includes both the Proposed Project Area and uncontrolled areas (i.e. public road right-of-ways) found within this geographic extent.”

3 DESCRIPTION OF PROPOSED PROPERTIES

RAI-28

Description of Deficiency

In TR Section 3.0, Figure 3-1 depicts a conceptual facility layout for the central processing plant and backup pond. The applicant supplemented the information with preliminary construction drawings submitted in the supplement data (ML13213A064).

Basis for Request

The supplemental data differs from the conceptual layout in the initial application submittal. Specifically, the plant location, backup pond location and outbound truck drive path have been modified. Please correct (update) the appropriate information in the application.

Section 3.2.3 of the SRP states:

> *"The application provides diagrams showing the proposed (or existing) plant/facilities layout in adequate detail."*

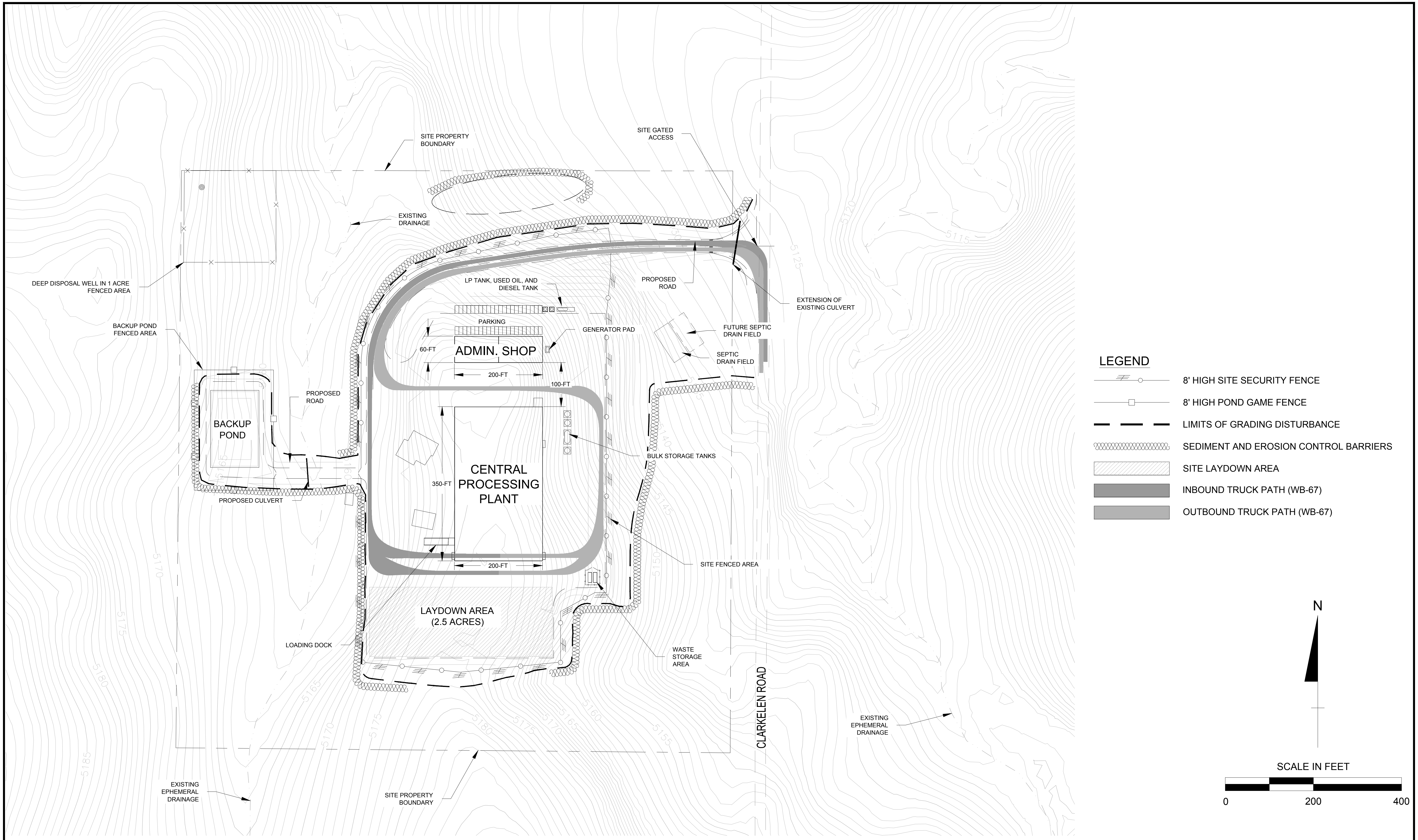
Formulation of RAI

Please revise the TR to incorporate the proposed changes in the supplemental data submittal.

RAI-28 Response

AUC has updated TR Figure 3-1 with the revised site plan provided in the supplemental data package.

This revised figure is shown below:



NOTE:
EXISTING CONDITIONS INFORMATION PROVIDED BY SURVEY PERFORMED BY INBERG-MILLER ENGINEERS JUNE 2012

TREC, Inc.
Engineering & Environmental Management
A Woodard & Curran Company

Conceptual Plant Facility Layout
Reno Creek Permit Application
AUC, LLC
Campbell County, Wyoming

FIGURE 3-1

Drawn: AJE | Checked: | Approved:

Rev. #	Description	Date
-	-	-
-	-	-
-	-	-

DRAWING: Z:\CURRENT_PROJECTS\3001_AUC\3001-2010-100 RENO CREEK PERMIT APP\CAD\FIGURES\2010-100_F-310_SITE_LAYOUT.DWG

Print Date: 6/10/2014 2:09 PM

RAI-29

Description of Deficiency

In TR Section 3.1.1 (page 3-3), the application states:

> *"..for purposes of this License Application, recoverable ore resources of on the order of 15.7 million pounds of uranium ...[b]ased on AUC analysis ... ore body closely resembles the roll-front deposits assessed previously by NRC in the ... ISR GEIS".*

Basis for Request

The wording in the application is deficient in stating the estimated ore reservoirs in the proposed license area. Relevant information to evaluate the AUC analysis, such as distribution and characteristics of the ore bodies, was not provided.

Section 1.1 of the SRP states:

> *"The staff should review the corporate entities involved; the location of the proposed activities; land ownership; ore-body locations and estimated uranium (U3O8) content."*

Section 3.1.3 of the SRP states:

> *"The description is sufficiently detailed to identify the mineralized zone(s), their areal distribution, and their approximate thickness. If more than one mineralized zone is to be leached, each zone should be defined separately. The estimated U3O8 grade should be specified."*

Formulation of RAI

a) *Please provide mapping that demonstrates the ore trends including the oxidation and reduction zones. Also see RAI-5.*
b) *Clarify whether the 15.7 MM lbs identified in the application is the correct amount for recoverable resources.*

RAI-29(a) Response

In TR Section 3.1.1 (pg 3-3), the fourth paragraph refers to the similarity of ore bodies at the Proposed Project to other nearby deposits. AUC has revised Figure 2.6A-17 to depict oxidation/reduction relationships and ore trends in plan view. The revised figure was also referenced in the response to RAI-10. The revised text for Section 3.1.1 is shown below:

"Though total mineable resources for the Proposed Project are not fully developed at this time, AUC estimates, for the purposes of this License Application, recoverable ore resources of on the order of 15.7 million pounds of uranium at an average grade of approximately 0.065 percent U_3O_8. Based on AUC analysis and a review of the ISR GEIS (NRC 2009, p.3-49), the Proposed Action's ore body closely resembles the roll-front deposits assessed previously by NRC in the Wyoming East Region, which includes the Proposed Project area, as well as those in all of the other ISR GEIS regional analyses. Depiction of the ore trends, including oxidation/reduction boundaries is shown on Figure 2.6A-17."

RAI-29(b) Response

As stated in TR Section 1.6, total recoverable resources within the Proposed Project boundary are not fully developed at this time. AUC estimates in place mineral resources of approximately 15.7 million pounds of uranium at an average grade of approximately 0.065 percent U_3O_8 contained within the Proposed Project Boundary.

RAI-30

Description of Deficiency

In TR Section 3.1.7, flow diagrams (Figures 3-6 and 3-7) show the restoration circuit which includes 50 gallons per minute attributed to the groundwater sweep (GWS). In Section 6.1.4, the application states that not all stages of groundwater restoration will be used if deemed unnecessary by AUC.

Basis for Request

The flow diagrams do not reflect times at which groundwater sweep is not performed.

Section 3.1.3 of the SRP states:

> *"Proposed plant material balances and flow rates should be acceptably described."*

Formulation of RAI

Please discuss the impact to the water balance when the groundwater sweep component is not performed.

RAI-30 Response

AUC has added the following text, as the 7th paragraph, to TR Section 3.1.7 to address times at which groundwater sweep will not be performed during the concurrent production and groundwater restoration phase of operations (Figure 3-6):

"Section 6.1.4, of the application states that not all stages of groundwater restoration will be used if deemed unnecessary by AUC. During this phase of concurrent production and groundwater restoration AUC may decide not to employ the groundwater sweep stage at some Production Units. This will eliminate 50 gpm of feed water to the restoration circuit and will result in a decrease of wastewater produced at the Secondary RO Unit by 17 gpm. The resultant wastewater flow rate from the Secondary RO Unit will be an estimated 129 gpm. The final estimated flow to the DDWs after the Secondary RO Unit brine is passed through the proposed wastewater treatment system and maintaining an average 1% bleed rate is 39 gpm. This is down from an estimated 44 gpm with the groundwater sweep component included."

AUC has added the following text, as the last paragraph, to TR Section 3.1.7 to address times at which groundwater sweep will not be performed during the groundwater restoration only phase of operations (Figure 3-7):

"Section 6.1.4, of the application states that not all stages of groundwater restoration will be used if deemed unnecessary by AUC. During this phase of groundwater restoration only AUC may decide not to employ the groundwater sweep stage at some Production Units. This will eliminate 50 gpm of feed water to the restoration circuit and will result in a decrease of wastewater produced at the Secondary RO Unit by 20 gpm. The resultant wastewater flow rate from the Secondary RO Unit will be an estimated 84 gpm. The final estimated flow to the DDWs after the Secondary RO Unit brine is passed through the proposed wastewater treatment system is 25 gpm. This is down from an estimated 31 gpm with the groundwater sweep component included."

RAI-31

Description of Deficiency

In the Supplemental data (ML13219A203) on Sheet C-3.0 "GRADING: INDEX", the amount of cut and fill required for earthwork preparation of the plant area may exceed 70,000 cubic yards. Section 6.2.3, of the TR states "no construction activities are planned that will require major re-contouring. Due to the fact that there will be no significant changes to the topography of the land during operations, a final contour map will not be necessary, and the post-ISR contours will reflect the pre-operation contours".

Basis for Request

The application fails to provide the rationale to explain why moving 70,000 cubic yards of material is not significant and explain how the proposed compaction methods will ensure a suitable foundation for the plant.

Section 3.1.3 of the SRP states:

> *"Staff should determine whether the hazards associated with the storage and processing of the radioactive materials and those hazardous materials with the potential to impact radiological safety, have been sufficiently addressed in the process design for the recovery plant, satellite processing facilities, well fields, and chemical storage facilities."*

Section 6.2.2 of the SRP states:

> *"The staff should determine whether the described approaches for reclaiming temporary diversion ditches and impoundments, reestablishing surface drainage patterns disrupted by the proposed activities, and returning the ground surface and structures for post-operational use are consistent with regulatory guidance and are sufficient to satisfy the requirements of 10 CFR Part 40, Appendix A, Criterion 6(6), and 10 CFR 40.42. The staff should ensure that the licensee intends to restore topography and vegetation to a state that is similar to pre-operational conditions. The staff should review the pre-reclamation survey plan to ensure that it provides adequate coverage to designate contaminated areas for cleanup. Particular attention should be focused on sampling temporary diversion ditches and surface impoundments, well field surfaces, process and storage areas, transportation routes, and operational air monitoring locations. These areas are expected to have higher levels of contamination than surrounding areas. The staff should also ensure that plans exist for the disposal of contaminated soils at an existing licensed*

> *byproduct material disposal facility, consistent with 10 CFR Part 40, Appendix A, Criterion 2."*

Formulation of RAI

(a) Please explain how the proposed compaction methods to be used will minimize any future subsidence.

(b) Please clarify the significance to the movement of 70,000 cubic yards in terms of changes to the pre-construction topography. Furthermore, should the post-ISR contours be returned to pre-operational contours, describe how those soils that need to be relocated for the post-operational contours are monitored to meet the bench-mark dose limits.

(c) Describe survey(s) to be conducted for both radium and uranium prior to backfilling the area covered by the CPP?

RAI-31(a) Response

The proposed construction methods will minimize potential for future subsidence by using the information found within the site geotechnical report (TR Addendum 4-A) to select proper soil compaction methods. The specific compaction methods will be determined by a qualified and licensed professional engineer.

RAI-31(b) Response

The determination of impacts related to the movement of 70,000 cubic yards ($yd^{3)}$ of soil as being of small significance is taken from SEIS' produced by the NRC. The most recent of which was the Ross ISR Project (Final Report, February 2014) that was deemed a "SMALL" impact from the proposed 80,000yd^3 of proposed excess subsurface soils. As the AUC project has a total of approximately 70,000yd^3 of material movement, with a net difference of under 2,500yd^3 between cut and fill operations, AUC's impacts would justifiably be considered small.

The methods for evaluating post reclamation soil radiation against bench mark dose limits is detailed in TR Section 6.4 (Methodologies for Conducting Post-Reclamation and Decommissioning Radiological Surveys).

RAI-31(c) Response

The Technical Report provides a preliminary discussion, in Section 6, of the protocols AUC plans to apply during final site decommissioning. A discussion that includes consideration of protocols contained within the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) has been added to TR Section 6.4 to include CPP decommissioning soil surveys.

AUC has added the following CPP soil decommissioning discussion as TR Section 6.4.5, Central Processing Plant Decommissioning Soil Surveys:

"Once the CPP has been removed and materials properly disposed as outlined in TR Section 6.3, radioactive contamination in near-surface soils within the CPP footprint of approximately 6500 square meters (~70,000 square feet) will be remediated to meet NRC requirements.

The CPP footprint will be gridded into approximately 65 (sixty-five) 10 meter x 10 meter grid elements. MARRSIM will be used to determine the fraction of the 65 grid elements to be sampled for contamination.

A 100%-coverage GPS-based gamma radiation scan of the grid elements will be performed, to identify any areas where the potential exists to exceed the applicable soil radium standard (see TR Section 6.4.1). Nine soil samples, uniformly distributed, will be taken to 6" depths within those grid elements. Additional sets of 9 subsamples will be taken within the grid elements, as needed, to satisfy sampling of the grid elements as specified by the MARSSIM calculations. Each set of 9 subsamples will be composited into a single composite sample; the composites will be analyzed for Ra-226 and Unat by a qualified laboratory.

Grid elements producing samples exceeding the allowable contamination limits for Ra-226 and/or Unat (using cleanup criteria outlined in TR Section 6.4, and using the sum-of-fractions rule where appropriate), will be excavated. Removed soil will be stored in barrels for disposal at a licensed facility. Additional samples, also composited from nine 6"-depth sub-samples, will be taken within the excavated grid elements and submitted for laboratory analysis. Excavation and re-sampling of areas found to be contaminated will continue until the contamination limits are met.

A final, 100%-coverage GPS-based gamma scan of the CPP footprint will be performed, and a report will be prepared containing a record of the above process as implemented. The report will document all acquired data, including a plot of the CPP area showing the final gamma scan results and the final grid element laboratory analysis data."

RAI-32

Description of Deficiency

In the Supplemental data (ML13219A203) on Sheet C-3.4 "GRADING: BACKUP POND DETAILS", the details indicate clean granular material only in the leak detection sump and a "geotextile drain material" installed in the slopes and floor of the pond.

Basis for Request

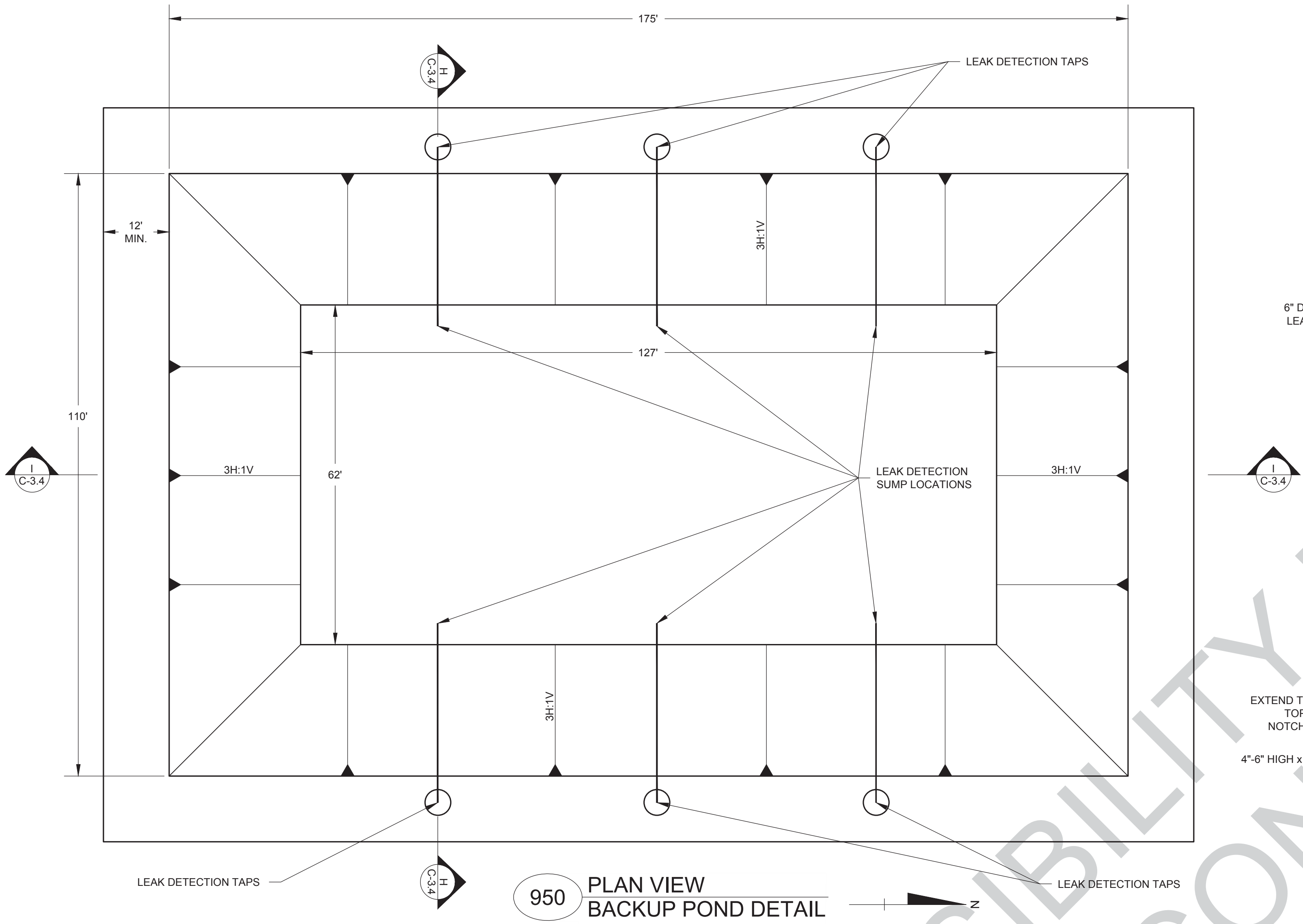
The limitation of the proposed granular material to the sump differs from previously acceptable designs and the term "geotextile drain material" is too vague for staff to determine if the material is suitable to meet the intended use (e.g., permeability). Regulatory Guide 3.11 recommends highly permeable soil or geosynthetic material.

Formulation of RAI

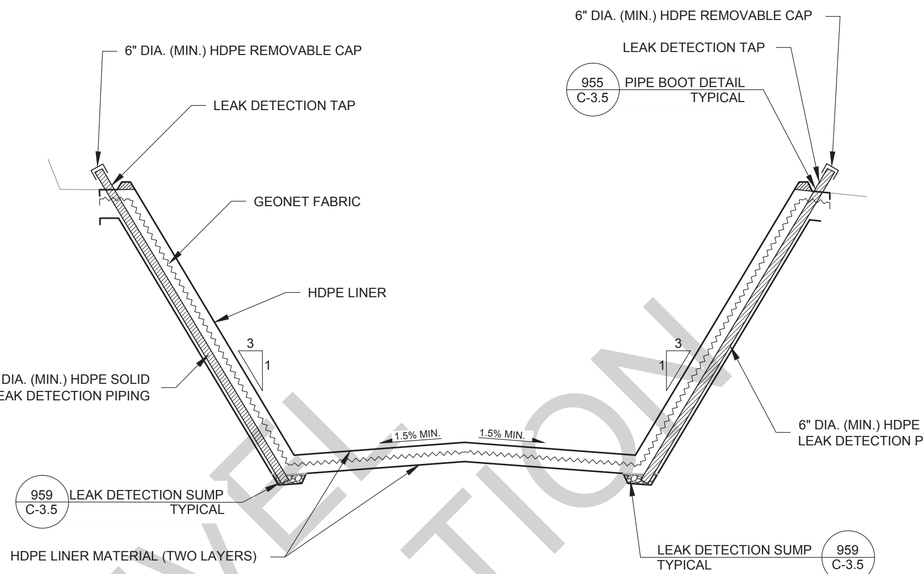
Please provide a more-in-depth description on the geosynthetic material to be used in the design for the surface impoundments.

RAI-32 Response

The material designated for the pond wastewater collection and removal system will be a minimum of 12" of granular drainage material with a hydraulic conductivity of $1x10^{-1}$ cm/sec or more, or, a geonet drainage material with a transmissivity of $3x10^{-4}$ m^2sec or more in accordance with 40 CFR Ch. 1, Part 264, Subpart K, Section 264.221.2.ii. The requirements of the granular fill material or geonet fabric as called out in subpart K will be specified in the project specifications. The call-out for "geotextile drain material" and "clean granular fill" on sheet C-3.4 will be changed to "geonet fabric" and "granular drainage material" respectively, to identify with the language presented in 40 CFR, Part 264, subpart K.



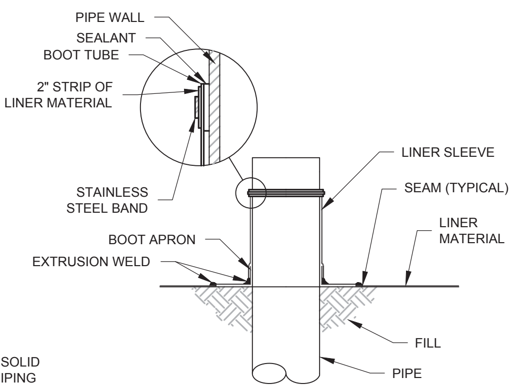
950 PLAN VIEW
BACKUP POND DETAIL
NTS



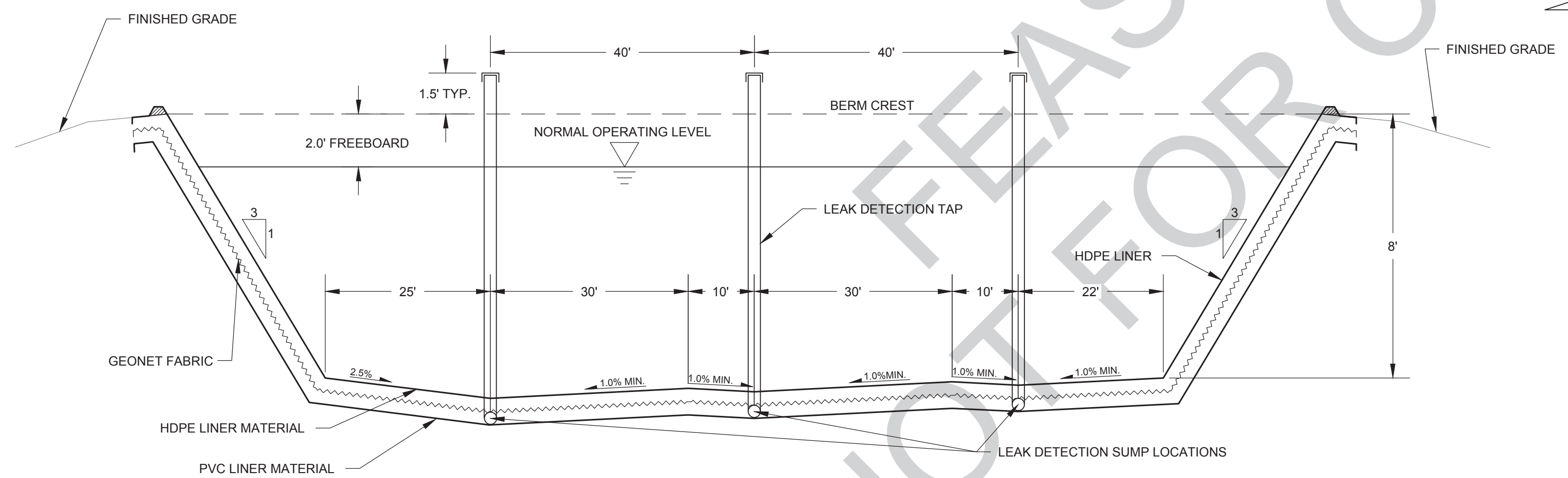
NOTE:

1. LINER MATERIALS SHOWN AS SEPARATED FOR VISUAL CLARITY. PVC LINER, GEOTEXTILE, AND HDPE LINER ABUTTED AGAINST EACH OTHER.

HH CROSS SECTION: BACKUP POND EAST/WEST
BACKUP POND DETAIL
NTS



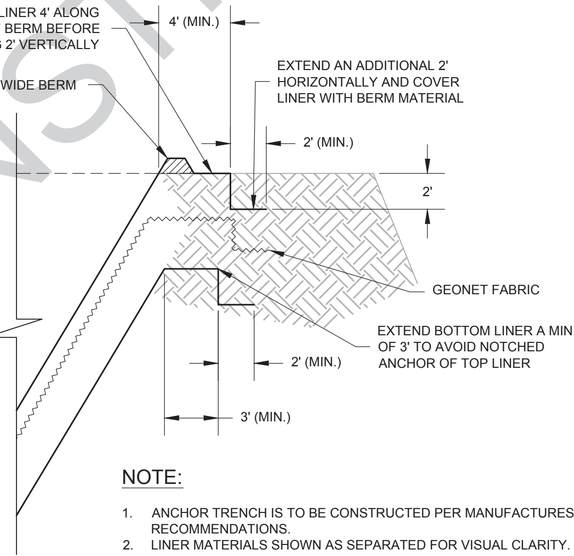
955 PIPE BOOT DETAIL
BACKUP POND DETAIL
NTS



II CROSS SECTION: BACKUP POND NORTH/SOUTH
BACKUP POND DETAIL
NTS

NOTE:

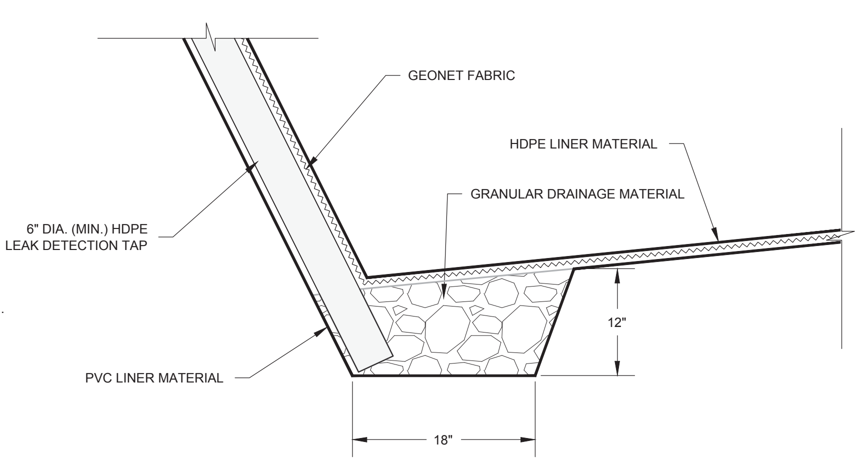
1. LINER SUB-BASE PREPARATION OF NATIVE SOILS TO BE COMPACTED TO 95% (MIN.) OF STANDARD PROCTOR



NOTE:

1. ANCHOR TRENCH IS TO BE CONSTRUCTED PER MANUFACTURES RECOMMENDATIONS.
2. LINER MATERIALS SHOWN AS SEPARATED FOR VISUAL CLARITY. PVC LINER, GEOTEXTILE, AND HDPE LINER ABUTTED AGAINST EACH OTHER.
3. REMOVE ALL DELETERIOUS AND LINER DAMAGE CAUSING DEBRIS PRIOR TO INSTALLING PVC LINER.

957 LINER ANCHOR DETAIL
BACKUP POND DETAIL
NTS



959 LEAK DETECTION SUMP
BACKUP POND DETAIL
NTS

NOTES:

1. ALL LINER PRODUCTS ARE TO BE INSTALLED PER MANUFACTURES RECOMMENDATIONS
2. LEAK DETECTION TAP: 6" MIN. DIA. HDPE PIPE
3. LEAK DETECTION TAPS USED AS WATER RETRIEVAL POINTS

Dig Safely.
If you need a locate
please call this number
811 or 800-849-2476

DRAWING REVISIONS TYPES: 1 PRE-BID 1 POST-BID 1 POST IFC

NO:	DATE	CADD	CHECK	APP'D	ISSUE / REVISION DESCRIPTION	NO:	DATE	CADD	CHECK	APP'D	ISSUE / REVISION DESCRIPTION

AUC LLC

90% REVIEW SET
NOT FOR
CONSTRUCTION

TREC, Inc.
Engineering & Environmental Management
www.treccorp.com

BOZEMAN OFFICE
1800 West Koch, Suite 6
Bozeman, MT 59715
Tel: (406) 586-8364
Fax: (406) 522-8460

CASPER OFFICE
900 Werner Court, Suite 150
Casper, WY 82601
Tel: (307) 265-0696
Fax: (307) 265-2498

GREAT FALLS OFFICE
600 Central, Suite 204
Great Falls, MT 59401
Tel: (406) 952-0745

BUTTE OFFICE
521 East Front Street
Butte, MT 59701
Tel: (406) 491-0912

IF THIS BAR DOES
NOT EQUAL ONE
INCH ADJUST
SCALES
ACCORDINGLY

PROJECT NO.:	CADD:	CHECKED BY:	APPROVED BY:	PLOT DATE:
2012-250	TBK	RRU	SLH	10/2/2012 3:31 PM

GRADING: BACKUP POND DETAILS
RENO CREEK PROJECT
PREPARED FOR
AUC LLC
CAMPBELL COUNTY, WYOMING

SHEET
C-3.4

DRAWING: Z:\Current_Projects\2012-250_AUC_Prefeasibility_Study\020-CAD\Sheets\Civil Site\2012-250_C03-GRADING.dwg

RAI-33

Description of Deficiency

In the Supplemental data (ML13219A203) on Sheet C-3.4 "GRADING: BACKUP POND DETAILS", the details indicate 2.0 feet of freeboard. The information lacks backup calculations on the suitability of the freeboard.

Basis for Request

The lack of calculations to support the calculation of needed freeboard is not acceptable.

Section 4.2.2 of the SRP states:

> *"The staff should also ensure that appropriate freeboard requirements are established, and that appropriate monitoring programs and reporting procedures are in place."*

Formulation of RAI

Please provide justification for the 2.0 feet of freeboard.

RAI-33 Response

AUC has performed and documented the calculations necessary to ensure adequate freeboard volume is available according to NRC 3.11 Basic Design Criteria item (e) which states the following: "freeboard must be sufficient at all times to prevent overtopping by flood inflows and wind generated waves and should include an allowance for settlement of the foundation and embankments."

The following considerations were taken into account for the freeboard calculations:

- Rainfall Volume
    - 6-hour/100-year precipitation = 2.2 inches
    - Top of pond area = 19,250 SF
    - Rainfall volume = 2.2in x 1ft/12in x 19,250 SF = 3,529 SF
- Wave Run Up (w/ wind tide effects at 80mph, max 6.2ft depth and 206ft length =1.0+0.1)
- Settlement (0.5ft)

The minimum total required freeboard height accounting for rainfall, wave run up, wind tide and settlement is 1.8 feet (0.2+ 1.0 + 0.1 + 0.5 = 1.8).

RAI-34

Description of Deficiency

TR Section 3.1.8 proposes a single surface impoundment as a "backup storage pond to temporarily store waste water as needed," especially if a deep disposal well is down for maintenance.

TR Section 4.3.5 states "[t]he backup storage pond is designed specifically as a redundancy system to the DDWs, which are the primary liquid 11e.(2) byproduct disposal option. Therefore, some of the requirements for tailings impoundments do not apply to the design of the backup storage pond. The primary difference is the limited use of the backup pond during the life of the facility. Control of potential windblown particulate releases from the dried fringe areas of the pond that has been temporarily in use will be managed via clean water wash down to remove residues, temporary application of commercially available dust suppression/stabilization sprays, or other means."

Basis for Request

The application lacks details on a corrective action plan for a loss of integrity of the primary liner at the surface impoundment, routine maintenance of the liner during which no fluids are stored within the impoundment (e.g., prohibit movement of the liner due to the wind). Generally, ISR facilities have multiple surface impoundments which served a redundancy function (i.e., should the integrity of the liner of one pond fail the contents of the failed pond can be transferred to the other impoundment). Furthermore, the surface impoundments at many ISR facilities maintain liquids at a minimum depth to help hold the liner in place. The proposed usage by the applicant differs from that at most facilities. Furthermore, though the application states that the use of the pond will be limited, NRC staff evaluates such ponds as if they will be used on a routine basis.

Section 4.2.2 of the SRP states:

> *"Verify that surface impoundments rely on standard engineering design to ensure proper containment performance, including appropriate leak detection systems."*

Formulation of RAI

- *Please provide a description of controls and contingencies that will be implemented should the liner develops a leak and procedures for routine maintenance.*
- *Describe the impacts to operations if the volume of the backup pond needed to be moved. The applicant should commit to making changes in operations as needed*

to be able to drain the backup storage pond if leaking occurs.

RAI-34 Response

~~As stated in TR Section 4.3.5.4, if the backup storage pond liner should develop a leak the water level in the storage pond will be lowered sufficiently to eliminate the leak. As identified in the "Basis for Request" of this RAI, ISR facilities generally have more than one lined retention pond to act as a redundancy in case of a liner leak. Based on the conceptual water balance that incorporates AUCs proposed land application system (included in TR Section 4.3) the volume of liquid effluent to be disposed in the DDWs is reduced by 102 gpm. Therefore, based on this new water balance there will be additional DDW capacity available during all phases of operations so in the event the liner of the pond develops a leak, the pond contents will be able to be routed to a DDW.~~

AUC stated in TR Section 4.3.5.4 Corrective Action Procedures that if the backup storage pond liner should develop a leak AUC will lower the water level in the storage pond sufficiently to eliminate the leak. As stated in the "Basis for Request" of this RAI ISR facilities generally have more than one lined retention pond to act as a redundancy in case of a liner leak. AUC however will rely on operational controls to reduce the amount of wastewater generated to free up disposal capacity in the DDW disposal system. Therefore AUC will commit to curtailing uranium recovery and groundwater restoration operations temporarily as needed to allow for draining of the backup storage pond directly to the wastewater storage tanks and on to the DDW disposal system.

As discussed in TR Section 3.1.7 Water Balance, the maximum amount of wastewater generated will be during concurrent uranium recovery and groundwater restoration operations. AUC has calculated that to drain the backup storage pond in a prompt and efficient manner, an approximate 30% reduction in operations will reduce the wastewater generated by 40 gpm thereby freeing up one DDW to receive fluid drained from the backup storage pond.

The following text has been added to TR Section 4.3.5.4:

~~"The water level in the backup storage pond will be lowered by routing the contents of the pond to a DDW with available capacity."~~ "The water level in the backup storage pond will be lowered by draining the pond to a DDW with available capacity. AUC will reduce uranium recovery and groundwater restoration operations as needed to free up disposal capacity in the DDW disposal system to receive fluid drained from the backup storage pond."

AUC has committed to maintain liquids at a minimum depth to help hold the liner in place through existing text in TR Section 4.3.5 which states “A small amount of fresh water will be maintained in the bottom of the backup storage pond to maintain weight on the pond liner during times when the pond is not being used to temporarily store liquid 11e.(2) byproduct.”

Based on the reduced volume of liquid effluent due to the proposed wastewater treatment and land application system, the backup storage pond will provide at least three months of capacity.

RAI-35

Description of Deficiency

In the Supplemental data (ML13219A203) on Sheet CD-9.2 "DRAINAGE DETAILS", the details indicate a 1.5-foot minimum depth to the "west interceptor ditch" surrounding the backup pond. On Sheet C-9.3 "STORM DRAINAGE: WEST INTERCEPTOR DITCH" in the supplemental information, the maximum elevation of the base on the drainage ditch is reported at 5166.841 (no units).

Basis for Request

At the scale of the mapping, it is difficult to ascertain the elevations of the berms surrounding the ditch. Furthermore, the application did not contain calculations to justify the 1.5-foot minimum depth meets the design criterion.

Section 2.2.1 of Regulatory Guide 3.11 states:

> *"If the tailings retention system has some external drainage area, and hydraulic structures (such as diversion channels) are needed to safely divert the probable maximum flood (PMF), the peak PMF inflows and runoff used to design such structures should be determined in accordance with the suggested flood design criteria in NUREG1623, "Design of Erosion Protection for Long-Term Stabilization".*

Formulation of RAI

Please provide a detailed description of how a 1.5-foot minimum depth of the "west interceptor ditch" surrounding the backup pond will be maintained. Provide calculations that demonstrate the minimum channel depth is sufficient to prevent run-on from the probable maximum flooding from areas upstream on the ponds.

RAI-35 Response

~~The site-civil construction plan set provided by AUC is currently in the conceptual design stage and is intended for feasibility analysis only. A standard detail has been provided stating the ditch will be a minimum of 1.5', therefore adjustments may be made as necessary to deepen the ditch to acquire the necessary volume capacity. Additional survey and runoff analysis data will be gathered prior to final design.~~

Hydrologic calculations are performed to determine the 100-year peak runoff rate for the interceptor ditch located upgradient of the "Backup Pond" as shown on the preliminary

Civil Site Construction Drawings for the Reno Creek Project dated October 2, 2012. Hydraulic calculations are performed to verify that the diversion channel has hydraulic capacity to convey the 100-year peak runoff.

Runoff calculations use the Soil Conservation Service (SCS) Unit Hydrograph for Type II, 24-hr storm event. The drainage area for the slope upgradient of the diversion channel was determined to be 2.3 acres as delineated based on USGS Digital Elevation Model (DEM) 10 meter contour files.

The Curve Number (CN) value was determined from information obtained via the Reno Creek Project vegetation characterization study. The p area is semi-arid grassland and shrublands with some minimal grazing. Vegetation cover was estimated to be approximately 75 to 80 percent. Soils in the area indicate loamy sands to sandy clay loams. The area was determined to be homogenous for soil and vegetative conditions. The hydrologic soil groups range between B and C based on USDA soil data. Hydrologic soil group C is assumed. From this information, a CN value of 74 was chosen from Table 2-2d of TR-55 (NRCS, 1986).

A minimum time of concentration of five minutes is assumed. The 100-year, 24-hour precipitation depth of 4.2 inches was determined from NOAA Atlas 2, Volume II-Wyoming, isopluvial maps.

Hydraulic calculations use the Manning's equation. A manning's n value of 0.1 is assumed based on the diversion ditch consisting of good stand of grass six to twelve inches in length (Table 3.4, McCuen). The diversion channel cross-section consists of a v-ditch with 3H:1V side slopes and a minimum depth of 1.5 feet. A minimum slope of 1.2% is assumed based on the longitudinal profile presented on Sheet Civil Site Construction Drawings C-9.3 (i.e. location of channel cross-section with lowest capacity).

The peak discharge from the 100-year, 24-hour event was calculated to be 6.8 cfs. The minimum hydraulic capacity of the diversion ditch is 8.8 cfs. The diversion ditch as designed on the preliminary Civil Site Construction Drawings for the Reno Creek Project dated October 2, 2012, has adequate capacity to convey the 100-year, 24-hour storm event. See Attached Calculations for input parameters and detailed results.

Standard Best Management Practices (BMP's) such as Erosion Control Blankets (ECB), Turf Reinforcement Mats (TRM), Anchor Reinforced Vegetation (ARV), Asphalt, or Riprap will be employed to maintain erosion control within the ditch channel. Typically the type of BMP used is dependent upon the slope of the ditch. The slope of the ditch will be established in the final design and will determine which method is to be employed. Detailed runoff control will be included in the Storm Water Pollution Prevention Plan (SWPPP) for the project.

REFERENCES:

Miller, J.F, et. al. *Precipitation-Frequency Atlas of the Western United States.* NOAA Atlas 2, Volume II-Wyoming. National Weather Service, Silver Spring, MA. 1973.

McCuen, Richard H. *Hydrologic Analysis and Design, Third Edition.* New Jersey: Pearson Prentice Hall.2005.

Natural Resources Conservation Service (NRCS). *Urban Hydrology for Small Watersheds, TR-55.* United States Department of Agriculture. Technical Release 55, June 1986.

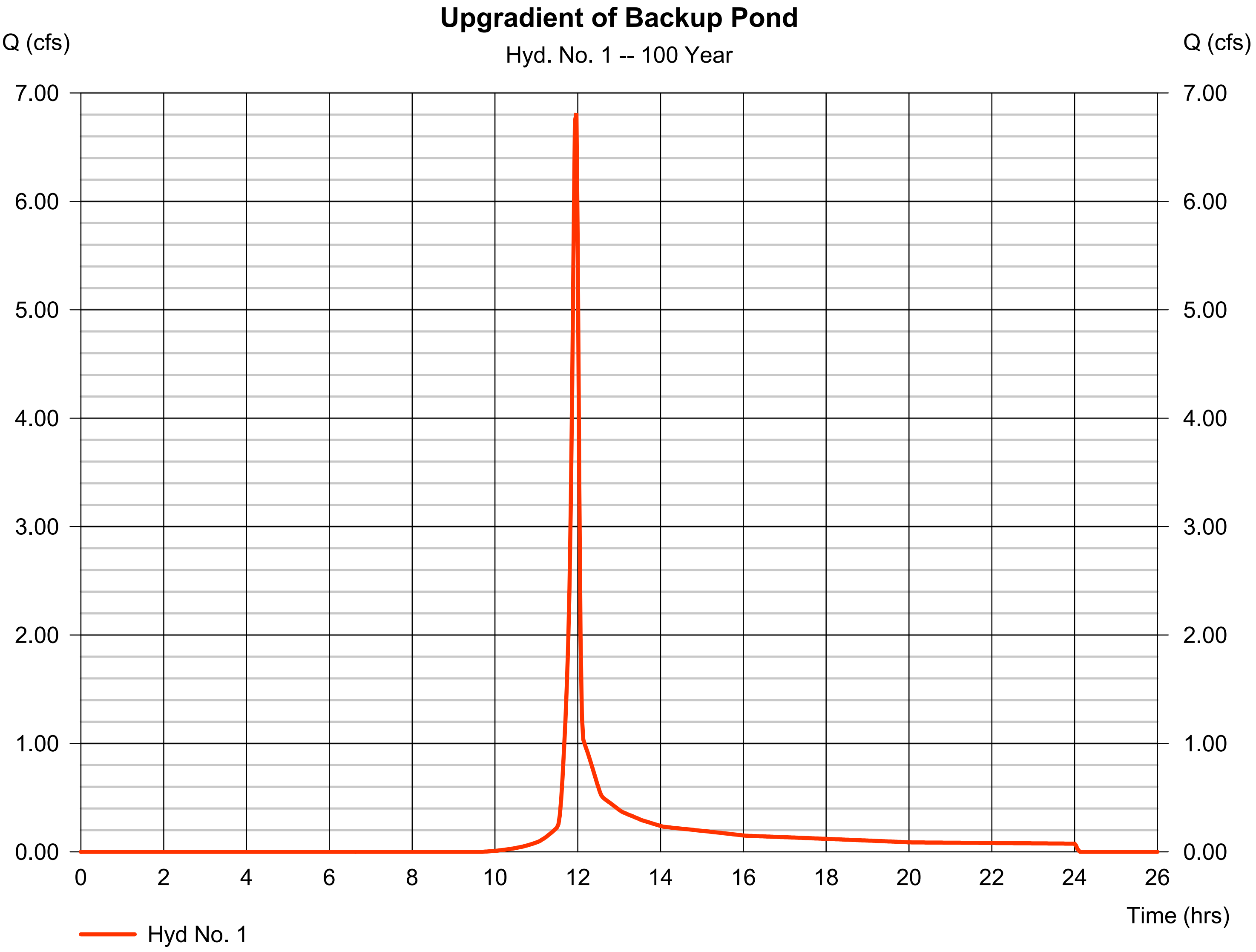
Hydrograph Report

Hyd. No. 1

Upgradient of Backup Pond

Hydrograph type = SCS Runoff
Storm frequency = 100 yrs
Time interval = 2 min
Drainage area = 2.300 ac
Basin Slope = 0.0 %
Tc method = User
Total precip. = 4.20 in
Storm duration = 24 hrs

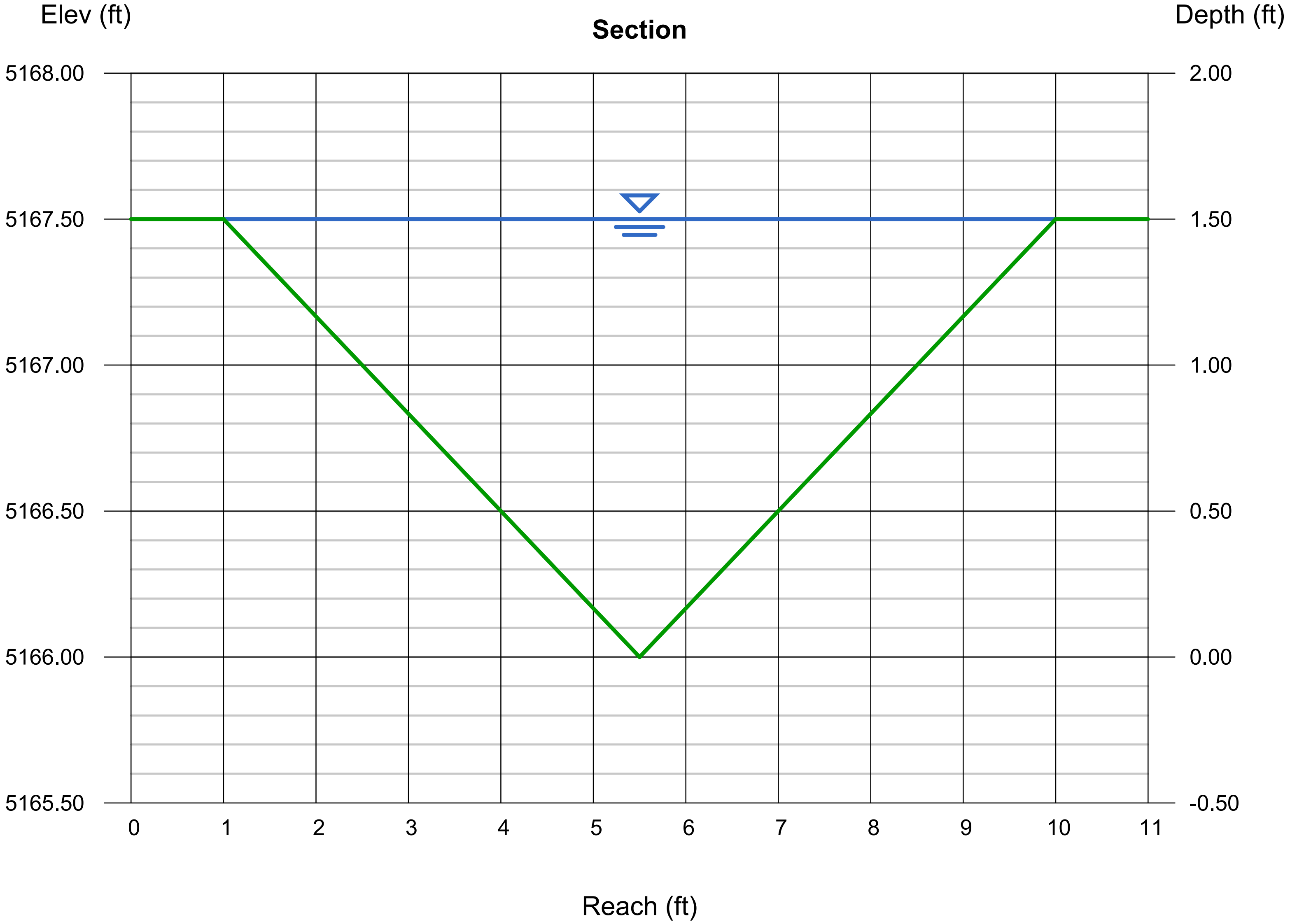
Peak discharge = 6.814 cfs
Time to peak = 11.97 hrs
Hyd. volume = 13,655 cuft
Curve number = 74
Hydraulic length = 0 ft
Time of conc. (Tc) = 5.00 min
Distribution = Type II
Shape factor = 484



Channel Report

Diversion Ditch

Triangular		**Highlighted**	
Side Slopes (z:1)	= 3.00, 3.00	Depth (ft)	= 1.50
Total Depth (ft)	= 1.50	Q (cfs)	= 8.756
		Area (sqft)	= 6.75
Invert Elev (ft)	= 5166.00	Velocity (ft/s)	= 1.30
Slope (%)	= 1.20	Wetted Perim (ft)	= 9.49
N-Value	= 0.100	Crit Depth, Yc (ft)	= 0.89
		Top Width (ft)	= 9.00
Calculations		EGL (ft)	= 1.53
Compute by:	Q vs Depth		
No. Increments	= 10		



RAI-36

Description of Deficiency

In TR Section 3.1.4.1 (page 3-14), the application states:

> *"AUC will use the SERP process to allow usage of the oxidant at the Proposed Project if the oxidant is not included in this application."*

Basis for Request

The application mischaracterizes use of the Safety and Environmental Review Panel (SERP) process in the proposed operations which is the fundamental process for a "Risk-Informed Performance-Based License" such as one sought by the applicant. The SERP process should provide the means for appropriately documenting changes (whether or not an amendment is sought) and identify whether or not an amendment from NRC is required for a change in the technical licensing basis or to the facility from that described in the application.

Section 5.2.4 of the SRP states:

> *"Procedures governing the functioning of the Safety and Environmental Review Panel ensure that approvals of any changes in the facility, the operating procedures, or the conduct of tests or experiments <u>are appropriately documented and reported</u>. These changes, tests, or experiments may be effected <u>without obtaining a license amendment</u> pursuant to 10 CFR 40.44, so long as the change, test, or experiment does not*
>
> *(a) Create a possibility for an accident of a different type than previously evaluated in the license application (as updated).*
>
> *(b) Create a possibility for a malfunction of a structure, system, or control with a different result than previously evaluated in the license application (as updated).*
>
> *(c) Result in a departure from the method of evaluation described in the license application (as updated) used in establishing the final safety evaluation report or the environmental assessment or technical evaluation reports or other analyses and evaluations for license amendments."*

Formulation of RAI

Please revise this statement to correctly characterize implementation of the SERP process.

RAI-36 Response

AUC has revised TR Sec. 3.1.4.1 to appropriately characterize the SERP process. The last sentence of this section now reads:

"AUC will utilize the SERP process to appropriately document usage of the oxidant and determine whether or not a license amendment will be required."

4 EFFLUENT CONTROL SYSTEMS

RAI-37

Description of Deficiency

In Section 4.2 of the TR, the applicant stated that the forced air ventilation system will be designed for a maximum of six air changes per hour.

Basis for Request

The applicant did not provide any flow rate and structural volume to demonstrate that it will meet a maximum of six air changes per hour. Regulatory Guide 8.37,Section C.3.1 states that, when practical, releases of airborne radioactive effluents should be from monitored release points (e.g., monitored stacks, discharges, vents) to ensure that the magnitude of such effluents is known with a sufficient degree of confidence to estimate public exposure. The flow rate(s) from fan(s) is one of several parameters that can be used to calculate and compute potential releases of radioactive material, including radon. NRC staff has determined that the applicant did not provide flow rate(s) from fan(s) and the volume of air inside the structure to validate the statement that the force air ventilation system will be designed for a maximum of six air changes per hour.

Formulation of RAI

Provide calculations that show the technical basis for the selection of ~~six~~ four as the number of max air charges needed per hour? Clarify where the maximum of ~~six~~ four air changes per hour applies (e.g., single room, area, or the entire facility). Include the volumetric flow rate that supports the conclusion of maximum of ~~six~~ four air changes per hour within the Central Processing Plant (CPP). In addition, demonstrate that the ventilation exhaust (fans) have the capacity to achieve four air exchanges per hour.

RAI-37 Response

The HVAC system will provide air circulation to the facility's main process area, where process vessels, tanks and other equipment are located, to reduce the potential concentration of radon gas. The processing plant design is in an advanced stage, but not currently finalized. The total system volumetric flow rate will be determined once all tanks, vessels, equipment, and building have been sized and fully specified although AUC anticipates a maximum of four exchanges per hour. AUC would also like to call attention to the Final Moore Ranch SER which states that the air exchange rate will be approximately

1.25 air exchanges per hour for the project's proposed CPP. This approved exchange rate is significantly lower than the level anticipated for AUCs proposed project. Following final engineering design work, AUC will provide NRC with calculations that show the technical basis for the selection of four as the number of max air charges needed per hour ninety days prior to the preoperational inspection.

Additionally, some process tanks, vessels and equipment will be equipped with active ventilation to exhaust gases that may be generated during operational processes. These active ventilation systems will exhaust directly to atmosphere to minimize the intrusion of gases or vapors entering the plant atmosphere from process solutions. During the first few months of plant operations, the HVAC system performance will be evaluated and adjustments made as necessary in response to results from the radiological monitoring program.

Based on this response AUC has revised the sentence relating to CPP air exchanges in TR Section 4.2 to read: "The forced air ventilation system will be designed for a maximum of four air changes per hour."

This following calculation examines the volumetric flow rate needed to replace all of the air inside of the CPP a maximum of four times each hour. This calculation does not take into account the volume equipment within the plant will take up as a final design has not been completed, nor does this calculation attempt to calculate the rate Radon gas will be generated within the CPP. Therefore the following calculation represents the maximum volumetric flow rate to achieve four air exchanges per hour within the general CPP area.

AUC will operate the ventilation system at a rate as needed to maintain Radon levels as required in Regulatory Guide 8.31. Therefore, AUC does not expect to operate the ventilation system at this maximum capacity on a continuous basis.

Knowns:

$A_{CPP} = 200\,ft * 350\,ft = 70{,}000\ \text{ft}^2$	The square-foot area of the CPP's occupied area

Assumptions:

$H_{CPP} = 20\,ft$	The average height of the CPP
$\eta_{VENT} = \frac{4}{hr}$	Anticipated number of air exchanges per hour

Calculations:

$V_{CPP} = A_{CPP} * H_{CPP} = 1{,}400{,}000\ ft^3$	Anticipated volume of CPP
$Q_{VENT} = V_{CPP} * \eta_{VENT} = 93{,}333\ \frac{ft^3}{min}$	Anticipated volumetric flow of HVAC system

Conclusion:

Based on the Conceptual CPP Building Layout, and an assumed 20 ft building height, the CPP ventilation system will need to provide 93,333 actual cubic feet per minute (ACFM) to meet the maximum 4 air exchanges per hour to mitigate the production of Radon gas within the CPP.

RAI-38

Description of Deficiency

In Section 4 of the TR, the applicant discussed deep well disposal but the applicant did not address land applications.

Basis for Request

The applicant should demonstrate if they plan to use land applications or make a statement that they will not use land applications. SRP Acceptance Criteria 4.2.3(1) states that common liquid effluents generated from the process bleed, process solutions, wash-down water, well development water, pumping test water, and restoration waters are properly controlled. Acceptable control methods include diversion of liquid wastes to surface impoundments, deep well injection, and land application/irrigation and solid effluents can be considered either as contaminated or as non-contaminated. For land applications, the applicant should comply with 10 CFR Parts 20 and 40. NRC staff cannot determine from the applicant's technical report if the applicant plans, or does not plan, to use the land application/irrigation methods at the site.

Formulation of RAI

Provide a statement on whether land application/irrigation will be used. If land application/irrigation is used, then provide a detailed explanation of the land application/irrigation process and methods that will be used to include identity of the property area and approximately acreage, the potential use of the land, the annual volume of liquids discharged or deposited onto the land, maximum possible flow rate. Also, include that applicant's plan to demonstrate compliance with 10 CFR 20.1301,10 CFR 20.1302, 10 CFR 20.2002, and 10 CFR 20.2007 will be achieved.

In addition, if the applicant plans to use land application/irrigation then:

- *Describe the area where the use of land application will be applied (clearly, identify whether this land is on property controlled by the licensee or on private/public property not controlled by the licensee).*
- *Define how much surface area does the applicant plan to use.*
- *Describe the purpose of the land application (i.e., use for industrial, commercial, recreational, agriculture, other).*
- *Describe the source of the water for land application.*
- *Estimate how much will be used on a daily, weekly, monthly, and annual basis.*

- *Describe the process to determine if the source of the water is suitable for land application (what regulatory criteria does the applicant plan to use to determine that the water is permissible for discharge for land application…i.e., 10 CFR 20 Appendix B, Table 2).*
- *Identify the radionuclides (and non-radiological chemical elements) that will be discharged to the land application.*

RAI-38 Response

~~AUC will revise TR Section 4.3 Liquid 11e.(2) Byproduct Material Disposal to incorporate the material presented in the following response.~~

- ~~***RAI Item: Provide a statement on whether land application/irrigation will be used***~~

~~AUC has completed design and testing of a variety of techniques for minimizing wastewater (liquid effluents) and finding additional disposal methods (including beneficial use) to decrease the company's reliance on DDW capacity. Based on the positive results of pilot scale laboratory tests performed on concentrated PZA formation water, AUC proposes to include land application as one component in combination with DDWs for wastewater disposal.~~

~~In order to design the land application process, AUC collected 250 gallons of PZA groundwater from Well PZM10 (which is chemically quite similar to potential barren lixiviant) and produced 10 gallons of concentrated RO brine solution from a small scale reverse osmosis unit for the pilot scale tests. Table 1 for this response (shown below) depicts the values of the constituents from the concentrated brine solution.~~

On September 4, 2014, AUC notified the NRC (ML14251A011) through electronic-mail (e-mail) that AUC will not incorporate land application as part of its wastewater disposal system into its Source Materials License for the Reno Creek Project. AUC also committed to withdraw RAI responses or portions of RAI responses that specifically discussed the possible incorporation of land application and revise them as appropriate.

Therefore, AUC has revised the following TR and ER Sections in response to RAI-38:

- TR Sec. 1.10 Byproduct Material Management

"Disposal options for liquid 11e.(2) byproduct material include up to four deep well injection in Class I wells or used as plant make-up water. AUC has not incorporated land application as a component of its wastewater disposal system in the proposed action."

- ER Sec. 1.4.9 Byproduct Material Management

"This section describes the proposed byproduct material management system. Liquid and solid byproducts are divided into two general categories: 11e.(2) byproduct material and non-11e.(2) byproduct material. The proposed byproduct management system is summarized below for each category. Additional details about Byproduct Management are found in Section 4.13 of this document. AUC has not incorporated land application as a component of its wastewater disposal system in the proposed action."

By revising AUCs response to RAI-38, this has eliminated the clarification questions and comments listed below that arose during our project manager to project manager meetings (August 6, 2014 and August 15, 2014) on the RAI responses.

Description of Concern

- *NRC referenced RG 4.14 for a comparison of land application vs discharge into surface water sources, however a quick review of RG 4.14 by AUC staff did not show anything related to either subject.*
    - *Has AUC discussed the land application process with the WDEQ?*
    - *Describe how AUC will integrate livestock sampling.*
    - *Correct Table 4 of TR RAI-38 to be consistent with locations on TR Figure 2.1-3.*
    - *Identify how AUC will evaluate/monitor environmental pathways.*
    - *Add land application to TR Figure 7-1 (Exposure Pathways).*
- *Provide an explanation and/or definition of permeate so the public will have a better understanding of the type of land application AUC is proposing.*
- *Provide an evaluation of land application potential impacts to water resources in the area.*
- *Describe where samples of the treated effluent will be collected prior to discharge.*
    - *Include the planned mitigation if effluent does not meet discharge limits.*
    - *Provide the linear footage of the rip rap/gravel bed.*
- *Describe how wastewater will management be affected if a sample does not meet release standards?*
- *Provide a location and description of the outfalls in relation to the check dams that will be receiving the treated effluent and the point of compliance.*
- *Clarify whether or not the new air modeling protocol includes land application.*

- *Provide calculations for the volume of solid waste that will be precipitated from the new proposed wastewater (land application) system.*
- *Provide revised Water Balance Figures that show the addition of the new proposed wastewater system (land application).*
- *In the response to TR-38, clarify how the release of the treated effluent through land application will be protective of public health and wildlife. Include a pathway analysis.*

All or part of RAI Responses for the following RAIs, included in AUCs RAI Response Document under cover dated June 13, 2014 (ML14169A452) have been revised to reflect the removal of land application as a wastewater disposal option:

- TR RAI-34;
- TR RAI-38;
- TR RAI-40;
- TR RAI-45; and
- ER Gen-4.

As a result of the withdrawl of the land application process TR RAI Figures 3-8 and 2.1-3 remain unchanged.

~~Table 1: RO Brine Constituent Concentrations~~

~~**Parameter**~~	~~**RO Brine**~~	~~**Units**~~
~~***General***~~		
~~pH~~	~~7.34~~	~~S.U.~~
~~Electrical Conductivity~~	~~22,300~~	~~µmhos/cm~~
~~Total Dissolved Solids~~	~~27,533~~	~~mg/L~~
~~Solids, Total Dissolved (Calc)~~	~~28,811~~	~~mg/L~~
~~Nitrogen, Ammonia (As N)~~	~~<1.20~~	~~mg/L~~
~~Silica as SiO2~~	~~169~~	~~mg/L~~
~~***Anions***~~		
~~Alkalinity, Total (As CaCO3)~~	~~1,140~~	~~mg/L~~
~~Alkalinity, Bicarbonate as HCO3~~	~~1,140~~	~~mg/L~~
~~Alkalinity, Carbonate as CO3~~	~~0~~	~~mg/L~~
~~Chloride~~	~~475~~	~~mg/L~~
~~Sulfate~~	~~17,620~~	~~mg/L~~
~~***Cations***~~		
~~Calcium~~	~~2,320~~	~~mg/L~~
~~Magnesium~~	~~340~~	~~mg/L~~
~~Potassium~~	~~128~~	~~mg/L~~
~~Sodium~~	~~6,510~~	~~mg/L~~
~~***Radiochemistry***~~		
~~Radium 226 (Dissolved)~~	~~3,680~~	~~pCi/L~~
~~Radium 226 (Total)~~	~~4,600~~	~~pCi/L~~
~~***Dissolved Metals***~~		
~~Aluminum~~	~~0.076~~	~~mg/L~~
~~Arsenic~~	~~0.259~~	~~mg/L~~
~~Barium~~	~~0.391~~	~~mg/L~~
~~Cadmium~~	~~<0.005~~	~~mg/L~~
~~Chromium~~	~~<0.005~~	~~mg/L~~
~~Copper~~	~~0.064~~	~~mg/L~~
~~Iron~~	~~2.7~~	~~mg/L~~
~~Lead~~	~~<0.01~~	~~mg/L~~
~~Manganese~~	~~1.28~~	~~mg/L~~
~~Mercury~~	~~<0.01~~	~~mg/L~~
~~Molybdenum~~	~~0.563~~	~~mg/L~~
~~Nickel~~	~~0.038~~	~~mg/L~~
~~Selenium~~	~~<0.05~~	~~mg/L~~
~~Uranium~~	~~2.9~~	~~mg/L~~
~~Vanadium~~	~~0.137~~	~~mg/L~~
~~Zinc~~	~~0.333~~	~~mg/L~~

- ~~***RAI Item: Provide a detailed explanation of the land application/irrigation process and methods that will be used to include identity of the property area and approximate acreage***~~

~~Liquid effluents at the Proposed Reno Creek Project will be generated from several sources such as process bleed, process solutions, wash-down water, well development water, and groundwater restoration. The constituents of concern dissolved in the liquid effluents can be categorized into three classes:~~

1. ~~Radiological constituents;~~
2. ~~Trace metals; and~~
3. ~~Total Dissolved Solids (TDS).~~

~~No single method fully optimizes treatment for all constituents. As a result, each class of chemical constituent can be subjected to a treatment method tailored to the site specific chemistry. Therefore, AUC conducted a research and testing program to identify methods to decrease each of the chemical constituents within the wastewater.~~

~~AUC has developed a treatment process to provide an effluent that will meet WDEQ/WQD Class III (Livestock) Water Quality Standards (Table 2 shown below) that can be put to beneficial use by area ranchers.~~

~~Table 2: WDEQ Class III (Livestock) Water Quality Characteristics~~

~~Parameter~~	**~~Units~~**	**~~WDEQ Class III (Livestock)~~**
~~General~~		
~~pH~~	~~s.u.~~	~~6.5 – 8.5~~
~~Total Dissolved Solids~~	~~mg/L~~	~~< 5,000~~
~~Anions~~		
~~Chloride~~	~~mg/L~~	~~< 2,000~~
~~Sulfate~~	~~mg/L~~	~~< 3,000~~
~~Radiochemistry~~		
~~Radium 226~~	~~pCi/l~~	~~< 5.0~~
~~Dissolved Metals~~		
~~Aluminum~~	~~mg/L~~	~~< 5.0~~
~~Arsenic~~	~~mg/L~~	~~< 0.2~~
~~Boron~~	~~mg/L~~	~~< 5.0~~
~~Cadmium~~	~~mg/L~~	~~< 0.05~~
~~Chromium~~	~~mg/L~~	~~< 0.05~~
~~Copper~~	~~mg/L~~	~~< 0.5~~
~~Lead~~	~~mg/L~~	~~< 0.1~~
~~Mercury~~	~~mg/L~~	~~< 0.00005~~
~~Selenium~~	~~mg/L~~	~~< 0.05~~
~~Vanadium~~	~~mg/L~~	~~< 0.1~~
~~Zinc~~	~~mg/L~~	~~< 25.0~~

~~Conceptual Wastewater Treatment System Design~~

~~Based upon the results of the pilot scale wastewater treatment study AUC proposes the following Wastewater Treatment System Design. The proposed Wastewater Treatment System Design is shown in TR Figures 3-5 to 3-7, Reno Creek Proposed Water Balance and consists of the following unit processes and purposes:~~

- ~~Radiological Constituent Removal~~
    - ~~Uranium Guard Column Ion Exchange System - Soluble Uranium Removal~~
    - ~~Ultrafiltration – Insoluble Radium Removal~~
    - ~~Radium Ion Exchange System – Soluble Radium Removal~~
- ~~Water Softening/Precipitation Process – Hardness Removal and Decrease Trace Metals Concentrations~~
- ~~Nanofiltration – Decrease Total Dissolved Solids Concentration~~

~~Figure 3-8 of the TR shows the conceptual CPP layout. This figure has been revised to incorporate the equipment that will be installed for the proposed wastewater treatment system. This revised figure is shown at the end of this response discussion. The proposed wastewater treatment system will fit into the conceptual CPP layout without increasing the size of the CPP building. The land size footprint of the treated effluent land application system is expected to be less than 1.5 acres (see discussion below). This is in contrast to solar evaporation ponds which require a much larger acreage to be effective in storing and reducing effluent volumes.~~

~~Radiological Constituent Removal Process~~

~~The first step in the wastewater treatment process will be to remove the radiological constituents. Uranium and radium 226 with trace amounts of radium 228 will be the main radiological constituents of concern in the liquid effluents produced at the Proposed Project. AUC will remove residual uranium from the wastewater through the use of guard columns. These columns will contain uranium removal ion exchange resin suitable for use with brine solutions.~~

~~Following the removal of uranium, the wastewater will be directed to an ultrafiltration system that will remove insoluble radium.~~

~~Soluble radium then will be removed from the wastewater through the use of ion exchange resin specifically designed for radium. In the pilot scale tests conducted by AUC the resin proved effective in removing greater than 90 percent of the radium (226 and 228) in a~~

~~single pass. The treated wastewater was then passed through a second column containing the radium resin with the result that the total radium concentration was reduced to less than 5 pCi/L.~~

~~It is anticipated that thorium-230 and lead-210 will not be present at concentrations above the release limits; however, if concentrations are above the limits, the effluent will be treated as necessary to satisfy effluent limits.~~

~~**Trace Metals**~~

~~***Water Softening/Precipitation Process***~~

~~The second step in the wastewater treatment process is to decrease the hardness of the solution and at the same time decrease the concentration of trace metals. The ISR industry has long known that arsenic, molybdenum, selenium and vanadium, if present in the ore body, will be dissolved in solution during uranium recovery operations. Based on column leach tests performed on core from the Reno Creek PZA, the trace metals that are expected to be present in the greatest concentrations in the wastewater produced at the Proposed Project are arsenic, molybdenum, and vanadium. During bottle roll tests, some detectable amounts of selenium were present. AUC will use a water softening process to reduce trace metal concentrations, reduce hardness and to slightly decrease TDS concentrations.~~

~~During the pilot scale tests AUC used the cold lime softening process (CLS) for water softening although other water softening technologies are available using such precipitants as aluminum hydroxide and aluminum chloride. Also available are ion exchange systems and membrane removal systems~~

~~Cold lime softening technology is a well-known and reliable method for removing hardness and alkalinity from water caused by minerals such as calcium, magnesium, iron and silica. Cold lime softening is a form of precipitation softening that works well at ambient temperatures, removing temporary and permanent hardness.~~

~~The process parameters used for the Cold Lime Softening are as follows:~~

- ~~Lime Addition and Rapid Mixing~~
- ~~Coagulant (Ferric Chloride) Addition and Rapid Mixing~~
- ~~Anionic Polymer Addition and Rapid Mixing~~
- ~~Flocculation~~
- ~~Settling or Solid/Liquid Separation~~

~~Pilot scale test results performed by AUC on the concentrated brine following radium removal indicate that CLS removes hardness and trace metals effectively, but was unable to break the ionic balance of the sodium sulfate solution. Key findings of the pilot scale tests are as follows:~~

- ~~High Lime Cold Softening provides excellent pretreatment for final polishing, but cannot achieve final discharge requirements solely.~~
- ~~Lime and Chemical Dosages are very modest, as sulfate resists precipitation and binding.~~
- ~~As relative hardness and other scaling risks are removed from water by CLS, Nanofiltration can concentrate remaining water and produce Class III discharge water without further expensive chemical treatment.~~

~~Cold lime softening will produce a solid precipitate that will be free of radiological constituents, since uranium and radium were removed in the previous steps of the process. Laboratory tests of the solid precipitate indicates that the solid precipitate will pass the Toxic Characteristic Leaching Procedure (TCLP) and also the Paint Filter Test (PFT).~~

~~TCLP is a solid sample extraction method for chemical testing to simulate leaching of hazardous metals within a landfill. The testing methodology is used to determine if a solid precipitate may be safely disposed in a landfill. PFT is the US EPA approved test method to determine the presence of free liquids in a representative sample of waste. It is referenced in the regulations pertaining to hazardous waste landfills since free liquids are forbidden from landfill disposal, unless exempted. AUC will dispose of the resulting solids from the CLS process in a licensed landfill.~~

~~Total Dissolved Solids~~

~~The third step in the in the wastewater treatment process is to decrease total dissolved solids (TDS) to acceptable concentrations for livestock use. Typical examples of chemical constituents that make up the TDS in solutions are calcium, sodium, magnesium, chloride, bicarbonate and sulfate. During the uranium recovery process (Production Only), TDS concentrations of the wastewater are predicted to be in the range of 10,000 mg/L. However, TDS concentrations in wastewater generated when the groundwater restoration (Production and Groundwater Restoration) phase of operations begins are expected to range upwards of 25,000 mg/L due to the use of the Secondary RO Unit. The brine from the Secondary RO Unit will be the main source of the wastewater generated and treated during the concurrent Production and Groundwater Restoration and Groundwater Only phases of operations (TR Figures 3-6 and 3-7, Reno Creek Proposed Water Balance).~~

~~AUC will employ nanofiltration to reduce TDS concentrations to acceptable limits, which for livestock is less than 5000 mg/L. The nanofiltration system will produce a permeate and a brine. The permeate produced from the nanofiltration system will be the resultant water that will be land applied for use as livestock water. The brine will be sent to the DDWs. The permeate will be released to designated outfall locations which will be located at or near ranchers stock water ponds already in use. NOTE: Such stock water ponds have been receiving CBM produced water discharges for up to 20 years, but the discharge rate has been declining severely as CBM production declines. Table 3 (shown below) depicts the expected final water quality that will be produced from the nanofiltration system.~~

~~Table 3: Predicted Effluent Quality~~

~~Parameter~~	~~Units~~	~~WDEQ Class III (Livestock)~~	~~Predicted Effluent Quality~~
~~General~~			
~~pH~~	~~s.u.~~	~~6.5 – 8.5~~	~~8.5~~
~~Total Dissolved Solids~~	~~mg/L~~	~~< 5,000~~	~~4,900~~
~~Anions~~			
~~Chloride~~	~~mg/L~~	~~< 2,000~~	~~124~~
~~Sulfate~~	~~mg/L~~	~~< 3,000~~	~~2,900~~
~~Radiochemistry~~			
~~Radium 226~~	~~pCi/l~~	~~< 5.0~~	~~< 5.0~~
~~Dissolved Metals~~			
~~Aluminum~~	~~mg/L~~	~~< 5.0~~	~~< 5.0~~
~~Arsenic~~	~~mg/L~~	~~< 0.2~~	~~< 0.2~~
~~Boron~~	~~mg/L~~	~~< 5.0~~	~~< 5.0~~
~~Cadmium~~	~~mg/L~~	~~< 0.05~~	~~< 0.05~~
~~Chromium~~	~~mg/L~~	~~< 0.05~~	~~< 0.05~~
~~Copper~~	~~mg/L~~	~~< 0.5~~	~~< 0.5~~
~~Lead~~	~~mg/L~~	~~< 0.1~~	~~< 0.1~~
~~Mercury~~	~~mg/L~~	~~< 0.00005~~	~~< 0.00005~~
~~Uranium~~	~~Mg/L~~	~~NA~~	~~<0.44~~
~~Selenium~~	~~mg/L~~	~~< 0.05~~	~~< 0.05~~
~~Vanadium~~	~~mg/L~~	~~< 0.1~~	~~< 0.1~~
~~Zinc~~	~~mg/L~~	~~< 25.0~~	~~< 25.0~~

- ~~***RAI Item: The potential use of the land, the annual volume of liquids discharged or deposited onto the land.***~~

~~The permeate from the nanofiltration system will be released to designated outfall locations so that it will flow to and be collected in existing ranch stock water ponds currently in use. AUC will not construct any additional ponds for its wastewater disposal project.~~

~~AUC plans on discharging the treated effluent under the auspices of a Wyoming Pollutant Discharge Elimination System (WYPDES) Program permit issued by the WDEQ/WQD.~~

- ~~***RAI Item: Maximum possible flow rate***~~

~~Three phases of operations will take place during the life of the Proposed Project:~~

1. ~~Production Only;~~
2. ~~Production and Groundwater Restoration; and~~
3. ~~Groundwater Restoration Only.~~

~~Each phase of operations will generate a range of wastewater flow rates however the largest flow rates will be generated during the concurrent Production and Groundwater Restoration phase of operations. TR Figure 3-6 shows the maximum flow rate of water to be land applied is 102 gpm. However, based on the operating parameters of the reverse osmosis (RO) units the amount of wastewater generated will vary due to higher or lower RO recovery rates (permeate) which will cause the wastewater generated (brine) to vary also. This change in brine flow rates will directly affect the amount of water available to be land applied.~~

~~A benefit of treating the wastewater to livestock quality standards is that the wastewater that must be disposed through deep well injection is reduced in volume. During the concurrent Production and Groundwater Restoration phase of operations the volume of wastewater sent to the DDWs will be decreased by an estimated 102 gpm. Less reliance on DDWs will mean more efficient control of mining solutions through a properly maintained bleed and more efficient groundwater restoration since there will be sufficient wastewater disposal capacity to support restoration.~~

- ~~***RAI Item: Include the applicant's plan to demonstrate compliance with 10 CFR 20.1301,10 CFR 20.1302, 10 CFR 20.2002, and 10 CFR 20.2007.***~~

~~There will be three radiological constituents of concern that will be included with the wastewater generated at the proposed facility:~~

1. ~~Radium 226;~~
2. ~~Uranium; and~~
3. ~~Radon 222.~~

~~As discussed previously, radium and uranium removal will occur as part of the wastewater treatment system. The concentration of radium will be reduced to acceptable levels that will comply with WDEQ/WQD livestock standards. The concentration of uranium will be reduced to acceptable levels that will comply with 10 CFR 20 Appendix B, Table 2, Column 2 effluent release standards to unrestricted areas of 3E-7 μCi/ml (0.44 mg/L). A grab sample of the treated effluent will be collected daily for uranium concentrations at the tail of each guard column and as the effluent is pumped from the Land Application Effluent Tank in the CPP to ensure compliance with the standards.~~

~~During the pilot scale tests conducted by AUC the radium resin proved effective in removing greater than 90 percent of the radium (226 and 228) in a single pass. The treated wastewater was then passed through a second column containing the radium resin with the result that the total radium concentration was reduced to less than 5 pCi/L. AUC will use a two pass system or more if needed to ensure the radium 226 concentrations are below the Class III Livestock water standards as set by the WDEQ/WQD.~~

~~AUC will calculate the radium loading capacity of the resin, which AUC will confirm by regular sample analyses of the tail samples of each of the radium columns. This is to ensure that when brake through of the first column is observed the resin will be replaced with a fresh charge of resin. The tail column will become the lead column and the column with the fresh bed of resin will become the tail column. The spent resin will be disposed in an appropriate 11e.(2) waste disposal facility.~~

~~AUC will also collect samples as the effluent is pumped from the Land Application Effluent Tank in the CPP to ensure compliance with the WYPDES discharge standards on a monthly basis.~~

~~There are two places in the wastewater treatment system where radon will be released from the treated effluent prior to being released to the out fall locations. These include the~~

~~Wastewater Clarifier Treatment Unit and the Land Application Effluent Tank in the CPP. Each of these tanks will be connected to a duct network that will be exhausted through the CPP roof. Radon will be removed from the effluent solution at these points thus preventing radon 222 releases at the outfall locations.~~

- ***~~RAI Item: Describe the area where the use of land application will be applied (clearly, identify whether this land is on property controlled by the licensee or on private/public property not controlled by the licensee.~~***

~~Table 4 (shown below) provides the proposed outfall locations and the landowners for the land applied effluent. Each of the outfall locations is located within the proposed Project Boundary. AUC controls the surface at each of the outfall locations through Surface Use Agreements with each of the landowners. TR Figure 2.1-3 shows the proposed outfall locations.~~

~~Table 4: Outfall Locations~~

~~Surface Owner~~	**~~Township~~**	**~~Range~~**	**~~Section~~**	**~~Document~~**
~~Leavitt~~	~~43N~~	~~73W~~	~~31~~	~~Surface Use Agreement~~
~~State of Wyoming~~	~~43N~~	~~74W~~	~~36~~	~~Surface Use Agreement~~
~~Reno~~	~~42N~~	~~73W~~	~~6~~	~~Surface Use Agreement~~

~~Each of these locations are adjacent to existing ranch stock water ponds currently in use by local ranchers. These stock water ponds are normally dry unless filled by rancher well water or until recently by coal bed methane (CBM) produced groundwater. AUC will split the effluent flow between the three stock ponds so that each will receive an estimated 34 gpm (102 gpm total) during maximum effluent production, however each outfall will be designed to handle the full effluent flow if necessary.~~

~~The three outfall locations AUC plans on using were existing locations built by the CBM industry. CBM produced water was land applied at these outfall locations for 10 or more years under WYPDES Permit numbers WY0042340 (Section 36), WY0048526 (Section 31) and WY00448542 (Section 6). The flow rates ranged from 130 gpm at the Section 6 location to 630 gpm at the Section 36 location.~~

- ~~***RAI Item: Define how much surface area does the applicant plan to use.***~~

~~Each outfall will be designed to protect against surface erosion. The effluent will be discharged onto a gravel bed to decrease the effluent velocity. The effluent will be collected and distributed to the land application through a manifold pipe system above each stock pond. The effluent will then drain down into the stock pond to be used as water for livestock. The area used by each outfall is expected to take up less than half an acre, therefore the total surface area will be less than 1.5 acres. AUC will follow the practice of the CBM operators and land apply through the outfall locations throughout the year.~~

- ~~***RAI Item: Describe the purpose of the land application (i.e., use for industrial, commercial, recreational, agriculture, other).***~~

~~The purpose of the land application is to reduce the overall consumptive use of groundwater by taking a portion of the wastewater generated by the Proposed Projects operations and treating it to produce a beneficial water source for local area ranchers.~~

~~For more than a decade local area ranchers have been dependent on coal bed methane produced groundwater to fill their stock ponds. As discussed in Section 2.7 of the TR the streams located near the Proposed Reno Creek Project are described as small ephemeral drainages. The nearest perennial stream is the Powder River, approximately 25-miles west of the Proposed Project site and there are no major lakes within a 50-mile radius of the Proposed Project.~~

~~As CBM projects wind down local ranchers are requiring a new source of water for their livestock. AUC proposes to fill this void by providing a source of water for livestock from appropriately treated effluent from the Proposed Project.~~

- ~~***RAI Item: Describe the source of the water for land application.***~~

~~The source of the land application wastewater will be from the operations of the Proposed Reno Creek ISR facility. Initially during the Production Only phase of operations liquid effluents at the Proposed Reno Creek Project will be generated from a combination of sources such as process bleed, process solutions, wash down water and well development water. This will be the source of the land application water that will be processed through the various treatment options proposed by AUC prior to discharge. The wastewater TDS concentration from this phase of operations is expected to be less than 10,000 mg/L since the Secondary RO Unit will not be in use. After treatment the TDS concentration of the~~

~~land applied effluent will be less than 5,000 mg/L which is the livestock standard of the WDEQ/WQD.~~

~~During the Production and Groundwater Restoration and Groundwater Restoration Only phases of operations all sources of liquid effluent generated at the facility will flow through the Secondary RO Unit. The purpose of the Secondary RO Unit is to decrease the amount of wastewater and provide additional permeate to enhance groundwater restoration. The brine generated by the Secondary RO Unit will be the source of the land application water that will be processed through the various treatment options proposed by AUC prior to discharge. The wastewater TDS concentration from this phase of operations is estimated to be approximately 25,000 mg/L. After treatment the TDS concentration of the land applied effluent will be less than 5,000 mg/L.~~

- ***~~RAI Item: Estimate how much will be used on a daily, weekly, monthly, and annual basis.~~***

~~Table 5 (shown below) provides the calculated gallons used during the maximum effluent rate of 102 gpm produced during the concurrent Production and Groundwater Restoration phase of operations.~~

~~Table 5: Gallons Used~~

~~Daily~~	**~~Weekly~~**	**~~Monthly~~**	**~~Annual~~**
~~146,880~~	~~1,028,160~~	~~4,406,400~~	~~53,611,200~~

- ~~***RAI Item: Describe the process to determine if the source of the water is suitable for land application (what regulatory criteria does the applicant plan to use to determine that the water is permissible for discharge for land application…i.e., 10 CFR 20 Appendix B, Table 2).Identify the radionuclides (and non-radiological chemical elements) that will be discharged to the land application.***~~

~~The expected effluent concentrations are listed in Table 3: Predicted Effluent Quality of this response. The process AUC has developed for treating the wastewater generated at the facility will meet WDEQ/WQD livestock standards for radium and the required non-radiological chemical elements. The WQD does not list a uranium concentration for livestock, however the uranium concentration will be less than the maximum effluent concentration listed in 10 CFR 20 Appendix B, Table 2, Column 2 of 3E-7 µCi/ml (0.44 mg/L).~~

~~AUC will discharge the treated effluent under a WQD issued WYPDES permit which will include effluent limits designed to protect livestock. WDEQ/WQD regulations in Chapter 1, Section 22(c) require that "in all Wyoming surface waters, radioactive materials attributable to or influenced by the activities of man shall not be present in the water or in the sediments in amounts which could cause harmful accumulations of radioactivity in plant, wildlife, stock or aquatic life" (WDEQ 2007). Therefore, AUC anticipates that the radiological effluent limits in the WYPDES permit will be protective of livestock.~~

RAI-39

Description of Deficiency

In Section 4.3 of the TR, the applicant stated that prior to commencement of pond construction, the applicant will submit to the NRC a backup storage pond design plan based on the site specific geotechnical investigation. The components of the backup storage pond design plan are outlined in Section 4.3 of the TR. SRP Acceptance Criteria 4.2.3(2) through Acceptance Criteria 4.2.3(4), and Acceptance Criteria 4.2.3(8) collectively address, in one manner or another, that the design and the operations of the on-site evaporation system are conducted to mitigate liquid waste from reaching the subsurface below the bottom of the on-site evaporation system, consistent with Regulatory Guide 3.11 (NRC, 1977).

Basis for Request

NRC staff has determined that the above acceptance criteria are implicit and prudent to provide all necessary information to NRC during the review of the application.

Formulation of RAI

Provide the backup storage pond design components, as outlined in Section 4.3 of the TR, in the license application; not prior to commencement of pond construction.

RAI-39 Response

On June 18, 2013, AUC received a letter from Mr. Chad Glenn requesting that AUC provide a detailed design of the backup storage pond for review. AUC provided the requested backup storage pond construction details in its Application Acceptance Review Comments (Supplemental data ML13219A203) response dated July 19, 2013. The information was provided in the civil engineering package titled “Civil_Site-20121002´on the DVD Optical Storage Media (OSM) (Labeled "Acceptance Review Package la- July 2014"). AUC will incorporate the civil drawing package into the Technical Report as Addendum 3-A and the complete geotechnical report as Addendum 4-A.

Additionally, AUC has revised the text referencing the submission of the backup storage pond design detail TR Section 4.3.5 as follows:

“The design of the backup pond is based on NRC Regulatory Guide 3.11, “Design, Construction, and Inspection of Embankment Retention Systems at Uranium Recovery Facilities”, 10 CFR Part 40, Appendix A, Criterion 5(A), and the pertinent laws and regulations indicated therein. It should be noted that these regulations apply to 11e.(2)

impoundments. The backup storage pond is designed specifically as a redundancy system to the DDWs, which are the primary liquid 11e.(2) byproduct disposal option. Therefore, some of the requirements for tailings impoundments do not apply to the design of the backup storage pond. The primary difference is the limited use of the backup pond during the life of the facility. Control of potential windblown particulate releases from the dried fringe areas of the pond that has been temporarily in use will be managed via clean water wash down to remove residues, temporary application of commercially available dust suppression/stabilization sprays, or other means.

A detailed backup storage pond design has been completed based on a site and material characterization study performed by Inberg-Miller Engineers. The report which includes the geotechnical test borings from the proposed pond locations (borings B9 through B12) is included in its entirety as Addendum 4-A, Subsurface Exploration and Geotechnical Engineering Report. The civil engineering package which contains the pond design details is included as Addendum 3-A. The pond location and estimated dimensions are indicated on Figure 3-1 of this TR.

AUC is submitting to NRC a backup storage pond design plan based on the site specific geotechnical investigation. The backup pond design plan includes the following information:

- Site and material characterization;
- Configuration and location;
- Slope stability analysis;
- Settlement;
- Liquefaction potential analysis;
- Pond storage/freeboard analysis;
- Surface water diversion design;
- Erosion protection design (embankment slopes and diversion ditches);
- Liner design;
- Leak detection system design;
- Hydrostatic uplift analysis;
- Construction specifications;
- Quality control testing program (methods and frequencies);
- Operational inspection plans; and
- Closure plans.

Sheets C-3.3 and C-3.4 of Addendum 3-A present the following information regarding the backup storage pond:

- Configuration and location;
- Surface water diversion design;
- Erosion protection design (embankment slopes and diversion ditches);
- Liner design;
- Leak detection system design; and
- Construction specifications.

Hydrostatic Uplift Analysis

In some locations of the Proposed Project area, a perched water table unit was encountered but not continuous across the site. The sand is generally saturated, and approximately 10 to 20 feet thick, occurring between 40 and 80 feet below ground surface. Four geotechnical exploratory borings were drilled within the proposed backup pond footprint to depths of 21.5 feet to observe subsurface and groundwater conditions. Groundwater was not encountered within any of the borings at the time of drilling and other factors that could contribute to fluctuations of groundwater levels were not identified.

Slope Stability Analysis

As required by the NRC regulations, slope stability analysis will be performed as a final step of the backup pond design. AUC anticipates the slope stability analysis to be completed directly and will provide the results to the NRC prior to licensing. Slope stability will require a post-construction model of the maximum fill slope using the soil strengths based on the soil types identified in the geotechnical study.

Liquefaction Potential Analysis

There has been little, if any, reported damage from liquefaction in Wyoming. The earthquake or pseudo-static model for external slopes will not be performed due to the low seismic potential for the project area.

Settlement

Based on the proposed construction and the subsurface profile encountered within the exploratory borings, settlement of the pond embankment foundation soils will be nominal. In addition, based on the liner system consisting of a double geomembrane and the infiltration of water into the soils beneath the pond is highly unlikely, further reducing any potential for settlement."

Additional information regarding the backup pond design have been addressed as follows:

- The liner design and leak detection system is provided in TR Section 4.3.5.1;
- Quality control and operational inspection plans are presented in TR Section 4.3.5.3. Closure plans and costs are presented in Addendum 6-A, Reclamation Plan;
- See RAI-32 response for a comprehensive description concerning the geosynthetic material to be used in the design of the leak detection system and revised Sheet C-3.4 (Grading: Backup Pond Details); and
- RAI-33 response provides the justification for 2.0 feet of freeboard indicted in the Sheet C-3.4 of Addendum 3-A.

RAI-40

Description of Deficiency

In Section 4.3 of the TR, the applicant identified a backup storage pond and a future additional backup pond in Figure 3-1 of the TR.

Basis for Request

The applicant did not provide any design plans or discuss the construction of the backup storage pond consistent with Regulatory Guide 3.11. SRP Acceptance Criteria 4.2.3(3) states that the design, installation, and operation of surface impoundments at the site used to manage 11e.(2) byproduct material meet relevant guidance provided in Regulatory Guide 3.11, Section 1.

Formulation of RAI

Provide detailed information on the design as well as drawings and pertinent analysis of the future additional backup storage pond. Include a description of the construction method(s), testing criteria, and quality assurance program that applies to this structure, as well as the planned mode of operation and associated inspection and maintenance programs.

RAI-40 Response

~~AUC has developed a wastewater disposal arrangement comprised of the installation of DDWs and the use of a wastewater treatment system that will reduce the volume of liquid effluent through land application. Due to this arrangement, AUC has determined that a second backup storage pond will not be required since there will be adequate liquid effluent disposal capacity throughout the life of the project. TR Section 4.3 has been revised by removing all references to a possible additional backup storage pond. TR Figure 3-1 has also been revised to remove the possible location of an additional backup pond.~~

Since the land application option has been withdrawn as part of the wastewater disposal system (RAI-38), AUC has revised the response to RAI-40 as follows:

AUC has determined that an additional backup storage pond is not currently required since AUC will adjust operation flow rates to accommodate liquid effluent disposal capacity throughout the life of the project. TR Section 4.3 has been revised by removing all references to a possible additional backup storage pond. TR Figure 3-1 has also been revised to remove the possible location of an additional backup storage pond.

RAI-41

Description of Deficiency

In Section 4.2.2 of the TR, the applicant indicates that the predominant airborne releases are Radon-222 from point and non-point sources. The applicant also indicates that the radon releases from the central processing building would occur from periodic tank ventilation during venting and backwashing operations, and from the normal building ventilation system, which will exhaust building air at various points in the structure and as such, no discrete monitoring locations would be available to make representative measurements of Radon-222 concentrations or air flow rates to estimate semi-annual emissions of Radon-222. The applicant indicates that because of these factors, the methods used to estimate Radon-222 emissions in Section 7.4 of this document will be used to estimate the semi-annual Radon-222 emissions from the facility as required in 10 CFR 40.65.

Basis for Request

NRC staff has determined that estimation of emission from the facility during operations is not acceptable. Regulatory Guide 8.37, Section 3 identifies surveys and effluent monitoring for airborne radioactive effluent monitoring, liquid effluent monitoring (if applicable), and unmonitored effluents. Regulatory Guide 4.14, C2, also discusses stack sampling to comply with 10 CFR 40.65. The stack monitoring is not confined only to the yellowcake dryer and packaging area, but other areas of the plant. NRC staff has determined that surveys and monitoring of the effluent provides a sufficient and reliable method for quantifying the amount of each of the principal radionuclides released to unrestricted areas in liquid and in gaseous effluents during operations.

Formulation of RAI

a) *Revise the text to describe the methods and protocols for surveying and monitoring the major potential effluent pathways in accordance with 10 CFR 40.65. Describe in the application how the results will be quantified for each principle radionuclide released to unrestricted areas in liquid and in gaseous effluents during operations. Define the effluent release design objectives for the proposed facility. Also, define areas of the project which are designated as unrestricted areas for the purpose of 10 CFR 40.65.*

b) *The applicant indicated that they will provide to the NRC staff, for review and written verification, written procedures for its airborne effluent and environmental*

> *monitoring program no later than 30 days before the preoperational inspection to show compliance with 10 CFR 40.65.*

NRC staff has determined that the applicant's response would require a license condition. The applicant needs to consider that if the response is not acceptable, this may delay operations. NRC staff recommends resolving this issue as soon as possible to avoid a license condition. NRC staff is seeking the following information:

- *Identify all potential air and gaseous effluent release points*
- *Discuss how each potential air and gaseous effluent release point will be monitored and how this information (or data) will be incorporated into the 10 CFR 40.65 report*
- *Discuss how the measurements from each potential air and gaseous effluent release point will be expressed as a quantity (as described in 10 CFR 40.65).*
- *Discuss the type of radiation measuring device and measurement of the effluent and how the measurements will be converted to a total quantity (expressed in Curies) and a release rate (Curies per unit time).*

If the applicant chooses to measure at a fence line (or restricted or control area), the applicant should demonstrate how the data from the measurements at a fence line will be extrapolated back to an effluent release point to identify the quantities of the principal radionuclides released to the environment.

RAI-41 Response

Please see the response to RAI 74.

~~AUC recognizes that the methodologies and supporting regulations for determining the quantity of the principal radionuclides from all point and diffuse sources will be accounted for are currently under evaluation and development. Therefore, rather than rely on current methods and regulations AUC commits to discuss and identify with NRC how AUC will determine the quantity of the principal radionuclides from all point and diffuse sources will be accounted for, and verified by, surveys and/or monitoring based on the updated methodologies and regulations. AUC will provide to the NRC staff, for review and written verification, written procedures for its airborne effluent and environmental monitoring program no later than 30 days before the preoperational inspection to show compliance with 10 CFR 40.65.~~

5 OPERATIONS

RAI-42

Description of Deficiency

In Section 5.3 and Section 5.7 of the TR, the applicant stated that a qualified designee will be trained to perform daily inspections, such as weekends and/or holidays, perform contamination surveys, and that an individual can qualify for a daily walkthrough inspection if specific training is received from the Radiation Safety Officer (RSO), and the training is documented in the individual's training records and is available for NRC inspection. This training will include all procedures in the standard operating procedure (SOP) for the daily inspection and any significant radiological hazards, the individual will immediately report the findings to the RSO.

Basis for Request

The applicant did not demonstrate that the qualified designee met the minimum qualification and experience for radiation safety staff consistent with Regulatory Guide 8.31, nor did the applicant require that the designee pass this training. SRP Acceptance Criteria 5.4.3(1) states that the personnel meet minimum qualifications and experience for radiation safety staff that are consistent with Regulatory Guide 8.31, Section 2.4 (NRC, 2002). NRC staff finds the designee's qualifications, as described by the applicant, are less than the training and experience of an RSO or Radiation Safety Technician (RST) recommended by Regulatory Guide 8.31. In addition, NRC staff finds that the applicant has not defined the qualifications of "selected individuals" or "qualified designee" in sufficient detail, nor are these qualifications consistent with qualifications of personnel as suggested in Regulatory Guide 8.31 (NRC, 2002) or with the "Inspection and Enforcement Circular 81-07, Control of Radioactively Contaminated Material" (NRC, 1981), which recommends that only qualified radiation safety individuals perform surveys releasing radioactive contamination to unrestricted areas.

Formulation of RAI

- *Define the radiation safety staff qualifications and the qualifications of the "selected individuals" or "qualified designee" consistent with Regulatory Guide 8.31, or propose alternative qualifications with rationale and justification for NRC consideration. Provide a detailed description of the types of contamination surveys the selected individuals or qualified designee will conduct.*

- *Provide additional information regarding the training program for the RSO designee so that the NRC can verify that it conforms to Regulatory Guide 8.31.*

  The applicant indicated that the designee's training and qualification will be consistent with his/her level of responsibility, and will also be consistent with RG 8.31. The applicant provided a list of the training and qualification. NRC staff reviewed the list and determined that it is not consistent with RG 8.31. For example, RG 8.31 includes 2 years of relevant work experience in applied radiation protection. The response states a minimum of three months experience at the Reno Creek ISR Facility. The response is not consistent with RG 8.31.

  It is recommended that the applicant review Crow Butte SER (ML14149A433) and Lost Creek SER for Amendment (ML13016A071) and determine if these programs are acceptable for provide an alternative response for NRC review.

RAI-42 Response

AUC has followed the reviewer's recommendation, therefore much of the material used to respond to this RAI parallels a recent NRC-approved Designated Operator training program developed by Crow Butte Resources staff in response to a similar RAI. AUC has revised the text in TR Section 5.4.3 as follows:

"TR Section 5.4.3 Qualifications and Requirements for Daily Walkthrough Inspections.

AUC commits to using the following approach to qualify Designated Operators (DOs) to conduct certain daily walkthrough inspections of storage and work areas at the Reno Creek Central Processing Plant Facility area (facility). The DOs will be responsible for the inspections only on weekends and holidays when neither the RSO nor RST is present. With the exception of the Thanksgiving holiday, the DO will not conduct the inspections for more than two days per week, or three days per week if a Federal holiday falls on Friday or Monday. For the Thanksgiving holiday, the DO may perform the inspections for up to four consecutive days. In all cases, either the RSO or RST will be available to the DO to provide support as needed.

Any issues noted by the DO during the daily inspection will be recorded on the standard daily inspection form, signed and dated and retained on file. The RSO or RST will review the inspection forms as a top priority upon return to the site, and will deal with noted problems. The RSO or RST will discuss and resolve any issues identified by the DO prior to the next weekend or holiday. Such discussions and their resolutions will be recorded in an RSO/RST DO Performance logbook, and made available to NRC inspectors upon request.

Before a DO may conduct inspections, he must be qualified by reason of education, training and experience to recognize proper implementation of radiation safety practices. In addition to the annual radiation worker training required by Regulatory Guide 8.31, Section 2.5, the operator seeking designation must complete training specific to daily inspection performance. The additional training will emphasize how the inspections affect employee safety. The DO must also demonstrate proficiency to the satisfaction of the RSO.

At a minimum, the operator seeking designation must have the following combination of education, training and experience:

Education: A high school diploma or equivalent.

Training:

1) New employee radiation safety training, including guidance concerning prenatal radiation exposure (Regulatory Guide 8.29);

2) Additional training relating to conducting daily inspections at the Reno Creek facility; and

3) Demonstration of proficiency, while accompanied by the RSO, in the performance of daily inspections. Details are provided below.

Experience: A minimum of three months of work experience in operations or maintenance at a uranium recovery facility, including work with procedures that involve health physics, industrial safety or industrial hygiene.

The inspection process and DO training:

AUC will conduct daily walk-through inspections of all work and storage areas at the Reno Creek facility to ensure proper implementation of radiation safety procedures. Such procedures include good housekeeping, and practices that minimize unnecessary contamination. Normally, these inspections are conducted by the RSO or an RST. However, on certain occasions as noted above, a qualified operator may be designated to conduct the daily inspection.

During the weekends and holidays when the RSO and RST are not onsite, the DO will observe, through direct visual inspection:

1) Radiation safety practices
2) Housekeeping
3) Implementation of the radiation safety program, throughout the facility

Such duties include inspecting for compliance with:

1) Radiation safety postings
2) Contamination control
3) Control point procedures
4) Procedures for control of airborne radioactivity
5) Worker protection practices in the yellowcake drying and packaging area
6) Proper storage of byproduct material

A qualified DO may not develop or administer the radiation protection program, other than conducting daily inspections. He may not approve equipment plans, process changes, or changes in standard operating procedures with the potential to affect the radiation protection program. He may not conduct radiation safety audits or make decisions concerning personnel dosimetry. He may not authorize work involving the potential for radiation exposure or radioactive contamination, for which there are no SOPs or a current radiation work permit. The DO will not have authority to release materials for unrestricted use. In the event of an unusual situation or emergency, the DO will contact the RSO or RST, who will be responsible for radiation protection decisions.

At the Reno Creek facility, the only daily activity required to be performed by the RSO or RST will be the daily inspection. Other RSO/RST activities such as instrument calibrations are performed on schedules not related to the daily inspection. While acting as DO, the operator will not perform other than daily radiation protection inspection activities.

The additional radiation safety training provided operators seeking designation involves four hours of training followed by an examination, with an 80% passing grade, covering the topics described below. This training does not include certain more advanced training topics required for the RSO or RST.

The additional training required for the Designated Operator includes the following topics:

1) Employee PPE usage
2) Contamination control
3) Entrance/exit station procedures

4) Radiation area boundaries
5) Required signs
6) Required labels
7) Leak detection/prevention
8) Yellowcake spill prevention
9) Ventilation
10) Housekeeping
11) Active monitors
12) When and how to contact the RSO or RST
13) Completion and control of the Daily Inspection Form

Upon completion of training, and prior to designation, an operator will be required to demonstrate, to the RSO, proficiency in conducting the daily inspections. Prior to assuming responsibility for an inspection, the operator seeking designation will perform a minimum of four daily inspections under the supervision of the RSO or RST. The supervised inspections will include coverage of the topics listed above, and will be documented via signatures on the inspection form. An operator who fails to demonstrate proficiency will be re-evaluated, after performing additional supervised inspections, until the RSO is satisfied with the operator's proficiency.

The designation process for each DO will be documented in a file which includes:

1) Education
2) Experience
3) Training results including an examination with passing score
4) The signed supervised inspection forms

An operator designation form will be signed by the DO and the RSO when the RSO is satisfied that the operator meets all requirements.

To remain qualified, the DO must complete annual refresher training addressing the same topics covered in the additional training described above. An examination will be required, with a passing grade of 80%. In addition, the DO must have completed two RSO- or RST-supervised inspections during the past year, including one within the past 6 months."

Elsewhere in the application the phrase 'selected individuals' has been removed and replaced with 'Designated Operator'. TR Sec. 5.7.6.5 has been revised to reflect this change in terminology and also it has been revised to remove any reference to the DO performing contamination surveys :

"…To address weekend inspection, it has been industry practice to train a Designated Operator to perform the weekend daily walkthrough inspections. …"; and

"…In order to accomplish this, in addition to their training as radiation workers in accordance with guidance in Regulatory Guide 8.31, Section 2.5, *Radiation Safety Training,* these individuals will receive specific training for inspections for radiological safety…"

To accommodate the additional position of Designated Operator, AUC has revised the following text in TR Sec. 5.7.9 (Quality Assurance Program):

"AUC has identified seven key position types and their responsibilities in Application Sections 5.1 and 5.2. These position types include the:

- Board of Directors;
- President and Chief Executive Officer;
- Reno Creek Site General Manager;
- Manager of Environmental Health and Safety;
- Radiation Safety Officer;
- Radiation Safety Technician;
- Designated Operator."

~~To better define the radiation safety qualifications, AUC has revised several sections in TR Section 5 as outlined below.~~

~~TR Sec. 5.3.1.1 now reads:~~

~~"The RSO, RST or Qualified Designee will conduct daily walkthrough inspections of all active plant areas including storage areas. Inspection allows for a survey of procedure compliance, contamination control, and housekeeping efforts. An individual can qualify for daily walkthrough inspection if specific training is received from the RSO, and the training is documented in the individual's training records and is available for NRC inspection. Training will be conducted in accordance with RG 8.31 (Sec. 2.4 and 2.5) and will include all procedures included in the SOP for the daily inspection. In the event the qualified individual notes any significant radiological hazards, the individual will~~

~~immediately report the findings to the RSO."~~

~~TR Sec. 5.4 now reads:~~

~~"Qualifications for the RSO, RST and Qualified Designees will conform to guidance from Regulatory Guide 8.31 (NRC, 2002). The following qualifications are the minimum requirements for the RSO, RST and Qualified Designees."~~

~~AUC has also added the following section to better define the qualifications and training for the qualified designee:~~

~~"Sec. 5.4.3 Qualifications and Training for the Qualified Designee~~

~~The Designee's training and qualifications will be consistent with his/her level of responsibility, and will also be consistent with RG 8.31 (Sec. 2.4 and 2.5). The Designee's duties will be limited to the completion and documentation of the daily radiation safety inspection. These daily duties will not be performed for more than three consecutive days without the on-site presence of, and review by, either the RSO or RST. The Designee will not perform any other radiation safety duties. The Designee's training and qualifications will include:~~

- ~~A high school diploma;~~
- ~~A minimum of three months experience working at the Reno Creek ISR Project;~~
- ~~Annual radiation worker training in accordance with RG 8.31 (Sec. 2.5); and~~
- ~~Daily inspections, equipment release surveys and personnel surveys, performed by the Designee during training, will be reviewed line by line by either the RSO or RST. Documentation of this set of training reviews will be maintained for NRC review during the next annual License Inspection.~~

~~The designee will complete a minimum of five days of successful performance of his/her responsibilities, under the direct supervision of the RSO/RST, before becoming a Qualified Designee. This training will include performance of all applicable inspections, performance of equipment release surveys, and performance/supervision of personnel contamination surveys. Annual training by the RSO or RST, meeting the same requirements noted here, will be required to maintain a designee's qualified status.~~

~~A written examination covering the guidance noted in Regulatory Guide 8.31 will be administered to the Designee-in-training, with results retained for three years. Areas of insufficiency identified by the exam will be the subject of additional training, followed by written re-examination on those topics, with additional re-training and examination as~~

~~necessary until the Designee-in-training successfully passes the examination in all topic areas. The RSO will document the Designee's successful completion of the training topics including daily radiation safety inspections, performance of release and personnel surveys per applicable SOPs, and recognition and reporting of hazards, to the appropriate individual(s), to initiate implementation of corrective actions. The RSO will maintain a file of all applicable documentation of the training, examinations and educational requirements of each Qualified Designee. This file will be available for NRC inspection.~~

~~The Qualified Designee will not act on behalf of the RSO or RST in any way other than the completion of the daily safety inspections, the performance of routine contamination surveys and the routine, daily inspection of survey monitors and incidental review of personnel exit surveys. The designee will not act as a radiation expert in the event of an emergency or distressed condition, except as immediate, short-term response is required to protect individuals or the environment, but will instead immediately contact the duty RST or the RSO for advice."~~

~~Elsewhere in the application the phrase 'selected individuals' has been removed and replaced with 'Qualified Designee' in TR Sec. 5.7.6.5 which now reads:~~

~~"…To address weekend inspection, it has been industry practice to train a Qualified Designee (usually the plant operators) to perform the weekend daily walkthrough inspections and to perform contamination surveys…"~~

~~To accommodate the additional position of Qualified Designee, AUC has revised the following text in TR Sec. 5.7.9 (Quality Assurance Program):~~

~~"AUC has identified seven key position types and their responsibilities in Application Sections 5.1 and 5.2. These position types include the:~~

- ~~Board of Directors;~~
- ~~President and Chief Executive Officer;~~
- ~~Reno Creek Site General Manager;~~
- ~~Manager of Environmental Health and Safety;~~
- ~~Radiation Safety Officer;~~
- ~~Radiation Safety Technician;~~
- ~~Qualified Designee."~~

RAI-43

Description of Deficiency

In Section 5.5 of the TR, the applicant stated that the training program will be administered in keeping with standard radiological protection guidelines and the guidance provided by Regulatory Guides 8.13, 8.29, and 8.31. Regulatory Guide 8.29 is designed to provide worker training about health risks from occupational exposure.

Basis for Request

The applicant did not include in its application the training on health risks from occupational exposure. SRP Acceptance Criteria 5.5.3(3) states that the radiation safety training program is consistent with Regulatory Guide 8.29 and this guide provides a basis for training employees on the risks from radiation exposure in the work place. Regulatory Guide 8.29 differs from Regulatory Guide 8.13, which covers radiation doses to prenatal/fetal, and Regulatory Guide 8.31, which covers basic radiation safety training. NRC staff has determined that the applicant adequately discussed the basic radiation safety training program and the instructions for prenatal radiation exposure as identified in Regulatory Guides 8.13 and 8.31, but did not address the risks from radiation exposure in the work place as described in Regulatory Guide 8.29. NRC staff determined that the topics identified in the TR reflect the training topics identified in Regulatory Guide 8.31. More specifically, NRC staff could not determine if the material, as described in Regulatory Guide 8.29, is addressed in the radiation safety training program.

Formulation of RAI

Provide a detailed description of AUC's training on the risks from radiation exposure in the work place and its relationship to the basic radiation safety training. Describe who is required to have this training and how often. Provide the technical basis for this type of training.

RAI-43 Response

The introductory paragraph in TR Section 5.5 presently states that AUC's "training program will be administered in keeping with standard radiological protection guidelines and the guidance provided in NRC Regulatory Guide 8.29, USNRC Regulatory Guide 8.31 Section 2.5, and NRC Regulatory Guide 8.13." AUC has revised the opening paragraph in TR Sec. 5.5.1.3 to clarify the training program standards as shown below:

"All AUC employees and contractors will receive training as radiation workers. The program will incorporate the following topics recommended in NRC Regulatory Guide 8.31 and will include all applicable instructional guidance material found in Regulatory Guide 8.29 which focuses on the health risks from occupational exposure."

Additional information found within TR Section 5.5 details training responsibilities for various classes of employees, contractors and visitors:

- Sec. 5.5.1.1 discusses visitor training
- Sec. 5.5.1.2 discusses contractor training
- Sec. 5.5.1.3 discusses employee training and
- Sections 5.5.2 through 5.5.5 all discuss testing, testing frequency and record requirements.

RAI-44

Description of Deficiency

Section 5.6 of the TR describes the controlled areas, restricted areas, and unrestricted areas of the Proposed Project. This section states that all entrances to the proposed NRC licensed facility and all controlled areas will be conspicuously posted with the words ANY AREA WITHIN THIS FACILITY MAY CONTAIN RADIOACTIVE MATERIAL, in order to be exempted from the requirements of 10 CFR 20.1902(e) for areas within the facility. Section 5.6.1 of the TR also states that the facility area will be enclosed using typical eight-foot security chain link fence equipped with a locking gate at the main entrance.

Basis for Request

The area that represents the proposed NRC licensed facility should be clarified. Based on the above statements, the proposed licensed facility is the area bounded by the eight-foot security chain link fence around the CPP area. However, this boundary does not include other areas where licensed activities are conducted (e.g., such as, wellfields, monitoring wells, and header houses).

Formulation of RAI

- *a) Clearly define the facility boundaries. Clarify if the facility boundary differs from the licensed areas.*
- *b) Provide additional clarification in TR Figure 5-2 regarding the designation of Controlled, Restricted and Unrestricted Areas. Clarify whether or not the monitor wells will be inside the controlled areas of the wellfields.*

RAI-44(a) Response

The Central Processing Plant Facility Area includes the Central Processing Plant, administrative office and shop, the fenced one acre area surrounding and including the deep disposal well, and the fenced area surrounding and including the backup pond. The Central Processing Plant Facility Area is included within the license area as a whole and only differs from those other areas where licensed activities are conducted (e.g., such as wellfields, monitoring wells and header houses) in that it contains restricted areas. Those areas where other licensed activities are conducted (e.g., such as wellfields, monitoring wells and header houses) all lie within controlled or unrestricted areas.

Paragraph one of page 5-21 of the Technical Report, has been updated to read as follows:

"All entrances to the proposed Central Processing Plant facility and all controlled areas will be conspicuously posted with the words "ANY AREA WITHIN THIS FACILITY MAY CONTAIN RADIOACTIVE MATERIAL," in order to be exempted from the requirements of 10 CFR 20.1902(e) for areas within the facility."

AUC has further clarified the definition of the NRC licensed facility area to be the Central Processing Plant Facility Area as shown in the new reference to new Figure 5-2 (shown below):

"5.6 Security

In accordance with 10 CFR Part 20, Subpart I, AUC is committed to providing a security program to prevent unauthorized entry to all controlled and restricted areas. A controlled area, as defined by 10 CFR Part 20, is an area outside of a restricted area but inside the site boundary, access to which can be limited by the licensee for any reason. Specifically, areas within the Proposed Project as shown in Figure 5-2 and classified as follows:"

Section 5.6.1 of the Technical Report, "License Area and Plant Security", has been updated to read as follows:

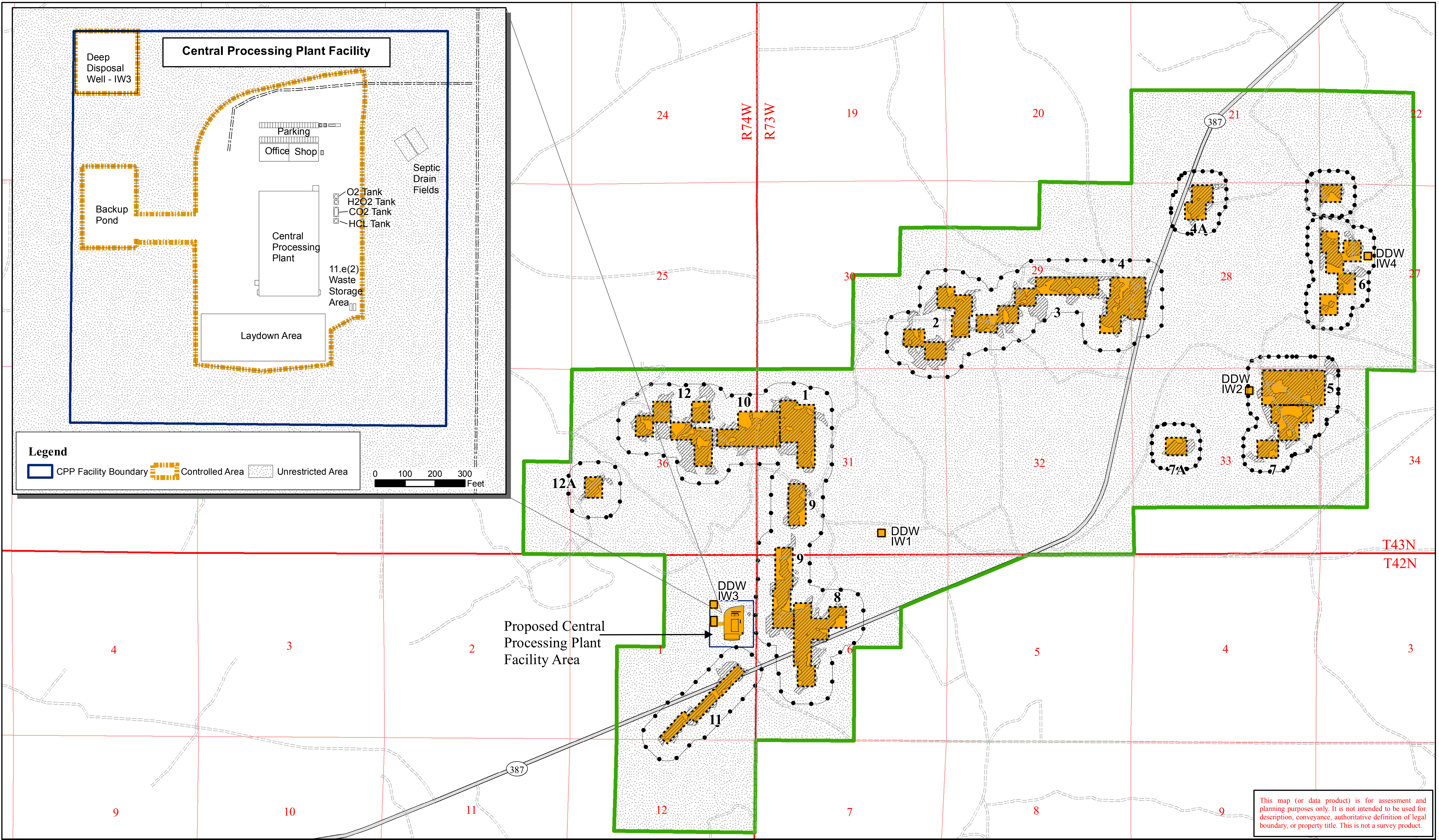
"5.6.1 License Area and Plant Security

AUC will use passive controls in its security program concerning the production units and outer facility perimeter. AUC will include four-stranded barbed wire fencing (WDEQ Guideline 10, Type III) surrounding all wellfield areas and install cattle guards at all wellfield entrances to help eliminate the possibility of livestock entering the area. The Central Processing Plant facility area will be enclosed using typical eight-foot security chain link fence equipped with a locking gate at the main entrance. All by product storage areas will also be fenced, locked, and display appropriated signage."

RAI-44(b) Response

AUC has revised Figure 5-2 to more accurately depict the controlled and unrestricted areas within the Proposed Project Boundary, which defines the extent of the licensed area. As discussed in TR Sections 2.1and 5.6 and shown on Figure 5-2, anticipated controlled areas include all fenced areas around the CPP, wellfields, backup pond and DDWs. The ring monitor wells will not be considered controlled, but will be secured with locked covers. The remaining areas that lie outside of these controlled areas represent the unrestricted areas.

AUC has removed depictions of restricted areas from Figure 5-2 since the restricted areas will lie within controlled areas. As discussed in Section 2.1and 5.6 of the TR, restricted areas will be defined to control access to protect individuals from exposure to radiation and 11e.(2) byproduct materials. This includes selected areas within the CPP building, 11e.(2) byproduct storage areas, lined backup pond, DDW buildings, and/or areas exceeding 2 mrem per hour.



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

AUC LLC
LAKEWOOD, CO

PROPOSED RENO CREEK PROJECT
CAMPBELL COUNTY, WY

TREC, Inc.
Engineering & Environmental Management
900 Werner Court
Suite 150
Casper, WY 82601
Phone (307) 265-0696
Fax (307) 265-2498
www.treccorp.com

Legend

Proposed Project Boundary	Monitor Well Ring
▨ Ore Body	Controlled Area
Production Unit	Unrestricted Area

Additional information regarding Controlled, Restricted, and Unrestricted areas can be found in TR Section 5.6

1:30,000

0 0.25 0.5 1 Miles

N E S W

DRAWN BY: EGS
CHECKED BY: RMD
APPROVED BY: RMD

Controlled and Unrestricted Areas

REV #	DESCRIPTION	BY	DATE	FIGURE
0	Draft for Review	EGS	3/31/14	5-2
1	Revision for RAI package	CAT	9/11/14	
2	Revision for RAI package	EGS	11/25/14	

Path: O:\WY_Projects\2010-100_AUC_Reno_Creek\Project_MXD\Submittal\RAI_NRC_r1\Controlled_Restricted_Areas.mxd

RAI-45

Description of Deficiency

In Section 5.7.2 of the TR, the applicant stated that general area surveys (i.e., air radon, air particulate, and gamma surveys) are identified in Figure 5-2 of the TR.

Basis for Request

NRC staff reviewed the general area surveys identified in Figure 5-2 of the TR and noted that the applicant did not address the conduct of general area surveys in the yellowcake drying and packaging area. SRP Acceptance Criteria 5.7.2.3(9) states that the monitoring program is sufficient to detect and control gamma radiation from uranium decay products in areas where large volumes of uranium may be present (e.g. processing tanks, yellowcake storage areas) and is consistent with Regulatory Guide 8.30.

Formulation of RAI

Provide a technical basis for not establishing general area surveys in the drying and packaging area or include in the application a commitment that general area surveys in the yellowcake drying and packaging area will be conducted. If such surveys will be conducted, then reflect the locations of such surveys in Figure 5-~~2~~3.

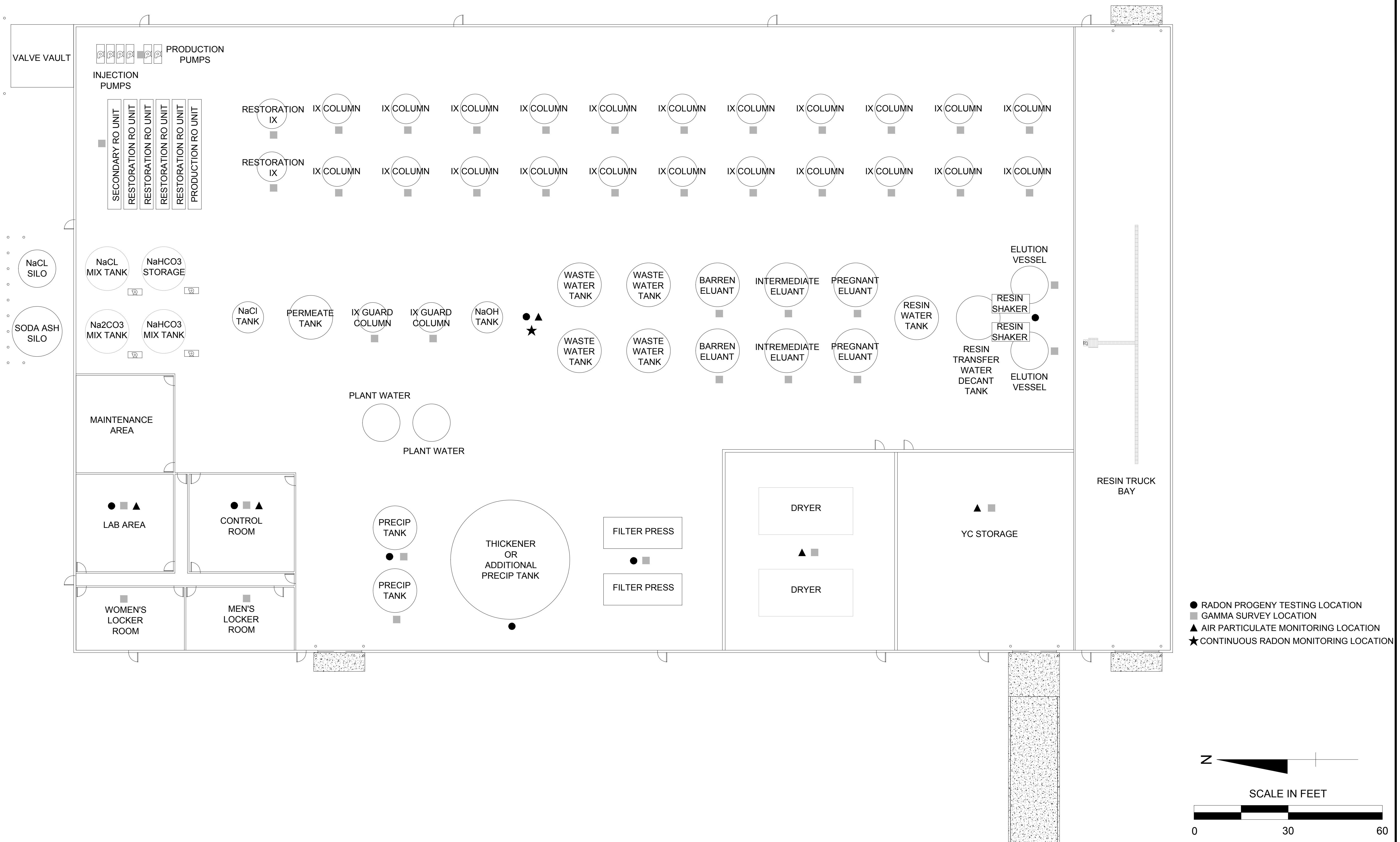
<u>RAI-45 Response</u>

AUC has revised Section 5.7.2 to include the yellowcake drying and packaging area as shown below. Also, due to the new figure (Fig. 5-2) developed as a result of RAI-44, the figure referenced in this response (RAI-45) has been re-numbered within the application to Figure 5-3 and depicts the location for the applicable surveys.

“This section describes AUC's approach for assessing the external exposure of personnel working at the Proposed Project. The approach includes general area surveys with hand held instrumentation. Fixed location dosimeters [thermo-luminescent or optically stimulated (TLD/OSD)], exchanged quarterly, will track radiological conditions in plant areas. TLDs/OSDs will be assigned to potentially exposed personnel to monitor individual exposures. Figure 5-3 displays the plant general arrangement; fixed dosimeter locations within the facility will be identified once final facility designs have been prepared. These locations will include monitors where relatively high exposure rates are anticipated such as the yellowcake drying and packaging area, and other areas such as offices, change rooms and lunchrooms. The survey plan, the schedule, and the detection instrument sensitivity, maintenance and calibration requirements, will conform to guidance provided in

Regulatory Guide 8.30. Table 5-1 displays the list of radiation detectors and Table 5-2 provides the MDAs for Air Sample and Contamination Control detectors."

The revised Table 5-1 and new Table 5-2 are provided in the response to RAI 46. ~~AUC has also revised the previous Figure 5-2 (now Figure 5-3) as shown below.~~ Since the land application option has been withdrawn as part of the wastewater disposal system (RAI-38), AUC has revised Figure 5-2 (now Figure 5-3) to reflect the original proposed action. This figure still shows the addition of the yellowcake drying and packaging area into the general area survey locations within the CPP, but this figure no longer includes equipment related to land application



CONCEPTUAL
SUBJECT TO CHANGE

TREC, Inc.
Engineering & Environmental Management
www.treccorp.com

RADIOLOGICAL SURVEY LOCATIONS
RENO CREEK PERMIT APPLICATION
AUC, LLC
CAMPBELL COUNTY, WYOMING

FIGURE 5-3

Drawn: EM	Checked: RL	Approved: DHG

Rev. #	Description	Date
1	Revision	12/17/14

DRAWING: Z:\CURRENT_PROJECTS\3001_AUC\3001-2010-100 RENO CREEK PERMIT APP\CAD\FIGURES\2010-107_F5-2_RADIOLOGICALSURVEYLOCATIONS.DWG

Print Date: 4/8/2014 10:44 AM

RAI-46

Description of Deficiency

In TR Section 5, Figure 5-1, the applicant shows the detector model, radiation detected, type and characterization.

Basis for Request

The applicant did not provide the lower limit of detection for the radiation detectors. SRP Acceptance Criteria 5.7.2.3(4) states that monitoring equipment has a lower limit of detection that allows measurement of ten percent of the applicable limits. NRC staff has determined that the lower limit of detection is an important method when measuring true activity or concentrations of surface contamination or volumetric concentrations that is very small and just above background. NRC staff needs the applicant to demonstrate, a priori, (by calculation) that the radiation detector in question can detect (or measure) ten percent of the applicable limits (i.e., 10% of 1000 dpm/100 cm^2 is 100 dpm/100 cm^2). Thus NRC staff is seeking to determine if such equipment can detect quantities sufficiently below the regulatory limit. NRC staff reviewed the application and did not find any lower limit of detection values for the radiation detectors as identified in Table 5-1. NRC staff has determined that the applicant did not estimate the lower limits of detection for the radiation detectors, as listed in Table 5-1, to determine if the measurement will meet ten percent of the applicable limits.

Formulation of RAI

- *Provide in the application, for each type of radiation detector AUC plans on using at the proposed project, and an estimate (a priori) of the lower limit of detection using the equation identified in Regulatory Guide 8.30. Determine and provide the lower limit of detection values, based on detector parameters, capable of detecting ten percent of the applicable limit.*
- *Provide MDAs for alpha and beta measurements to be consistent with the response to RAI 49*

RAI-46 Response

The list of radiation detection instruments AUC plans to use on the proposed project has been updated to reflect our currently anticipated set of instruments and can be found in revised table 5-1 shown below. A new table (Table 5-2) provides estimates of Minimum Detectable Activity for each instrument of interest. The estimates were developed using parameters, also shown in Table 5-2, selected as appropriate for a field laboratory environment. Table 5-2 also incorporates an MDA estimate for the Ludlum 43-93 detector, based on a recent Uranerz Energy Corporation response to a similar USNRC Request for Additional Information. That Uranerz document, dated February 14, 2014, is included as Appendix A in this response package. The document, NRC ML#14066A397, represents the most recent calculations and discussion concerning the capability of the Ludlum 43-93 detector in meeting the detection limits required for free release of equipment and personnel from a licensed facility. The Uranerz document is the most current approach to analysis of the sensitivity of the 43-93 instrument in an environment potentially influenced by significant levels of interfering gamma radiation. AUC has revised the last sentence in TR Sec. 5.7.2 to reflect the proper reference to both tables as shown below:

"Table 5-1 lists the radiation detection instruments AUC plans to use on the Proposed Project. Table 5-2 provides estimates of Minimum Detectable Activity for each instrument."

The revised Table 5-1 and new Table 5-2 have been inserted into the TR and are shown below. The remaining tables in Section 5 have been renumbered to accommodate the new table.

In NUREG-1507 Strom and Stansbury provide a Minimum Detectable Activity (MDA) calculation applicable when background and sample count times are different:

$$MDA = \frac{3 + 3.29\sqrt{R_b t_g (1 + \frac{tg}{tb})}}{t_g E}$$

Rb: Background counting rate (cpm)

Tg: Sample counting time (min)

Tb: Background counting time (min)

E**:** Efficiency (%)

AUC has initially applied this equation to determine whether beta contamination regulatory requirements for release of personnel and equipment can be met in areas with gamma backgrounds.

The average efficiency of the 43-93 detector, per Ludlum's website, is about 25%, +/- 20% uncertainty. AUC has used a conservative efficiency of 20% here. The background count time (Tb) used is 5 minutes; sample count time (Tg) is 30 seconds. The removable contamination release limit for betas is 1,000 dpm/100cm^2.

$$1000 \text{ dpm/100 cm}^2 \quad \frac{3 + 3.29\sqrt{R_b 0.5(1 + \frac{0.5}{5}})}{0.5(.20)} \quad =$$

So, Rb = 1600 cpm

To meet the removable beta contamination limit of 1,000 dpm/100 cm^2, equipment being released should be located in an area with an instrument background less than 1600 cpm.

For personnel monitoring, AUC staff must verify that beta detector background count rates are below 1600 cpm. Based on experience reported for operating ISR facilities, AUC anticipates that monitoring stations can be located such that gamma exposure rates are roughly 25 uR/hr. Ludlum's website notes that the 43-93 beta detector's gamma sensitivity is 15-20 cpm per uR/hr. Therefore, at 25 uR/hr gamma, the beta instrument's gamma-related background count rate would be 500 cpm, indicating that the required MDA for beta detection can be easily met. Applying the equation above, at a background count rate of 500 cpm, the Ludlum 43-93 instrument's beta MDA would be 575 dpm/100 cm^2. AUC has revised Table 5-2 to include this estimated MDA for beta measurements.

Table 5-1: Radiation Detectors

Detector	Radiation Detected	Type	Characteristics
Ludlum Model 19	Gamma	Handheld, combined unit	Energy dependent; 175 cpm/mR/hr,
Ludlum 44-10	Gamma	High sensitivity	Energy dep.; 900 cpm/uR/hr Cs-137; separate datalogger
Ludlum 43-78	Alpha	Holds 4" air filters	37% efficiency for Th-230; separate datalogger
Ludlum 3030	Alpha/beta	Benchtop apha/beta counter	Integrated unit; simultaneous alpha/beta counting; 32% effic. for Th-230; 26% effic. for Sr-90/Y-90.
Ludlum 43-93	Alpha/beta	Contamination survey	20% Effic. For Pu-239 and Sr-/Y-90; separate datalogger

Table 5-2: MDAs For Air Sample and Contamination Control Detectors

Detector	Use	Equation	Bg CPM	Bg Count Time (Min.)	Flow Volume (l)	Efficiency	MDA (see notes)	Note
Ludlum 43-78	Radon	$\frac{3+3.29\sqrt{R_b t_g}\left(1+\frac{t_g}{t_b}\right)}{(Eff.)(t_g)(Vol.)(.21)(K)}$	0.4	60	15	0.37	0.03	1 & 2
Ludlum 43-78	Alpha particle detection	$\frac{3+3.29\sqrt{\left[R_b t_g\left(1+\frac{t_g}{t_b}\right)\right]}}{(Eff.)(t_g)(Vol.)(C)}$	1	60	2800	0.37	2.97E-12	1 & 2
Ludlum 3030	Alpha particle detection	$\frac{3+3.29\sqrt{\left[R_b t_g\left(1+\frac{t_g}{t_b}\right)\right]}}{(Eff.)(t_g)(Vol.)(C)}$	0.5	60	190	0.32	2.98E-12	1 & 2
Ludlum 43-93	Contamination monitor	$\frac{3+3.29\sqrt{\left[R_b t_g\left(1+\frac{t_g}{t_b}\right)\right]}}{(Eff.)(t_g)}$	500	5	NA	0.2	575 dpm/100cm^2.	3

Notes:

1) MDA equation per NUREG-1507 reference. K = Kusnetz factor = 60: converts to WL. C = 2.22E9: converts to uCi/ml.

2) Required radon sample analysis MDA = 0.03. Required air particulate sample analysis MDA = 3 E-12 uCi/ml.

3) Ludlum 43-93 beta particle surface contamination MDA calculated for an interfering gamma radiation field of 25uR/hr, Using the provided equation and the Ludlum website-noted 43-93 gamma sensitivity of 15-20 cpm per uR/hr.

RAI-47

Description of Deficiency

In Section 5.7.3 of the TR, the applicant stated that the primary source for airborne uranium particulates will occur during packaging operations and these operations will be confined to the enclosed drying room which will be under negative pressure during operation. In conjunction with this statement, the applicant also stated in Section 5.7 of the TR that the sampling locations are selected to characterize various locations in the process (e.g. lixiviant, precipitation, and drying/packaging areas).

Basis for Request

The applicant did not depict in a drawing of the facility layout the airborne uranium particulates sample collection locations that will be used during the packaging operation. SRP Acceptance criteria 5.7.3.3(1) states that the applicant provides one or more drawings that depict the facility layout and the location of samplers for airborne radiation. NRC staff reviewed Figure 5-2 and determined that the applicant placed four air particulate and nine air radon monitoring locations within the central processing plant. However, in reviewing Figure 5-2, NRC staff did not find any airborne uranium particulate monitoring station in the drying/packaging area which the applicant deemed as the primary source for airborne uranium particulate. NRC staff determined that the applicant did not address or explain why the primary source for airborne uranium particulates is not monitored for airborne uranium particulates.

Formulation of RAI

Provide a technical basis or justification for not conducting airborne particulate sampling at the primary source for airborne uranium particulates, or commit to conducting airborne particulate sampling at the primary source for airborne uranium particulates and depict the location of this type of sampling on the facility layout drawing. NOTE: This RAI is slightly different than RAI-45. This RAI focuses only on the airborne particulate. RAI-45 focuses on general radiation surveys, which can also include airborne particulate.

RAI-47 Response

AUC commits to conducting airborne particulate sampling at the primary source for airborne uranium particulates. A revised Figure 5-2 (re-numbered to 5-3 within the application as a result of new figure for RAI-44) has been inserted into the application, depicting the location for this type of sampling on the facility layout drawing. Figure 5-2 (renumbered to 5-3) is provided in the response to RAI 45.

RAI-48

Description of Deficiency

In Section 5.7.3 of the TR, the applicant stated that it plans to estimate radionuclide air concentrations, with the initial air particulate samples obtained following plant startup. The sample will be composited according to the sampler location as shown in Figure 5-2 of the TR. Samples submitted to a contract laboratory for radioisotope analysis will be analyzed for natural uranium, Thorium-230, and Radium-226 and the results will be used in the sum of fractions rule to ensure the appropriate use of the Derived Air Concentrations (DAC) from 10 CFR 20 Appendix B, Table 1. This includes the DAC for Class W natural uranium, which is 3.0 E10 uCi/ml. The applicant stated that the laboratory results of the initial radio-isotopic analysis confirm that natural uranium is the primary radionuclide of concern in the air particulate samples and that other uranium decay products may be disregarded, measurement of airborne uranium will be performed by gross alpha counting of the air filters using an alpha particle detector system, such as the Ludlum Model 43-1 or similar coupled to an appropriate scaler.

Basis for Request

The applicant needs to conduct isotopic analysis in addition to an initial analysis to comply with 10 CFR 20, Subpart C. Acceptance Criteria 5.7.3.3(3) states that planned surveys of airborne radiation are consistent with the guidance in Regulatory Guide 8.30 and specifically 10 CFR 20, Subpart C. NRC staff has determined that the applicant needs to estimate radionuclide air concentration on a more frequent basis other than an initial sample at startup. NRC staff has determined that an initial sample (depending on when the air samples are collected after startup) may not be representative of the mixture of radionuclides in air over a longer time period (i.e., one year or two years). NRC staff has determined that the radionuclide air concentration will change with time or buildup until it reaches an equilibrium state, assuming that there is no change to the operation over time. NRC staff has determined that the applicant needs to conduct radionuclide air concentrations semi-annually for the first year and annually thereafter to check the type and amount of radionuclides. The mixture of radionuclides needs to include, uranium, uranium progeny, radon (Radon-222), and radon progeny.

Formulation of RAI

In the application, commit to conduct isotopic analyses of radionuclides in air concentrations semi-annually for the first year, and annually thereafter to ensure that the mixture of radionuclides in air is in compliance with 10 CFR 20.1204(g).

RAI-48 Response

AUC commits to conducting isotopic analyses of concentrations of radionuclides in air semi-annually for the first year, and annually thereafter, to ensure that the mixture of radionuclides in air is in compliance with 10 CFR 20.1204(g). AUC has revised the fifth paragraph of Section 5.7.3.1 to include subsequent sampling as shown below:

"To estimate radionuclide air concentrations, the initial air particulate samples obtained following plant startup will be composited according to the sampler location as shown on TR Figure 5-3. These sample locations are selected to characterize various locations in the process (e.g., lixiviant, precipitation, and drying/packaging areas). Samples will be submitted to a contract laboratory for radioisotope analysis. Samples will be analyzed for natural uranium, ^{230}Th, and ^{226}Ra. AUC will compare analysis results using the sum of fractions rule to ensure the use of the appropriate DACs from 10 CFR 20 Appendix B Table 1. Because ^{230}Th will not be solubilized in the recovery solutions and therefore will not be available for dispersion in the CPP, during the time period between initial plant startup and receipt of the analytical results for these samples, AUC will apply the DAC for U-Nat or ^{226}Ra to the initial, onsite gross alpha counting results. The DAC for both natural uranium and ^{226}Ra is 3 x 10-10 µCi/ml for solubility Class W, the solubility class to be assumed initially (Table 5-2). Following this initial sampling event, AUC will conduct isotopic analyses of concentrations of radionuclides in air semi-annually for the first year, and annually thereafter, to ensure that the mixture of radionuclides in air is in compliance with 10 CFR 20.1204(g)."

RAI-49

Description of Deficiency

In Section 5.7.6 of the TR, the applicant stated that since any beta-gamma contamination at an ISR (or uranium mill) should be associated with alpha emitting nuclides, no special monitoring or survey for beta-gamma emitters are required and the lack of detectable alpha contamination assures no beta-gamma contamination.

Basis for Request

The applicant needs to monitor for beta-gamma emitters consistent with 10 CFR 20 Subpart F. Acceptance Criteria 5.7.6.3(3), Acceptance Criteria 5.7.6.3(8) and Acceptance Criteria 5.7.6.3(9), in general, states that the action levels for surface contamination are set in accordance with Regulatory Guide 8.30 and Table 5.7.7.3-1 of NUREG-1569. Footnote a in Table 5.7.6.3-1 states that where surface contamination by both alpha and beta-gamma emitting nuclides exists, the limits established for alpha and beta-gamma emitting nuclides should apply independently. NRC staff has determined that aged yellowcake as well as both uranium and radon progeny, remain in certain areas of the facility from spills and maintenance activities. Further, Radon-222 is also a radioactive constituent in groundwater and ISR lixiviant, and is produced from the decay of Radium-226 in the plant. Radon-222, a radioactive gas with a 3.8 day half-life, decays to several solid particles that tend to be electrically charged, produce no alpha decay (Lead-214 and Bismuth-214) and can deposit on surfaces or attach to dust particles. The short-lived progeny decay to Lead-210 a beta-emitter and does not produce alpha emission, can build-up in buildings, if the ventilation is not adequate to ensure complete air exchange or an inadequate contamination control program where potential contaminants are allowed to migrate.

Formulation of RAI

In the application, commit to developing and implementing a survey program for beta-gamma contamination for personnel exiting from restricted areas that will meet the requirements of 10 CFR Part 20, Subpart F.

RAI-49 Response

AUC will commit to developing and implementing this survey program. Text confirming this commitment has been added to TR Section 5.7.6 as shown below:

"AUC commits to developing and implementing a survey program for beta-gamma contamination for personnel exiting from restricted areas, which will meet the requirements of 10 CFR Part 20, Subpart F."

RAI-50

Description of Deficiency

In Section 5.7.7 of the TR, the applicant identified the different environmental pathways that will be monitored consistent with Regulatory Guide 4.14 (Section C.2, Regulatory Position, Pre-operational Monitoring) and the applicant further stated that the potential air particulate releases from the CPP processes will be monitored in a manner to that employed for baseline determination of air particulate concentrations.

Basis for Request

The applicant did not address:

1) *How they will monitor and measure the effluent from the yellowcake dryer and packaging stack and other stacks as described in Section C.2 and,*
2) *How emission controls will be used to ensure facility releases to the environment are as low as is reasonably achievable (ALARA) and consistent with 10 CFR 40 Appendix A, Criterion 8.*

Regulatory Guide 1.21 "Measuring, Evaluating, and Reporting Radioactive Material and Liquid and Gases and Solid Waste," Rev 2 (06/2009) and Regulatory Guide 4.1 "Radiological Environmental Monitoring for Nuclear Power Plants" Rev 2 (06/2009) defines effluent as the liquid or gaseous waste containing plant-related, licensed radioactive material, emitted at the boundary of the facility (e.g., buildings, end-of-pipe, stack, or container) as described in the final safety analysis report. Although these guides are prepared for nuclear power plants, NRC staff has determined that the definition for effluents is applicable to any materials facility that release gaseous or liquid waste containing plant-related, licensed radioactive material. Regulatory Guide 8.37 provides guidance on designing an acceptable program for establishing and maintaining ALARA levels for gaseous and liquid effluents at material facilities.

Formulation of RAI

Identify all potential effluent release points at the facility, commit to measure and quantify the amount of radioactive materials released from major potential release points (and estimate smaller potential release points), identify what controls are used to ensure that facility releases to the environment are ALARA consistent with 10 CFR 40, Appendix A, Criterion 8.

NRC staff is seeking the following information:

- *Identify all potential air and gaseous effluent release points*
- *Discuss how each potential air and gaseous effluent release point will be monitored and how this information (or data) will be incorporated into the 10 CFR 40.65 report*
- *Discuss how the measurements from each potential air and gaseous effluent release point will be expressed as a quantity (as described in 10 CFR 40.65).*
- *Discuss the type of radiation measuring device and measurement of the effluent and how the measurements will be converted to a total quantity (expressed in Curies) and a release rate (Curies per unit time).*

If the applicant chooses to measure at a fence line (or restricted or control area), the applicant should demonstrate how the data from the measurements at a fence line will be extrapolated back to an effluent release point to identify the quantities of the principal radionuclides released to the environment.

RAI-50 Response

Please see the response to RAI-74.

~~Attempts to directly measure sources of radiological emissions at uranium ISR facilities is very difficult for radon. This is due to the diffuse nature of radon releases (from well heads and module buildings in the wellfield, from ion exchange/elution circuits in the plant, from ponds, etc.). For the potential "particulate" source term, the off-gas treatment system of the vacuum dryer discharges through the vacuum pump at the end of the train. There are no "stacks" or other discrete locations in modern ISRs at which meaningful measurements, representative of isokinetic sampling conditions, can be made (e.g., see Regulatory Guide 4.16, Monitoring and Reporting Radioactive Materials in Liquid And Gaseous Effluents from Nuclear Fuel Cycle Facilities and ANSI/Health Physics Society (HPS) N13.1-1999, Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities).~~

~~Accordingly, it has been the NRC acceptable historical practice of ISR licensees to demonstrate compliance with the semi-annual reporting requirements of 10 CFR § 40.65 by estimating radiological source terms via methods provided in Regulatory Guide 3.59 or NUREG-1569, Appendix D, by estimating off-site doses via the MILDOS code and verifying compliance to 10 CFR Part 20 limits via results from the environmental monitoring program (e.g., radon and long-lived particulates in air).~~

~~These direct measurements of radionuclide concentrations at points of compliance in unrestricted areas (e.g., "site boundary locations") historically have been accepted by NRC as "verification of calculation via measurement." AUC is unaware of any design or operational conditions proposed for proposed project that require an approach different than that which has been acceptable to NRC for other ISR licensees for many years. If in NRC's view, there are reasons for and new methods that require modified methods relative to those that have been acceptable in the past, AUC is prepared to address these when NRC provides the justification and technically sound basis in a revised response to this RAI or as a response to an "Open Issue."~~

~~No changes to the TR were made in response to this RAI.~~

RAI-51

Description of Deficiency

In Section 5.7.7 of the TR, the applicant stated that during operations, the applicant will conduct sediment sampling on an annual basis and discrete grab samples of sediment will be collected at the same baseline surface water sampling location as discussed in Section 3.4.1 of the Environmental Report. The applicant further stated in Section 5.7.7 of the TR that all sediment samples will be collected to a depth of five centimeter for consistency with the baseline sediment sampling surveys, then analyzed for natural uranium, Radium-226, Lead-210 and gross alpha.

Basis for Request

The applicant did not analyze for Thorium-230. SRP Acceptance Criteria 5.7.7.3(1) states that the proposed airborne effluent and environmental monitoring program is consistent with Regulatory Guide 4.14, Section 1.1 and 2.1, and ALARA requirements as described in Regulatory Guide 8.37. Regulatory Guide 4.14 recommends that the type of analysis include natural uranium, Thorium-230, Radium-226, and Lead-210. NRC staff has determined that the applicant plans to analyze for natural uranium, Radium-226, Lead-210, gross alpha, but not Thorium-230.

Formulation of RAI

Provide adequate justification for not including Thorium-230 in the sediment sampling regimen, or include Thorium-230 analysis for sediment sampling.

RAI-51 Response

To be consistent with Regulatory Guide 4.14 (Section 2.2) AUC has revised TR Sec. 5.7.7.4 to remove gross alpha and include Thorium-230. This text now reads:

"During operations, AUC will conduct sediment sampling on an annual basis. Following Regulatory Guide 4.14, discrete grab samples of sediment will be collected at the same baseline surface water sampling locations discussed in ER Section 3.4.1. All sediment samples will be collected to a depth of five cm for consistency with the baseline sediment sampling surveys, then analyzed for natural uranium, ^{226}Ra, ^{210}Pb and ^{230}Th.

AUC has also revised TR Table 5-4 to be consistent with the above statement regarding radionuclides analyzed during operational sediment sampling as shown below:

Table 5-4: Summary of the Major Elements of the Operational Environmental Monitoring Program

Program Element/Section Reference	**Location**	**Radionuclides Analyzed**	**Sampling Frequency**
Existing Groundwater Supply Wells	Private wells within 2-km of project area similar to pre-operational baseline monitoring	Dissolved and suspended uranium, ^{226}Ra, ^{230}Th, ^{210}Pb, ^{210}Po	Quarterly
Surface Water	Surface waters passing through project area and reservoirs subject to runoff similar to pre-operational baseline monitoring	Dissolved and suspended uranium, ^{226}Ra, ^{230}Th, ^{210}Pb, ^{210}Po	Quarterly (as available)
Particulates in Air [1]	Locations with the highest predicted concentrations, nearest residences and control location similar to preoperational baseline monitoring	Total uranium, ^{230}Th, ^{226}Ra, $^{210-}$Pb	Continuous-Composites of filters analyzed quarterly
Radon in Air	Particulate in air locations and other areas of interest similar to pre-operational baseline monitoring	^{222}Rn	Continuous via Track-Etch units or equivalent — analyzed quarterly
Soil	Particulate in air locations and other locations with the highest predicted concentrations similar to pre-operational baseline monitoring	Total uranium, ^{226}Ra, ^{210}Pb	Annually
Sediment	Surface waters passing through project area and reservoirs subject to runoff similar to pre-operational baseline monitoring	Total uranium, ^{226}Ra, ^{210}Pb, ^{230} Th	Annually (as available)
Direct Radiation	Particulate in air locations and other areas of interest similar to pre-operational baseline monitoring	Continuous via TLD or OSL or equivalent dosimetry	Quarterly

RAI-52

Description of Deficiency

In Section 5.7.8.2 of the TR, the application references surface water sampling reported in Section 2.7 and 2.9, and that the operational monitoring program consist of "all pre-operational surface water locations." In Section 2.9, the applicant proposes that the operational surface water environmental monitoring program consists of only 4 of the 12 surface water bodies sampled for the site characterization and only a single sampling event.

Basis for Request

The proposed operational (and pre-operational) monitoring program represents a departure of the sampling parameters and frequency of monitoring of surface water impoundments recommended in in Regulatory Guide 4.14 and the application does not include justification for departures from such a program.

Section 5.7.8.3 of the SRP states:

> *"The reviewer should ensure that pre-operational water quality sampling locations for applicable surface-waters are indicated in the application. The pre-operational data should be collected on a seasonal basis for a minimum of 1 year before in situ leach operations. Procedures for monitoring surface-water quality during operations should be discussed in the application: this discussion must include a monitoring schedule, monitor locations, and a list of sampled constituents. The applicant may be exempted from monitoring during operations if the site characterization demonstrates that no significant flow of ground water to surface water occurs near the site (e.g., if surface-water bodies are perched and ephemeral)."*

Formulation of RAI

Please see RAI 26.

RAI-52 Response

The information stated in 2.9.9 regarding the sampling of perennial stream was provided in error. As noted in the second sentence of Section 5.7.8.2:

"The Proposed Project area does not contain perennial streams and all surface water features are ephemeral and only contain natural runoff during heavy rainfall and snowmelt events."

The contradictory nature of the statements between TR Section 2.9.9 and TR Section 5.7.8.2 has been corrected. Section 2.9.9 now reads:

"AUC conducted baseline surface water sampling at four sampling locations beginning in September 2010. Surface water sampling locations are shown in Figure 2.9-1. This sampling included ephemeral stream drainage channels where surface waters are present at least part of the year. These locations are widely distributed across the site, including locations roughly upstream and downstream from proposed facility locations. All surface water features are ephemeral in nature, therefore the majority of these are not available for seasonal monitoring."

See also RAI 26 response.

RAI-53

Description of Deficiency

In Section 5.7.8.1.2 of the TR, the application states that the "Production Unit" is the basic unit for establishing baseline water quality, performing the groundwater protection monitoring program and completing the restoration activities. Chapter 1 of the application states that 12 Production Units are planned for the license area. The schedule on Figure 1-3 suggests 15 production units, 1 through 12, 4A, 7A and 12A.

Basis for Request

The application is inconsistent in the description on the number of the wellfield primary units.

Section 1.2 of the SRP states:

> *"The reviewer should determine whether the application provides a sufficiently comprehensive summary of the nature of the facilities, equipment, and procedures to be used in the proposed in situ leach activity including the name and location. Reviewers should keep in mind that the development and initial licensing of an in situ leach facility is not based on comprehensive information. This is because in situ leach facilities obtain enough information to generally locate the ore body and to understand the natural systems involved. More detailed information is developed as each area is brought into production. Therefore, reviewers should verify that sufficient information is presented to reach only the conclusion necessary for initial licensing. However, reviewers should not expect that information needed to fully describe each aspect of a full operation will be available in the initial application. For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications."*

Formulation of RAI

Resolve discrepancies between Figure 1-3 and Section 5.7.8.12 of the TR regarding the number of planned Production Units for the license area.

RAI-53 Response

AUC concurs with the reviewer and has revised the first bulleted item in Sec. 1.0 which now reads:

- "A series of sequentially developed Production Units (15 total) consisting of injection and recovery wells to inject lixiviant and to recover pregnant lixiviant;"

AUC has reviewed the entire application and has revised all incorrect references of 12 Production Units to the correct number of 15 in all applicable sections.

In addition, AUC has revised the application to change the number of wellfields per Production Unit from "three to seven" to "one to seven." For instance, this revision has been made in the first paragraph in Sec. 1.7 which now reads:

"The ISR process contemplated by AUC is a phased, iterative approach, in which AUC will sequentially construct and operate a series of up to 15 Production Units. Each Production Unit will have from one to seven wellfields, each of which will be equipped with its own header house. AUC expects each header house will serve between 15 to 30 recovery wells and 25 to 50 injection wells (recovery and injection wells are also referred to as production wells) depending upon the design of each wellfield. An estimated 67 header houses are planned to be constructed for the Proposed Project. More detailed discussions relevant to the Proposed Project's ISR process methods and operations can be found in Sections 3 and 5 of this TR."

AUC has reviewed the entire application and has made this revision in all applicable locations.

RAI-54

Description of Deficiency

In Section 5.7.8.1.2 of the TR, the application states "AUC proposes to adapt the statistical principles", "…use the Unified Guidance to evaluate baseline groundwater data .... [establish] restoration target values (RTVs)" and "statistically sound treatment of Outliers and Non-Detects". While these are generalized goals of a groundwater detection monitoring program, the statement lacks any specific commitments. For example, what is the proposed confidence level (e.g., 95%) for the "statistically sound treatment" of outliers.

Basis for Request

The application provides no specificity to the procedures for establishing groundwater protection standards required by to 10 CFR Part 40 Appendix A Criterion 5B(5).

Section 1.2 of the SRP states:

> *"The reviewer should determine whether the application provides a sufficiently comprehensive summary of the nature of the facilities, equipment, and procedures to be used in the proposed in situ leach activity including the name and location. Reviewers should keep in mind that the development and initial licensing of an in situ leach facility is not based on comprehensive information. This is because in situ leach facilities obtain enough information to generally locate the ore body and to understand the natural systems involved. More detailed information is developed as each area is brought into production. Therefore, reviewers should verify that sufficient information is presented to reach only the conclusion necessary for initial licensing. However, reviewers should not expect that information needed to fully describe each aspect of a full operation will be available in the initial application. For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications."*

Formulation of RAI

Provide example calculations on the method AUC will adapt for a Production Unit to establish standards required by Criterion 5B(5). For clarity, the applicant should define RTV in terms of NRC regulatory language.

RAI-54 Response

In Production Zone monitoring statistical testing is done to assure agreement to a standard, whether it is a previously determined background value or some defined groundwater protection standard (GWPS). There is also a related issue with compliance monitoring which assumes a site is contaminated until proven otherwise this certainly would fit the situation of the production zone at the cessation of mining activities.

Elise Stritz in her presentation to the NMA in 2013 (ISR Wellfield Background and Restoration Ground Water Quality Data: Collection, Statistical Analysis and Public Access) cites NRC Regulatory Information Summary RIS 90-05:

"Licensees and applicants must commit to achieve the ground water quality standards in 10 CFR Part 40, Appendix A Criterion 5B (5) for all restored aquifers which conforms to the standards promulgated by EPA in 40 CFR Part 192 Subpart D 192.32 (2). These standards state the concentration of a hazardous constituent (Criterion 13) must not exceed :

a. the Commission approved background concentration of that constituent in ground water;
b. the respective value in the table in paragraph 5C if the constituent is listed in the table and if the background level of the constituent is below the value listed or;
c. an alternative concentration limit established by the Commission."

She concludes that the NRC accepts GWPS which can be technically justified. The statistical methods described below provide the usual framework for such justification.

Statistical methods provide methods to demonstrate that a set of samples is equal to or less than a background population. One type of hypothesis testing relies upon the Student's t distribution, and compares two sets of data. This is commonly called a two-sample evaluation and it can compare a background population, usually derived before operations start, to a second sample population, which in this case will be the data obtained during operations or during or after restoration.

Chapter 16 in the Uniform Guidance document (USEPA, 2009) describes several detection monitoring tests that may be used depending upon the nature of the population distributions. A two-sample hypothesis test is used to compare the two populations and the USEPA program ProUCL Version 5 can perform such a test. ProUCL can also perform a variety of other statistical evaluations, such as the preparation of box plots, and quartile plots to better examine the data.

In general the first step is to examine the data for the population distribution(s). Goodness-of-fit tests will be performed to define the underlying data populations. Tests for outliers are also conducted in this initial evaluation, and they may be removed from subsequent steps in the evaluation process. Then depending upon the nature of the distribution either a parametric method (based upon *t-test* type statistics) or a non-parametric method will be selected. This requires that enough data is collected in the second data set to provide a reasonable statistical comparison. The two-sample test is ideally suited for the type of before and after comparisons required to demonstrate that background levels have been achieved. Several parametric tests based upon t-test statistics are available for normal and log normal distributions. For data that do not conform to a normal, gamma or lognormal distribution, non-parametric testing methods such as the Wilcoxon Rank Sum test will be used. For censored data sets, general due to detection limit issues the Tarone-Ware test or the Gehan test (which is available in ProUCL) will be employed. One of the potential problems with all two sample testing methods is that they require that at a minimum several samples be collected before a statistical test performed. Four samples is absolute minimum, and the Uniform Guidance recommends eight samples. This is not an issue in the restoration testing as a large pre mining baseline set of samples are collected as well as a significant number of confirmation samples that in this case make up the second set. For the statistical testing proposed for restoration evaluation most sample sets are nearer to 40 samples.

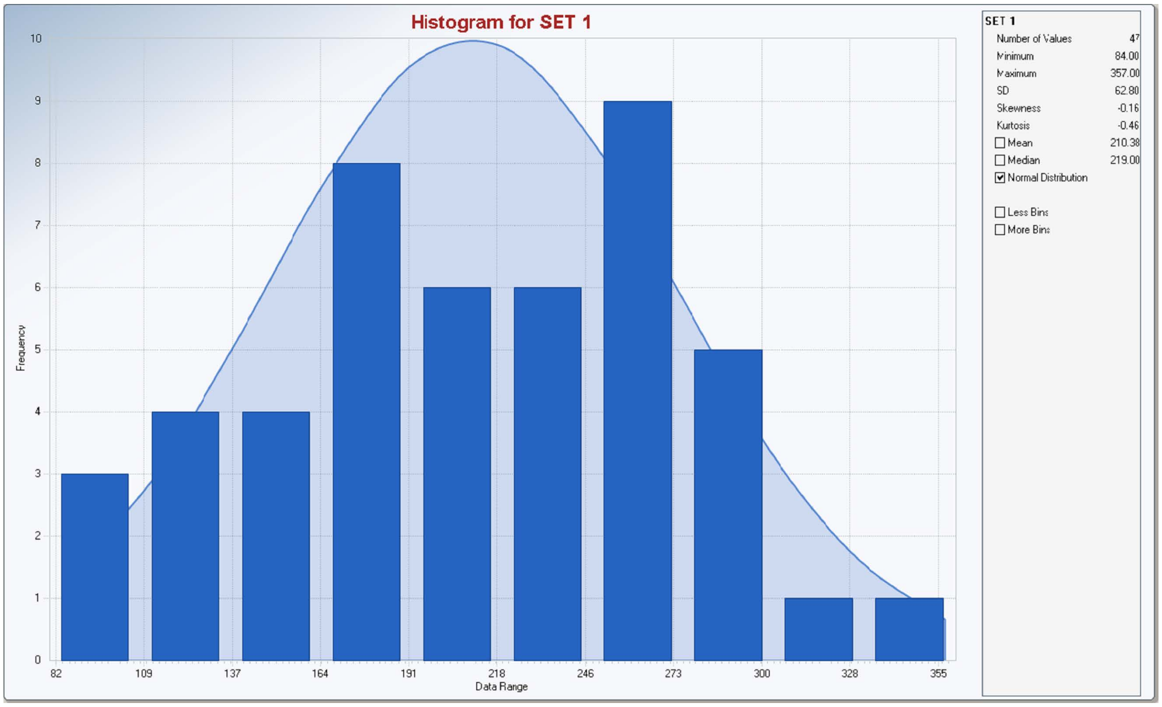
The example used below was set up to provide an overview of the statistical evaluation process, rather than represent an actual set of conditions. In the following example, which primarily demonstrate process, it was decided the develop data sets that have enough difference between them that the conclusion, in this case that they are different, and set 2 is less than set 1, becomes easily grasped without resorting to the t-test and the hypotheses testing as the one and only deciding factor. Basically, in this example one should look over the nature of the two sample sets and say yes I can see that they are different. Then we use the hypothesis testing to confirm that observation in a quantitative way. Thus when actual conditions suggest a closer overlap of baseline and compliance samples one can rely upon the conclusions from the t-test.

Two data sets, loosely based upon alkalinity observations reported as mg/L $CaCO_3$, from the Reno Creek site, were developed to simulate two separate normal distributions. The original data sets were smaller and additional points were added to improve the overall normal distributions and to raise the number of data points to more than 40. Therefore, the current sets do not represent actual site data, they are merely set up to provide an illustrative example. There were no non-detects in either data set, and this is expected for a parameter such as alkalinity. Outliers were identified in the initial data sets and they were removed. SET 1 is considered to represent the baseline values (pre-mining), and SET 2 represents the measured values after completion of the initial restoration. Basic statistics (Table 1 shown below) provide the range, mean and standard deviations for the two data sets. The results indicate that the mean concentrations are lower in the second data set. Figures 1 and 2 (shown below) provide the histograms for these two data sets.

Table 1. Summary Statistics for Set 1 and Set 2 Alkalinity Measurements.

Parameter	SET 1	SET 2
Number of samples	47	44
Minimum	84	56
Maximum	357	248
Mean	210.4	147.3
Median	219	145
Standard Deviation	62.8	48.01

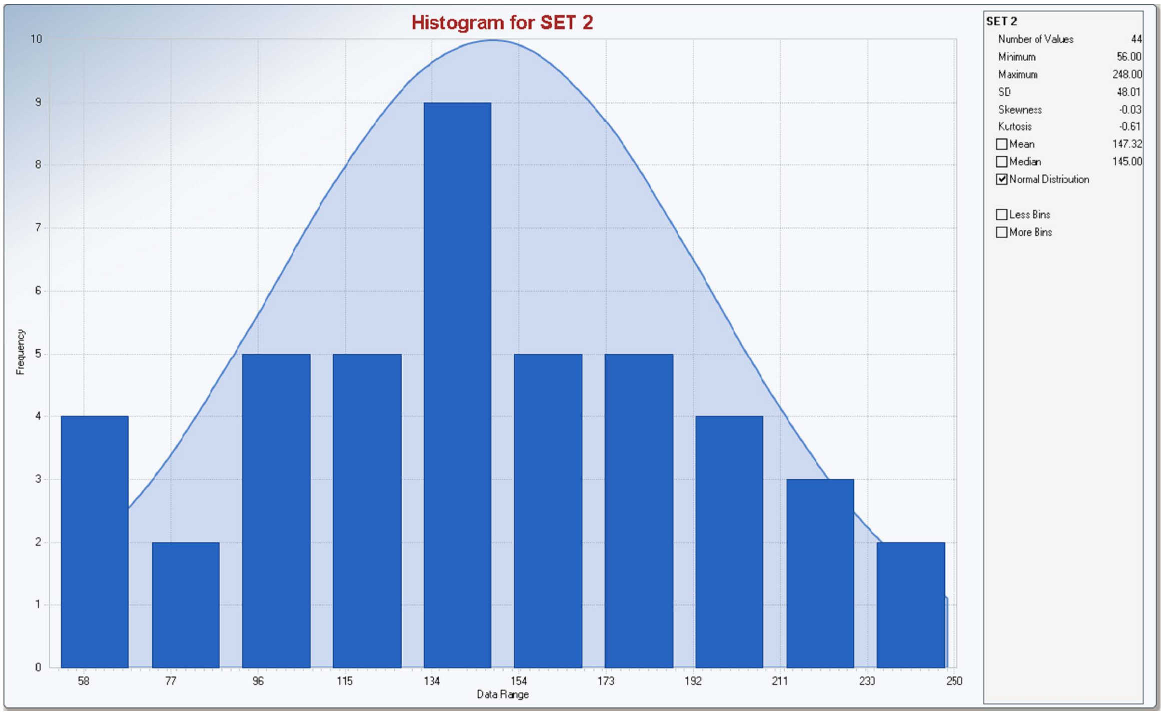
Figure 1. Histogram for Set 1.



Number of Values 47
Minimum 84.00
Maximum 357.00
SD 62.80
Skewness -0.16
Kurtosis -0.46
☐ Mean 210.38
☐ Median 219.00
☑ Normal Distribution

☐ Less Bins
☐ More Bins

Figure 2. Histogram for Set 2.



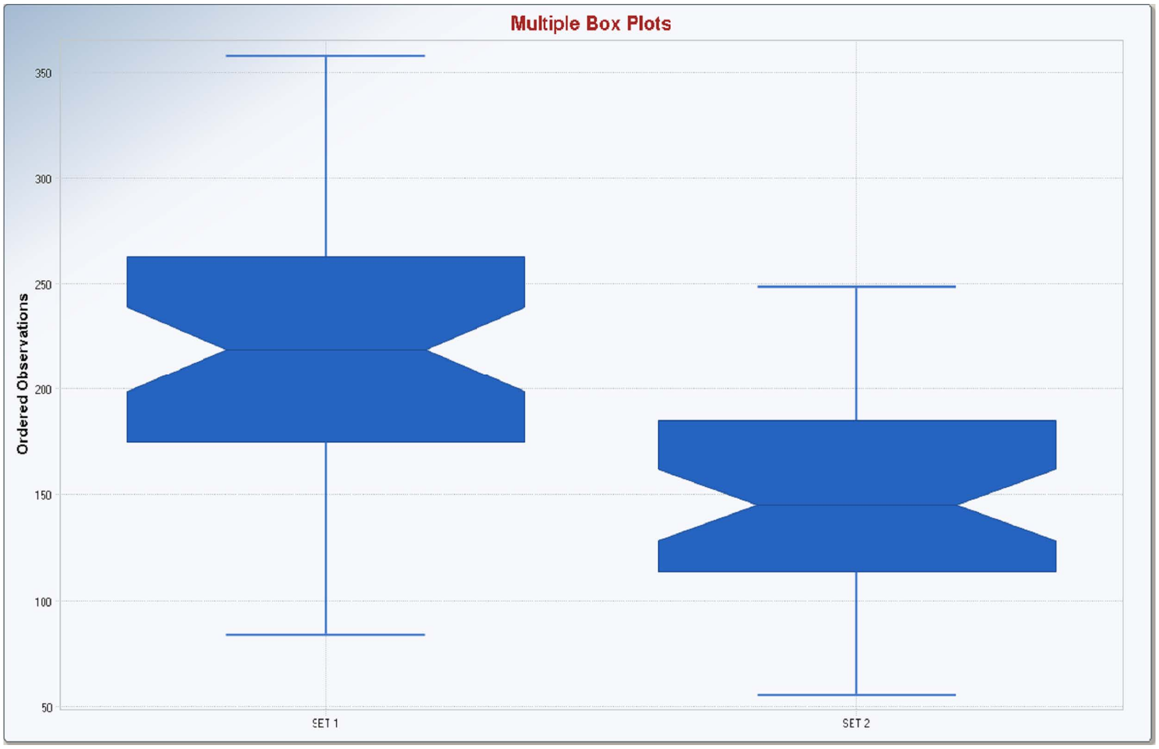
SET 2

Number of Values	44
Minimum	56.00
Maximum	248.00
SD	48.01
Skewness	-0.03
Kurtosis	-0.61
☐ Mean	147.32
☐ Median	145.00
☑ Normal Distribution	

☐ Less Bins
☐ More Bins

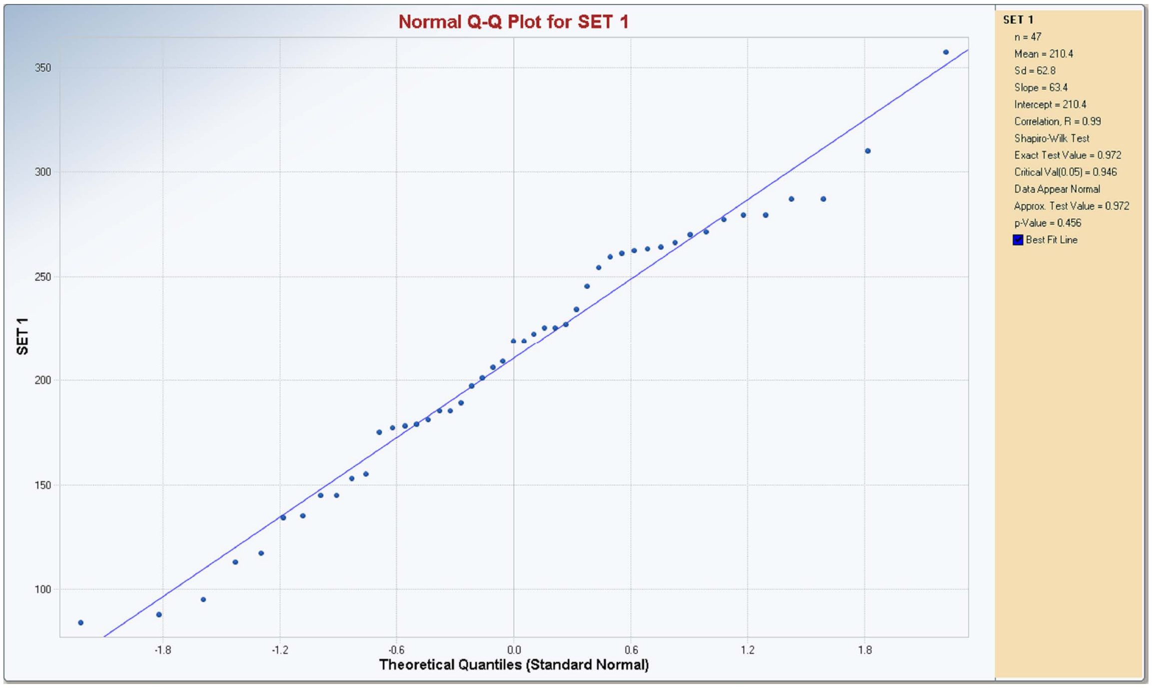
Box plots were prepared (Figure 3 shown below). The plots support differences in the two data sets.

Figure 3. Box plots for Sets 1 and 2.



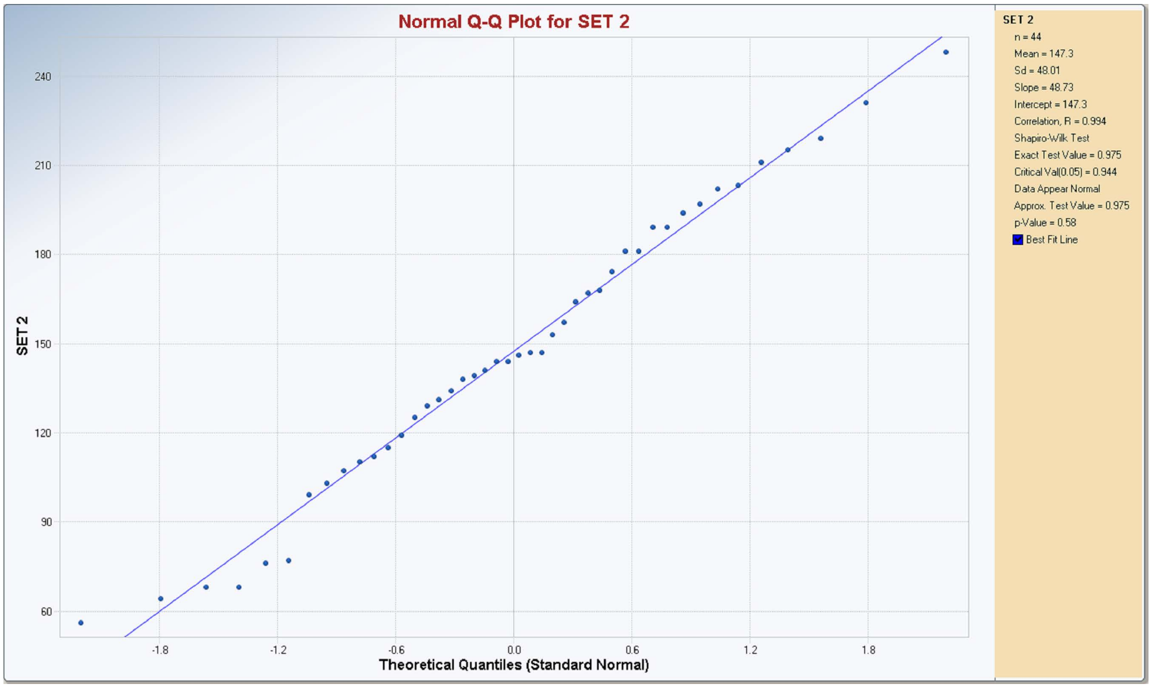
Goodness of fit (GOF) estimates were performed to determine whether the populations followed normal populations for both datasets (Figures 4 and 5 shown below). The GOF calculations confirmed that the datasets were both normally distributed.

Figure 4. Quantile plot and GOF results for Set 1.



SET 1
n = 47
Mean = 210.4
Sd = 62.8
Slope = 63.4
Intercept = 210.4
Correlation, R = 0.99
Shapiro-Wilk Test
Exact Test Value = 0.972
Critical Val(0.05) = 0.946
Data Appear Normal
Approx. Test Value = 0.972
p-Value = 0.456
■ Best Fit Line

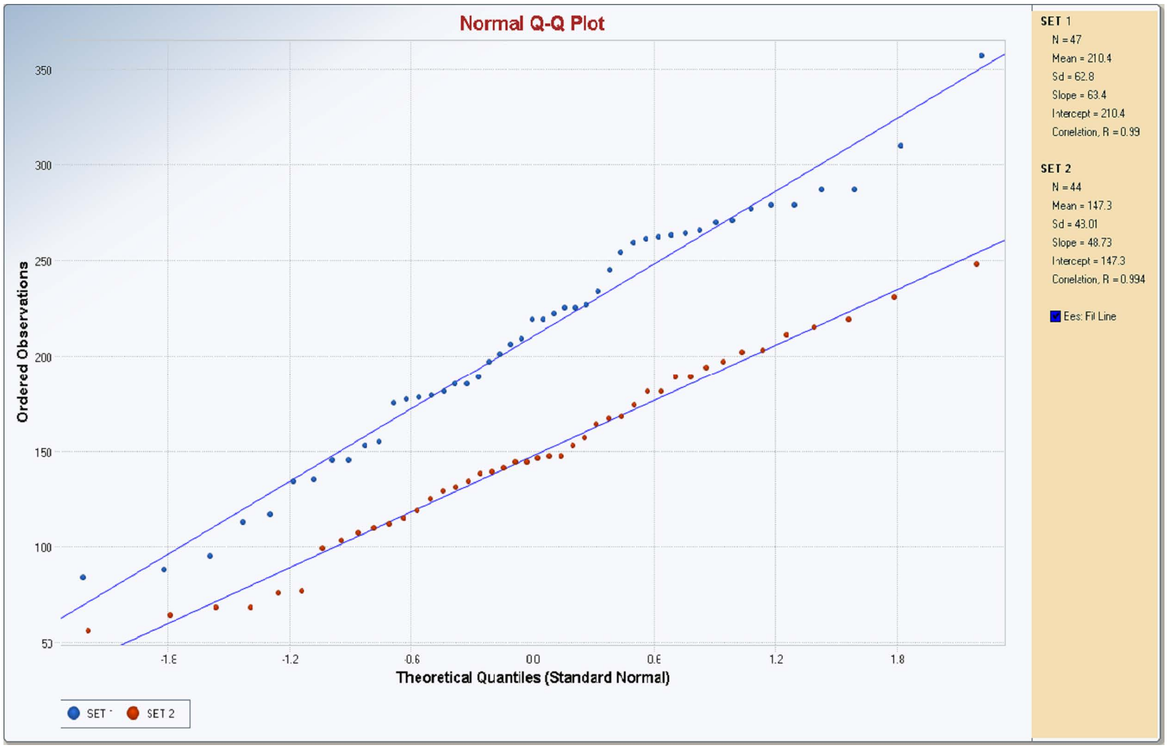
Figure 5. Quantile plot and GOF results for Set 2.



SET 2
n = 44
Mean = 147.3
Sd = 48.01
Slope = 48.73
Intercept = 147.3
Correlation, R = 0.994
Shapiro-Wilk Test
Exact Test Value = 0.975
Critical Val(0.05) = 0.944
Data Appear Normal
Approx. Test Value = 0.975
p-Value = 0.58
■ Best Fit Line

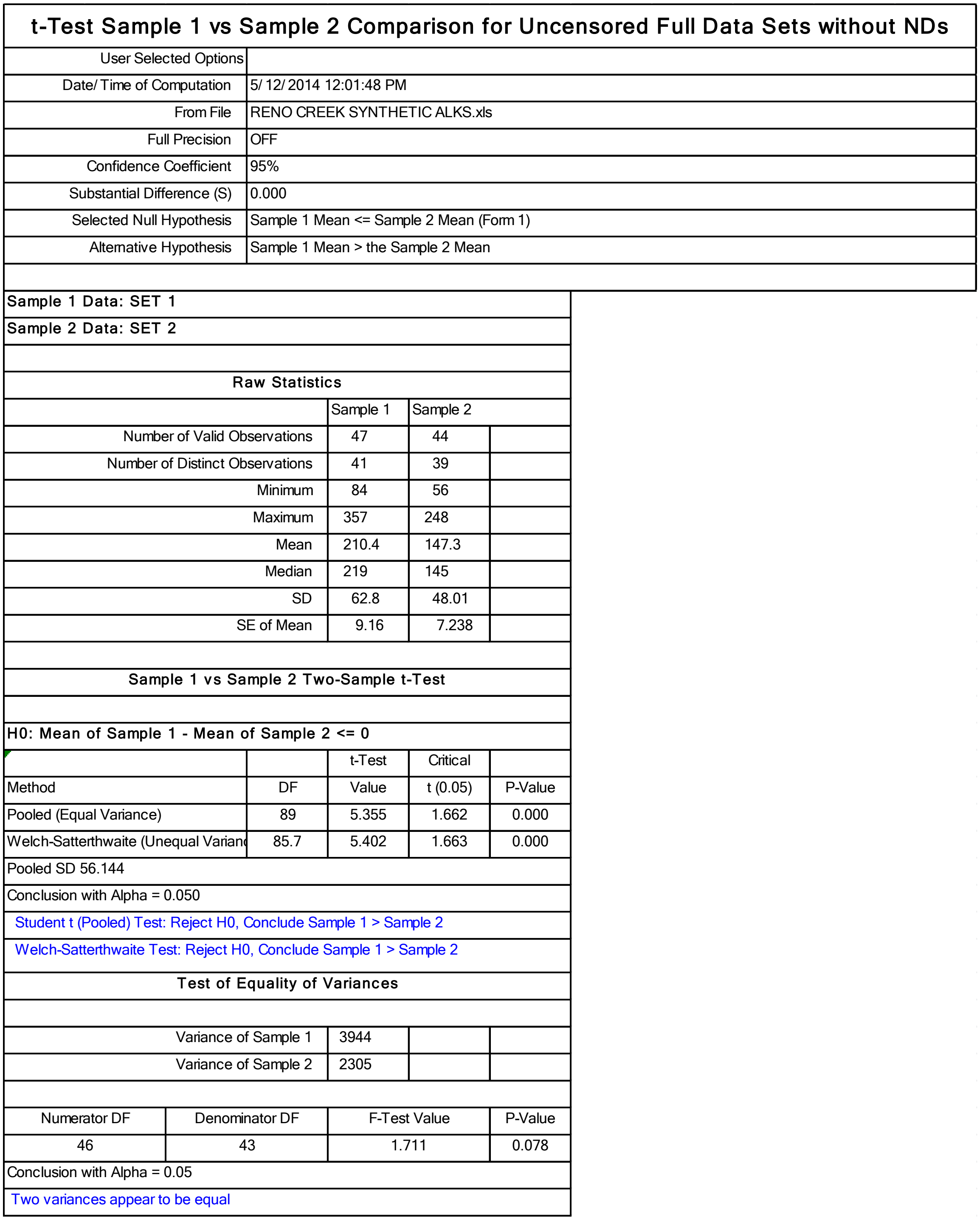
A multiple Quartile Quartile Plot using ProUCL version 5.0 permits a more direct comparison of the two distributions for the two data sets. This clearly suggests that they are different.

Figure 6. Multiple Quartile plot for Sets 1 and 2.



A two sample test using ProUCL was then applied using a parametric (t-test) based hypothesis test (Table 2 shown below). The results confirm the earlier observations. In the hypothesis testing section of the ProUCL output start with **H0: Mean of Sample 1 – Mean of Sample 2 <=0,** there are two P-Values listed at 0.000, this is the decimal point limit set up by ProUCL and that even with Confidence Coefficient of 99.9% these samples would be classified as different.

Table 2. Summary of Two-Sample Hypothesis testing using ProUCL.



t-Test Sample 1 vs Sample 2 Comparison for Uncensored Full Data Sets without NDs

User Selected Options	
Date/ Time of Computation	5/ 12/ 2014 12:01:48 PM
From File	RENO CREEK SYNTHETIC ALKS.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0.000
Selected Null Hypothesis	Sample 1 Mean <= Sample 2 Mean (Form 1)
Alternative Hypothesis	Sample 1 Mean > the Sample 2 Mean

Sample 1 Data: SET 1

Sample 2 Data: SET 2

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	47	44
Number of Distinct Observations	41	39
Minimum	84	56
Maximum	357	248
Mean	210.4	147.3
Median	219	145
SD	62.8	48.01
SE of Mean	9.16	7.238

Sample 1 vs Sample 2 Two-Sample t-Test

H0: Mean of Sample 1 - Mean of Sample 2 <= 0

		t-Test	Critical	
Method	DF	Value	t (0.05)	P-Value
Pooled (Equal Variance)	89	5.355	1.662	0.000
Welch-Satterthwaite (Unequal Varian	85.7	5.402	1.663	0.000

Pooled SD 56.144

Conclusion with Alpha = 0.050

Student t (Pooled) Test: Reject H0, Conclude Sample 1 > Sample 2

Welch-Satterthwaite Test: Reject H0, Conclude Sample 1 > Sample 2

Test of Equality of Variances

Variance of Sample 1	3944
Variance of Sample 2	2305

Numerator DF	Denominator DF	F-Test Value	P-Value
46	43	1.711	0.078

Conclusion with Alpha = 0.05

Two variances appear to be equal

The t-test results indicate that the two groups are different and that the second group is less than the first group.

Comparing the Upper confidence limit (UCL) of the means provides additional evidence that the sample mean of set two is less than the UCL of the background population (Table 3 shown below). The comparison is between the UCL of the mean for SET 2 which is 159.5 mg/L (at 95%) with the mean of SET 1, which as shown above is 210.4 mg/L.

Table 3. Summary of UCL Calculations for Sets 1 and 2.

Normal UCL Statistics for Uncensored Full Data Sets			
User Selected Options			
Date/ Time of Computation	5/ 12/ 2014 4:14:59 PM		
From File	RENO CREEK SYNTHETIC ALKS.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
SET 1			
General Statistics			
Total Number of Observations	47	Number of Distinct Observations	41
		Number of Missing Observations	0
Minimum	84	Mean	210.4
Maximum	357	Median	219
SD	62.8	SD of logged Data	0.339
Coefficient of Variation	0.298	Skewness	-0.157
Normal GOF Test			
Shapiro Wilk Test Statistic	0.972	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.946	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.0997	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.129	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	225.8	95% Adjusted-CLT UCL (Chen-1995)	225.2
		95% Modified-t UCL (Johnson-1978)	225.7
Suggested UCL to Use			
95% Student's-t UCL	225.8		
SET 2			
General Statistics			
Total Number of Observations	44	Number of Distinct Observations	39
		Number of Missing Observations	0
Minimum	56	Mean	147.3
Maximum	248	Median	145
SD	48.01	SD of logged Data	0.368
Coefficient of Variation	0.326	Skewness	-0.0277
Normal GOF Test			
Shapiro Wilk Test Statistic	0.975	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.944	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.0708	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.134	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	159.5	95% Adjusted-CLT UCL (Chen-1995)	159.2
		95% Modified-t UCL (Johnson-1978)	159.5
Suggested UCL to Use			
95% Student's-t UCL	159.5		
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)			
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.			
For additional insight the user may want to consult a statistician.			
Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be			
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.			

These statistical methods demonstrate the basic approach that AUC expects to follow in their restoration evaluation program. If sample population distributions are classified as non-parametric then the equivalent non-parametric methods will be employed in the hypothesis testing.

RAI-55

Description of Deficiency

In Section 5.7.8.1.3 of the TR, the application states "AUC will adapt the statistical principles ... to determine the UCLs". The applicant did not define the statistical principles (e.g., well-by-well basis, a wellfield average basis, or combination thereof).

Basis for Request

The application provides no specificity to the procedures for establishing upper control limits (UCLs) for the wellfield excursion monitoring program.

Section 1.2 of the SRP states:

> *"The reviewer should determine whether the application provides a sufficiently comprehensive summary of the nature of the facilities, equipment, and procedures to be used in the proposed in situ leach activity including the name and location. Reviewers should keep in mind that the development and initial licensing of an in situ leach facility is not based on comprehensive information. This is because in situ leach facilities obtain enough information to generally locate the ore body and to understand the natural systems involved. More detailed information is developed as each area is brought into production. Therefore, reviewers should verify that sufficient information is presented to reach only the conclusion necessary for initial licensing. However, reviewers should not expect that information needed to fully describe each aspect of a full operation will be available in the initial application. For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications."*

Formulation of RAI

Please provide specific statistical principles to be used for the method AUC will adapt for determining a Production Unit UCLs.

RAI-55 Response

The statistical method employed for excursion monitoring by the ISR industry is, to use the USEPA description, essentially a prediction limit method with retests. For each parameter used to define excursions, the Wyoming Department of Environmental Quality Land Quality Division defines an Upper Control Limit (these are control limits and although similar to they are not the same as the confidence limits discussed previously) based upon a mean value plus five standard deviations. Prediction limit methods are discussed in detail in the Uniform Guidance Document (USEPA, 2009). According to the Uniform Guidance these tests fall into the class of methods known as the statistical interval methods. Such methods provide a convenient and statistically valid approach to test for differences between background and the compliance point groundwater measurements. A prediction limit (PL) is calculated using background concentration data. The method offers enough flexibility that PL's can be constructed so that as few as one new measurement per compliance well may suffice for a test. This permits a more rapid detection of an excursion than do the two-sample statistical methods used commonly to assess RTVs which require sufficient data to calculate reliable statistics for the second sample population.

Monitoring well data will be examined using several methods to better understand the nature and distribution of the sample populations for the indicator parameters. Averages (mean values) assuming that normal populations are present will be based initially upon a wellfield average basis. But these samples will be sorted if necessary into different subgroups. For instance, given the large areal extent of the perimeter ring of monitoring wells the possibility exists that more than one population for alkalinity or chloride concentrations could be identified. Such differentiations are also likely to occur for the monitoring wells that are above the production zone. These different populations will be separated and assigned to specific portions of the perimeter monitoring system or assigned to the overlying formation. Goodness-of-fit tests will be performed to define the underlying data populations for the different spatial groups. Summary statistics for the selected parameters (primarily the mean and standard deviation) for these new groups will be prepared. Outliers will be eliminated prior to calculation of summary statistics. For groups that do not follow simple population distributions, non-parametric methods will be used. Prior to selection of a non-parametric method, additional samples may be collected to confirm the finding of a non-parametric distribution. If it is still concluded that a non-parametric distribution remains, then methods will be set up to provide an upper control limit that is comparable to the upper control limit used for the simpler distribution populations. In many non-parametric procedures the maximum observed value among the sample data set is assigned to be the prediction limit (USEPA, 2009).

Using the mean and standard deviation values for the different groups of monitoring wells AUC will calculate the mean plus five standard deviation value to define the Upper Control Limit as defined in WDEQ Guideline No. 4 Reference Document 4. In accordance with NUREG 1569, a plus 20 percent margin is allowed if only a single parameter (one excursion indicator) exceeds the Upper Control Limit. Two retests are allowed before a final decision is made that an actual excursion has taken place.

REFERENCES

USEPA, 2009, Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance," EPA-530-R-09-007, 888 p.

USEPA, 2013, ProUCL version 5.0.00 User Guide – Statistical software for environmental applications for data sets with and without nondetect observations. EPA/600/R-07/041, 256 p.

RAI-56

Description of Deficiency

In Section 5.7.8.1.3 of the TR, the application proposes a perimeter ring well spacing of 500 feet in the fully saturated aquifer and 400 feet in the partially saturated aquifer based on the numerical model results.

Basis for Request

As discussed in RAI-14, staff requests additional clarification on the numeric model used and requests justification for the 500-foot spacing from the production area to the perimeter monitoring well ring.

Formulation of RAI

See RAI-14

RAI-56 Response

Clarification on the numerical model used to justify the 500 foot spacing from the production area to the perimeter monitor well ring is provided in response RAI-14(c).

RAI-57

Description of Deficiency

In TR Section 5.7.8.1.4, the application states that the Production Unit Hydrologic Data Package is reviewed by SERP and AUC will provide a copy to NRC for "review only".

Basis for Request

It has been NRC's policy to require new licensees, by license condition, to submit the first package to NRC staff for review and verification and subsequent packages for NRC review. The SERP review process will be required for all packages to establish the groundwater protection standards required by Criterion 5B(5).

Section 1.2 of the SRP states:

> *"The reviewer should determine whether the application provides a sufficiently comprehensive summary of the nature of the facilities, equipment, and procedures to be used in the proposed in situ leach activity including the name and location. Reviewers should keep in mind that the development and initial licensing of an in situ leach facility is not based on comprehensive information. This is because in situ leach facilities obtain enough information to generally locate the ore body and to understand the natural systems involved. More detailed information is developed as each area is brought into production. Therefore, reviewers should verify that sufficient information is presented to reach only the conclusion necessary for initial licensing. However, reviewers should not expect that information needed to fully describe each aspect of a full operation will be available in the initial application. For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications."*

Formulation of RAI

Please provide a commitment to submit the first wellfield package for NRC staff review and verification and subsequent packages for NRC review.

RAI-57 Response

AUC has made revisions to the text in TR Section 5.7.8.1.4 to commit to submit the first wellfield package for NRC staff review and verification and subsequent packages for NRC review. It now reads:

"AUC will submit the first Production Unit Hydrologic Data Package to NRC staff for review and verification. AUC will submit all subsequent Production Unit Hydrologic Data Packages to NRC staff for review."

RAI-58

Description of Deficiency

In Section 5.7.8.1.6 of the TR, the application did not provide commitments for providing NRC a quarterly report on the status of wells on excursion status.

Basis for Request

All licenses have a license condition that NRC will be provided a quarterly report.

Section 1.2 of the SRP states:

> *"The reviewer should determine whether the application provides a sufficiently comprehensive summary of the nature of the facilities, equipment, and procedures to be used in the proposed in situ leach activity including the name and location. Reviewers should keep in mind that the development and initial licensing of an in situ leach facility is not based on comprehensive information. This is because in situ leach facilities obtain enough information to generally locate the ore body and to understand the natural systems involved. More detailed information is developed as each area is brought into production. Therefore, reviewers should verify that sufficient information is presented to reach only the conclusion necessary for initial licensing. However, reviewers should not expect that information needed to fully describe each aspect of a full operation will be available in the initial application. For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications."*

Formulation of RAI

Please provide a commitment to provide a quarterly report to NRC on the status of wells on excursion status.

RAI-58 Response

AUC has added the following text to provide NRC with quarterly reports for wells on excursion status in the last paragraph of TR Section 5.7.8.1.6:

"AUC will provide a quarterly report to NRC on the status of wells on excursion status."

RAI-59

Description of Deficiency

In Section 5.7.8.1.6 of the TR, the application states that "[i]f neither the second or third sampling data do not exceed the UCLS, then ... the well is removed from excursion status."

Basis for Request

Grammatically, the sentence is a double negative. Technically, the sentence is inaccurate - a well is placed on (not removed from) excursion status only after the initial data are verified by the second or third sampling result.

Section 1.2 of the SRP states:

> *"The reviewer should determine whether the application provides a sufficiently comprehensive summary of the nature of the facilities, equipment, and procedures to be used in the proposed in situ leach activity including the name and location. Reviewers should keep in mind that the development and initial licensing of an in situ leach facility is not based on comprehensive information. This is because in situ leach facilities obtain enough information to generally locate the ore body and to understand the natural systems involved. More detailed information is developed as each area is brought into production. Therefore, reviewers should verify that sufficient information is presented to reach only the conclusion necessary for initial licensing. However, reviewers should not expect that information needed to fully describe each aspect of a full operation will be available in the initial application. For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications."*

Formulation of RAI

Please revise the sentence accordingly.

RAI-59 Response

AUC has revised the text of the third bullet of TR Section 5.7.8.1.6. as shown below:

- "If the UCL concentrations are not exceeded in the second sampling event, and the UCL concentrations are not exceeded in the third sampling event, then the monitor well will not be placed on excursion status; and"

RAI-60

Description of Deficiency

In Section 5.7.8.1.6 of the TR, the applicant states:

> *"In compliance with NUREG-1569, Section 5.7.8.3 (Criterion 5), AUC will consider corrective action complete when all excursion indicators are below their respective UCLs, or if only one excursion indicator exceeds its respective UCL by less than 20 percent."*

Basis for Request

The application states incorrectly, by incomplete references to guidance in the SRP, the procedures for termination of excursion status for a well.

The application fails to address the subsequent sentence in the referenced criterion of the SRP:

> *"Stability in the excursion indicator concentrations must be demonstrated by measurements over a suitable time period before the corrective action measures can be discontinued."*

Staff has required demonstration of stability for all prior licenses.

Formulation of RAI

Please revise the narrative to include stability monitoring before termination of the corrective action measures (and excursion status).

RAI-60 Response

AUC has revised the last bullet in TR Section 5.7.8.1.6 to include a commitment to stability monitoring of the excursion indicator concentrations as shown below:

- "In compliance with NUREG-1569, Section 5.7.8.3 (Criterion 5), AUC will demonstrate stability in the excursion indicator concentrations by measurements over a suitable time period before the corrective action measures can be discontinued. The corrective action will be considered complete after three consecutive weekly sampling events indicate that all excursion indicators have stabilized below their respective UCLs or if only one excursion indicator exceeds its respective UCL by less than 20 percent."

RAI-61

Description of Deficiency

In Section 5.7.8 of the TR, the application reiterates text from the SRP Criterion (30) in SRP Section 5.7.8.3 regarding actions should an excursion status exceed the 60 days.

Basis for Request

The application fails to clearly state that the applicant will follow the stated text.

Section 1.2 of the SRP states:

> *"The reviewer should determine whether the application provides a sufficiently comprehensive summary of the nature of the facilities, equipment, and procedures to be used in the proposed in situ leach activity including the name and location. Reviewers should keep in mind that the development and initial licensing of an in situ leach facility is not based on comprehensive information. This is because in situ leach facilities obtain enough information to generally locate the ore body and to understand the natural systems involved. More detailed information is developed as each area is brought into production. Therefore, reviewers should verify that sufficient information is presented to reach only the conclusion necessary for initial licensing. However, reviewers should not expect that information needed to fully describe each aspect of a full operation will be available in the initial application. For license renewals and amendment applications, Appendix A to this standard review plan provides guidance for examining facility operations and the approach that should be used in evaluating amendments and renewal applications."*

Formulation of RAI

Please revise the text to indicate the applicant's commitment following an excursion status exceeding 60 days.

RAI-61 Response

AUC has added the following text to comply with the stated text in NUREG-1569 to the beginning of the fifth paragraph of TR Section 5.7.8.1.6 which now reads:

"AUC commits to comply with the stated text in NUREG-1569, Section 5.7.8.3 (Criterion 5) for an excursion exceeding 60 days."

RAI-62

Description of Deficiency

In Section 5.7.9 of the TR, AUC commits to preparing a Quality Assurance Plan (QAP) and provides goals and objectives for preparation of that QAP. AUC commits to developing applicable SOPs before a preoperational inspection and initiation of operations "as required by the standard license condition in SER Appendix A".

Basis for Request

The information presented in the application QAP is insufficient. First, many of the terms used in the descriptions by the applicant are vague and too generalized. For example, the term "applicable SOPs" does not specify which SOPs will be developed and may be subject to interpretation. Furthermore, because the Safety Evaluation Report (SER) has not been completed and thus a standard license condition does not exist, the staff has difficulty in reconciling statements in the application. While it is true that safety evaluation reports for prior projects have included such a standard license condition, the license condition was developed after staff having a reasonable assurance that that specific applicant could complete the QAP after review of information provided in the application. In the case of AUC, the applicant's argument is that a QAP will be developed similar to past applicants due to a license condition and provided minimum information for staff to evaluation.

Formulation of RAI

Please provide a description of specific information to be included in a QAP for staff to review.

RAI-62 Response

AUC has made revisions to Section 5.7.9 to provide the specific information to be included in the QAP as shown below:

"The QA section will include both planned and systematic actions necessary to provide adequate confidence in the assessment of all monitored results. A Quality Control (QC) section will be included in the QA, and will include Proposed Projects to provide accepted measurement techniques, control the characteristics of measurement equipment, and proposed processes that will meet established standards. The QA program will provide assurance to the regulatory agencies and to the public that the monitoring results are valid. AUC commits to developing a QA Program that will include the following criteria:

- Establish and apply all radiological, effluent and environmental programs to be consistent with RG 4.14 (Sections 3 & 6) (NRC 1980) and RG 4.15 (1979);
- Ensure all record keeping is in accordance with NUREG-1569 (Section 5.3.2); included will be the provision under 10 CFR 20 stating the licensee must retain survey and calibration records for three years instead of the two years mentioned in RG 4.15 (NRC, 1979);
- Address all aspects of decommissioning including a confidence interval (or one to be specified) before collecting decommission samples. This data will be used to demonstrate compliance and that the QA procedures to verify the compliance data are precise and accurate; and
- AUC will develop and implement written standard operating procedures (SOP's) prior to operation for appropriate radiation safety practices to be followed in accordance with 10 CFR Part 20. SOP's for operation activities shall enumerate pertinent radiation safety practices to be followed."

AUC will provide the NRC staff a completed QAP at least 60 days prior to the preoperational inspection to verify the QAP is consistent with Regulatory Guide 4.15. A QAP table of contents outlining the anticipated information is provided as Appendix D of this document:

6 GROUNDWATER QUALITY, RESTORATION, SURFACE RECLAMATION AND FACILITY DECOMMISSIONING

RAI-63

Description of Deficiency

In Section 6.1.1 of the TR, the application incorporates the following terminology: "Groundwater will be restored"; "consistent with the groundwater protection standards"; "using BPT and ALARA"; "Commission approved baseline conditions or Restoration Target Values (RTV)"; and, "approved RTV within the range of statistical variability".

Basis for Request

The terminology may be confusing and is at times often vague leading to staff's interpreting the meaning of the applicant.

For example:

- *"Groundwater will be restored" - This statement alone does not define the extent of the area for which groundwater is to be restored. Staff would need to assume that the applicant refers to groundwater at a specific production unit as a groundwater production standard would be defined on that basis.*
- *"Consistent with the groundwater protection standards" - The applicant will be required to* <u>*meet*</u> *not* <u>*be consistent with*</u> *the groundwater protection standards.*
- *"Using BPT and ALARA" - BPT (best practicable technology) is not defined in NRC regulations and importantly, using ALARA is a requirement of Criterion 5B(6) only if alternate concentration limits (ACLs) (Criterion 5B5c) are to be used.*
- *"Commission approved baseline conditions or Restoration Target Values (RTV)" - As written, the phrase can be interpreted as one standard or another (i.e., commission-approved background concentrate or an RTV). However, the applicant will be required to meet the commission-approved background concentration. (Note: Criterion 5B(5) of 10 CFR Part 40 Appendix A uses the term "background" in defining the "Commission-approved background concentration" for the groundwater protection detection monitoring program required under Criterion 7(A), whereas Criterion 7 of 10 CFR Part 40 Appendix A uses the term "baseline" for data collected during the pre-operational monitoring program. On the other hand, the SRP uses the terms in reverse. Consequently, in the past, industry and*

staff have used the terms "baseline" and "background" interchangeably).

- *"Approved RTV within the range of statistical variability" - The applicant needs to clarify this phrase. The commission-approved background concentration should be developed using the background values and incorporates estimated spatial variability in the data prior to operations. As written, one can interpret that the applicable standard will be the RTV plus some factor for statistical variability after the restoration is complete.*

Formulation of RAI

Please revise the narrative in the application accordingly.

RAI-63 Response

AUC has revised the text in TR Section 6.1.1 Groundwater Restoration Criteria as requested. The revised text is presented below:

"Groundwater affected by uranium recovery operations within the ore zone of the PZA in each Production Unit will be restored to the numerical ground water protection standards as required by 10 CFR 40, Appendix A, Criterion 5(B)(5) on a constituent-by-constituent basis. Criterion 5(B)(5) requires that the concentration of each constituent not exceed:

(a) The Commission-approved background concentration of that constituent in the groundwater;

(b) The respective value given in the table in paragraph 5C, Maximum Values for Ground-Water Protection, 10 CFR 40, Appendix A if the constituent is listed in the table and if the background level of the constituent is below the value listed; or

(c) An alternate concentration limit (ACL) established by the Commission.

AUC commits to a primary goal of groundwater restoration to return all constituents to the Commission-approved background concentration for each Production Unit (Criterion a, above). However, ISR operations will alter the groundwater geochemistry within the PZA; therefore, it is possible that some constituents will not be returned to Commission-approved background concentrations. If some constituents cannot be restored to background or maximum contaminant levels (whichever is greater) for those constituents listed in the table in paragraph 5C (Criterion b above) after AUC has demonstrated that it has made practicable efforts to restore the specified constituents, then AUC will submit a license amendment application requesting approval of ACLs pursuant to Criterion 5(B)(6), 10 CFR 40, Appendix A, for these constituents from the NRC (Criterion c above).

AUC recognizes that while prior Class-of-Use is not a standard in the context of Criterion 5(b)(5), NRC has recognized that demonstration of compliance with Wyoming's Class-of-Use standards can be a component of an application for an ACL."

RAI-64

Description of Deficiency

In Section 6.1 of the TR, the application states:

> *"The groundwater baseline water quality data will be determined from data collected from wells completed in the PZA."*

Basis for Request

The application is unclear as to the completion interval of wells used to establish the groundwater protection standards for a wellfield. Wells used to establish the commission-approved background concentration will be limited to the ore zone within the PZA aquifer undergoing the principal activities, i.e., lixiviant injection, and not throughout the entire aquifer as defined as the "PZA aquifer" by the applicant. Staff will require that wells screened in the PZA aquifer outside of the ore zone be abandoned prior to operations or the applicant will have to increase the surety calculations to denote the fact that the wells provide a conduit for lixiviant migration through the entire PZA aquifer.

Formulation of RAI

Please revise the application to reflect the completion interval for wells to be used for the baseline monitoring.

RAI-64 Response

AUC has revised the text in the second paragraph of TR Section 6.1.2 to clarify the completion interval for wells used to collect baseline groundwater quality data for each Production Unit to establish commission-approved background concentrations:

"AUC will establish Commission-approved background groundwater quality prior to the start of uranium recovery operations by sampling a subset of production wells (injection and recovery wells) completed exclusively within the uranium mineralized zones of the PZA (i.e. PZM-Wells). Baseline water quality constituents from the PZM Wells will be used, on a constituent by constituent basis, to monitor and evaluate restoration activities in returning the affected groundwater back to pre-operational quality as reasonably as practicable."

RAI-65

Description of Deficiency

In Section 6.1.2 of the TR, the application states:

> *"Specific restoration values will be established prior to uranium recovery in each Production Unit by computing specific restoration values for specific constituents."*

Basis for Request

This sentence appears to be circular reasoning and does not add value.

Formulation of RAI

Please clarify the meaning and intent of the sentence.

RAI-65 Response

AUC has revised the 3rd paragraph in TR Section 6.1.2 to read:

"Restoration Target Values will be established prior to the start of uranium recovery operations in each Production Unit by processing the analytical results from sampled production wells using geochemical statistical methods for each constituent listed in Table 6-1."

RAI-66

Description of Deficiency

In Section 6.1.3 of the TR, the application states:

> *"In the event that unforeseen conditions such as inclement weather, mechanical failure, or other factors that may result in placing an employee at risk or potentially damaging the surrounding environment occur, notification to NRC and the WDEQ will be made if any of the wells cannot be monitored within 65 days of the last sampling event."*

In Section 5.7.8.1.5, the application states:

> *"AUC requests that in the event of certain situations such as inclement weather, mechanical failure, or other factors that may result in placing an employee at risk or potentially damaging the surrounding environment, NRC allow a delay in sampling of no more than five days. In these situations, AUC will document the cause and the duration of any delays."*

Basis for Request

The application requests a 65-day extension for a sampling requirement during restoration without providing a basis for that request.

Formulation of RAI

Please provide an example of unforeseen condition that would delay a sampling requirement for 65 days.

RAI-66 Response

AUC has replaced the second paragraph of TR Section 6.1.3 for clarification that AUC is only requesting a five day delay of monitor well sampling due to unforeseen events to read as follows:

"AUC requests that in the event of certain situations such as inclement weather, mechanical failure, or other factors that may result in placing an employee at risk or potentially damaging the surrounding environment, NRC allow a delay in sampling of no more than five days. In these situations, AUC will document the cause and the duration of any delays."

RAI-67

Description of Deficiency

In Section 6.1.5 of the TR, the applicant proposes to sample groundwater in the perimeter ring monitoring wells only for the excursion parameters during the stability monitoring period.

Basis for Request

This statement is contrary to policy of NRC to demonstrate compliance with the groundwater protection standards should a well exhibit extended time on excursion status during operations or restoration. Staff will require a commitment that the applicant provides confirmatory sampling of the monitoring wells that were on excursion status during the life of the wells for the full suite of chemical parameters to demonstrate adherence to the groundwater protection standards, or provide justification for not analyzing the full suite.

Formulation of RAI

Please revise the text in the application to document the commitment to performing confirmatory sampling.

RAI-67 Response

AUC has included the following text after the second paragraph under TR Section 6.1.5 to commit to confirmatory sampling for monitor wells that had been placed on excursion status as shown below:

"Additional confirmatory samples will be collected from monitor wells (RM or OM) that were placed on excursion status during uranium recovery operations or during active groundwater restoration activities at the same frequency as the PZM-Wells. The samples will be analyzed for the full suite of constituents presented in Table 6-1. The sample results will be compared to the initial baseline samples collected for the monitor wells prior to the start of uranium recovery operations."

RAI-68

Description of Deficiency

In Section 6.1.6 of the TR, and on Figure 1-3, the applicant expects the combination of active restoration, stability monitoring and surface reclamation and decommissioning of the wellfields to exceed 24 months, and furthermore, by the application, requests NRC approval for an alternate schedule in accordance with 10 CFR 40.42(i).

Basis for Request

The application incorrectly asks for NRC approval of the proposed schedule as an alternate schedule in accordance with 10 CFR 40.42(i).

While the applicant is correct that a request for an alternate schedule would be required for a wellfield, staff differentiates groundwater restoration of a specific wellfield as decommissioning of one outdoor area, from the decommissioning and reclamation of the wellfield surface features including abandonment of the wells. The applicant's proposed schedule for restoration of a specific production unit is less than 24 months (see Figure 1-3); thus, it is premature to request NRC's approval of an alternate schedule. In the event that the restoration may be delayed beyond 24 months or beyond the commission-approved schedule in this proposal (even an alternate schedule), the applicant would be required to request an alternate schedule to justify and evaluate the impacts of the delay in accordance with provisions in 10 CFR 40.42.

Formulation of RAI

Please revise the text accordingly.

RAI-68 Response

AUC has revised the text in Section 6.1.6 as shown below:

"As shown in TR Figure 1-3 Proposed Project Schedule, AUC expects active groundwater restoration will be completed in each PU in less than 24 months. Also TR Figure 1-3 shows that stability monitoring and decommissioning of each PU will each take less than 24 months as well. AUC understands that if any of these activities separately will exceed the 24 month period as required in the decommissioning regulations of 10 CFR 40.42 then AUC will be required to request an alternate schedule to justify and evaluate the impacts of the delay in accordance with provisions in 10 CFR 40.42(i)."

RAI-69

Description of Deficiency

In Section 6.2 of the TR, the applicant stated that they will submit a standard Production Unit (PU) decommissioning plan specific to PU1 for approval at least 12 months prior to the completion of groundwater restoration in accordance with NRC requirements. The applicant further stated in Section 6.2 of the TR that decommissioning will not begin in a Production Unit until final approval of groundwater restoration has been received from the NRC and the WDEQ.

Basis for Request

The applicant did not commit to having a decommissioning plan (which includes the reclamation plan) approval at least 12 months before the planned commencement of reclamation of a well field or licensed area. SRP Acceptance Criteria 6.2.3(7) states that the applicant commits to providing final (detailed) reclamation plans for land (soil) to the NRC for review and approval at least 12 months before the planned commencement of reclamation of a well field or licensed area. The final decommissioning plan includes a description of the areas to be reclaimed, a description of planned reclamation activities, a description of methods to be used to ensure protection of workers and the environment against radiation hazards.

Formulation of RAI

In the application, explain how the reclamation plan differs from the decommissioning plan or include the reclamation plan within the decommissioning plan. Only make reference to the decommissioning plan. The decommissioning plan must be submitted to the NRC for approval when the licensee has decided to permanently cease principal activities at the entire site or in any separate building or outdoor area.

RAI-69 Response

AUC has revised the opening paragraphs of Section 6.2 as follows:

"Upon completion of licensed ISR operations at the Proposed Project, all lands disturbed by ISR production activities will be reclaimed to the extent necessary so that they can be released for unrestricted use. AUC commits to providing a final detailed decommissioning plan for each Production Unit to NRC. In accordance with SRP Acceptance Criteria 6.2.3(7), AUC commits to including a final (detailed) reclamation plan for land (soil) to the NRC for review and approval at least 12 months before the planned commencement of reclamation of a PU or licensed area. The reclamation plan will be submitted as part of the decommissioning plan, which will include a description of the areas to be reclaimed, a description of planned reclamation activities (e.g. replacing excavated soils, re-contouring affected areas, reestablishing original drainages, and re-vegetation), and a description of methods to be used to ensure protection of workers and the environment against radiation hazards.

Once operations permanently end for the entire site, AUC commits to providing NRC with a final site decommissioning plan for the CPP and any remaining pipelines and other infrastructure at least 12 months prior to commencement of final decommissioning for NRC approval. The final decommissioning plan will also include a final site reclamation plan for land (soil)."

RAI-70

Description of Deficiency

In Section 6.2 of the TR, the applicant discusses the plans and schedules for reclaiming disturbed lands.

Basis for Request

The applicant did not discuss acceptable methods for sampling during decommissioning. SRP Acceptance Criteria 6.2.3(2) states that survey areas should include diversion ditches, surface impoundments, well field surfaces and structures in process and storage areas, on-site transportation routes for contaminated material and equipment, and other areas likely to be contaminated. A sampling grid of 100 m^2 *(for soil) should be used and a statistical basis for sample size should be provided. Acceptable methods for sampling are provided in NUREG-1575 "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)." MARSSIM is a document that provides detailed guidance for planning, implementing, and evaluating environmental and facility radiological surveys conducted to demonstrate with a dose or risk based regulation. MARSSIM focuses on the demonstration of compliance during the final status survey following scoping, characterization, and any necessary remedial actions.*

Formulation of RAI

Commit to address, within the decommissioning plan, a separate final status survey plan. The final status survey plan should provide a detailed survey plan that includes the planning, implementing, and evaluating radiological surveys that will demonstrate how the licensee will meet compliance (radium benchmark dose) during the final status survey consistent with MARSSIM or equivalent.

RAI-70 Response

AUC has added the following text as the first paragraph in Section 1.3 of Addendum 6-A as shown below:

"Within the decommissioning plan, a separate final status survey plan will be provided that includes the planning, implementation, and evaluation of radiological surveys that demonstrate how AUC will meet compliance during the final status survey."

RAI-71

Description of Deficiency

In Section 6.2 of the TR, the applicant stated that, prior to reclamation, the applicant will identify the disposition of all non-radiological components and hazardous materials, including all structures and equipment.

Basis for Request

The applicant needs to commit to addressing the non-radiological hazardous materials in the decommissioning plan. NRC staff determined that the applicant did not commit to addressing the non-radiological hazardous materials in the decommissioning plan. SRP Acceptance Criteria 6.2.3(8) states that the decommissioning plan addresses the non-radiological hazardous constituents associated with the wastes according to 10 CFR Part 40, Appendix A, Criterion 6(7). Any unusual or extenuating circumstances related to such constituents should be discussed in the reclamation plan or decommissioning plan in relation to protection of public health and the environment and should be evaluated by staff.

Formulation of RAI

In the application, commit to addressing the non-radiological hazardous constituents associated with the wastes in accordance with 10 CFR 40, Appendix A, Criterion 6(7) in the decommissioning plan.

RAI-71 Response

AUC has revised the third paragraph in TR Sec. 6.2 to include the new text as shown below:

"Prior to reclamation, the disposition of all non-radiological components and hazardous materials, including all structures and equipment will be identified. AUC commits to decommissioning the non-radiological components and hazardous materials in accordance to 10 CFR 40, Appendix A, Criterion 6(7). Those that may be decontaminated to regulatory standards will be demolished, and disposed of at a permitted nonhazardous materials disposal facility (e.g., a local landfill). Contaminated structures and equipment will be dismantled and transported off-site to a licensed facility for disposal as solid 11e.(2) byproduct material, in accordance with 10 CFR Part 40, Appendix A, Criterion 2. Salvaged equipment may also be transferred to another AUC project or NRC licensee. Non-11e.(2) regulated materials including uncontaminated materials and equipment and septic system materials will be disposed of in an approved sanitary landfill, compliant with the rules and regulations of WDEQ/SHWD."

To clarify the content of AUC's Restoration Action Plan (RAP) which includes further decommissioning discussions, AUC has revised the first bulleted item of the introductory paragraph for TR Sec. 6 which now reads:

"…Further and/or more detailed discussions can be found in:

- Addendum 6-A Restoration Action Plan (RAP) which includes:
    - Financial Assurance tables;
    - Groundwater restoration and well plugging discussions;
    - Facility decommissioning plans (decommissioning plan will include surface reclamation activities);
    - Radiological survey and environmental discussions;
    - Project management; and
    - Labor and equipment overhead, and contractor profit."

RAI-72

Description of Deficiency

In Section 6.2 of the TR, the applicant stated that structures and equipment that may be decontaminated to regulatory standards will be demolished, and disposed of at a permitted nonhazardous materials disposal facility (e.g., a local landfill).

Basis for Request

The applicant did not identify as to what regulatory standards that structures and equipment may be decontaminated. SRP Acceptance Criteria 6.2.3(8) states that the decommissioning plan addresses the non-radiological hazardous constituents associated with the wastes according to 10 CFR Part 40, Appendix A, Criterion 6(7). Any unusual or extenuating circumstances related to such constituents should be discussed in the reclamation plan or decommissioning plan in relation to protection of public health and the environment and should be evaluated by staff. NRC staff has determined that the applicant needs to consider the non-radiological hazardous material as described in 10 CFR 40. It is not clear from the applicant's statement as to whether the applicant is decontaminating structures and equipment for radiological and/or non-radiological purposes and what regulatory standards will be used for decontamination.

Formulation of RAI

In the application, identify the regulatory standards that will be used for radiological and/or non-radiological components that will be decontaminated prior to demolition and disposal to a permitted non-hazardous materials disposal facility (e.g., local landfill).

RAI-72 Response

To better identify the regulatory standard used for non-radiological hazardous waste decontamination levels, AUC has included reference to WDEQ Solid and Hazardous Waste Division, Hazardous Waste Management Rules and Regulations (Wyoming Environmental Quality Act, W.S. 35-11-101 et seq.) as the regulatory standards to which structures and equipment not classified as 11e.(2) regulated will be adhered to.

This new text is included within the third paragraph of TR Section 6.2 as shown below:

"Prior to reclamation, AUC will identify the disposition of all non-radiological components and hazardous materials, including all structures and equipment. Those that may be decontaminated to WDEQ/SHWD, Hazardous Waste Management Rules and Regulations (Wyoming Environmental Quality Act, W.S. 35-11-101 et seq.) regulatory standards will be demolished, and disposed of at a permitted nonhazardous materials disposal facility (e.g., a local landfill). Contaminated structures and equipment classified as 11e.(2) will be dismantled and transported off-site to a licensed facility for disposal as solid 11e.(2) byproduct material, in accordance with 10 CFR Part 40, Appendix A, Criterion 2. Salvaged equipment may also be transferred to another AUC project or NRC licensee. Non-11e.(2) regulated materials including uncontaminated materials and equipment and septic system materials will be disposed of in an approved sanitary landfill, compliant with the rules and regulations of WDEQ/SHWD."

RAI-73

Description of Deficiency

TR Addendum 6A, Section 1.3 (Radiological Surveys) explains that following removal of all structures and re-grading of the site to approximate original contours, and before topsoil is spread on the re-graded area, a gamma survey and soil sampling will be conducted as described in Section 6.4 of the TR. Soils will be cleaned up in accordance with the requirements of 10 CFR Part 40, Appendix A, Criterion 6(6) including consideration of ALARA goals and the chemical toxicity of uranium. The proposed limits and ALARA goals for cleanup of soils are summarized in Section 6.4 of the TR. Any areas that do not meet these limits will be remediated by removing contaminated soils to an appropriately licensed site and the area regraded. The process will be repeated until all sites meet the ALARA goals for cleanup. The preliminary unit costs and areas subject to these surveys are provided in the Attachment RAP2(E).

Basis for Request

Staff could not locate Attachment RAP-2(E) in the application.

Formulation of RAI

Revise this section by either incorporating Attachment RAP-2(E), or referring to the correct location of this information in the application.

RAI-73 Response

AUC has revised the last sentence in Section 1.3 of TR Addendum 6-A as shown below:

"The preliminary unit costs and areas subject to these surveys are provided in Attachment 1, Table 5-2 of this addendum."

RAI-74

Description of Deficiency

In Section 4 and Section 5 of the TR, the applicant discusses the release of radon from the facility. The applicant discussed methods to control the release (Section 4.1), the monitoring of radon progeny for in-plant air monitoring (Section 5.3), and the monitoring of environmental radon in air (Section 5.7). In Section 5.7.7 of the TR, the applicant did not identify or discuss an air radon concentration limit. In Addendum 7A, pg. 7A-21, Summary, last paragraph, the applicant states the following: "In summary, all doses calculated for the boundary locations, permanent residences in the vicinity of the project or visiting members of the public are small fractions of the 100 mrem/yr limit specified in 10 CFR 20.1301."

Basis for Request

The NRC staff determined that the applicant did not discuss how it will evaluate the radiation dose from radon progeny to members of the public during operations. During the review of the application, NRC staff reviewed all applicable sections of the application. In Addendum 7A, the applicant computed radiation doses at multiple receptor points using the software computer program MILDOS. MILDOS determined the dose at the various receptor points using the radon progeny limit of 1.0×10^{-10} *uC/ml. This method is to be used as a predictive tool prior to construction. The applicant must address how it will evaluate the member(s) of the public likely to receive the highest exposures from licensed operations on an ongoing basis throughout its operational lifetime.*

Staff observes that the use of predictive modeling, such as Regulatory Guide 3.59, and the MILDOS-AREA computer code, has never been explicitly approved for demonstrating compliance with radiation protection standards during operations. On the contrary, Regulatory Guide 3.59 is for use when environmental monitoring data is not yet available and it directs applicants and licensees where to look for separate guidance on compliance with radiation protection standards.

10 CFR 20 Appendix B, Table 2, identifies two air concentration limits for Radon-222 to members of the public. One limit is for radon without daughters and the other limit is for radon with daughters. The NRC staff has determined that the application did not address which air concentration limit for Radon-222 that the applicant will use for meeting 10 CFR 20.1301 and 10 CFR 20.1302 during operations. In September 2011, NRC staff published interim guidance for comment on radon and compliance with 10 CFR 20.1301

(ML112720481). In this guidance, it states that compliance with 10 CFR 20.1301/1302 must account for radon progeny during operations. This point is supported by the National Council on Radiation Protection and Measurement (NCRP) Report No. 97 that states, "The short-lived Radon-222 daughters, Po218, Pb-214, Bi-214, and Po-214, when inhaled, are the radionuclides that deliver the alpha radiation dose to the bronchial tissues that is implicated in radiogenic lung cancer." The NRC staff has determined that the radon with daughters limit accounts for the large fraction of the radiation dose produced by radon and radon progeny. The Statements of Consideration (SOC) for NRC's 1991 revision of 10 CFR Part 20 (56 FR 23360, 23374; May 21, 1991) states that uranium recovery facilities must consider the dose from radon progeny.

Formulation of RAI

(a) NRC staff is seeking the following information::

1) *The applicant needs to identify the air concentration limit for Radon-222 that it will use to determine compliance with 10 CFR 20.1301 and 10 CFR 20.1302 during operations.*
2) *Provide an explanation and identify how radon (radon-222) progeny will be factored into analyzing potential public dose from operations consistent with 10 CFR Part 20, Appendix B, Table 2,*

(b) Provide an explanation of how, in accordance with 10 CFR 40.65, the quantity of the principal radionuclides from all point and diffuse sources will be accounted for, and verified by, surveys and/or monitoring. NRC staff is seeking the following information:

1) *Identify all potential air and gaseous effluent release points.*
2) *Discuss how each potential air and gaseous effluent release point will be monitored and how this information (or data) will be incorporated into the 10 CFR 40.65 report.*
3) *Discuss how the measurements from each potential air and gaseous effluent release point will be expressed as a quantity (as described in 10 CFR 40.65).*
4) *Discuss the type of radiation measuring device and measurement of the effluent and how the measurements will be converted to a total quantity (expressed in Curies) and a release rate (Curies per unit time).*
5) *If the applicant chooses to measure at a fence line (or restricted or control area), the applicant should demonstrate how the data from the measurements at a fence line will be extrapolated back to an effluent release point to identify the quantities of the principal radionuclides released to the environment.*

(c) discuss how it will employ this method to demonstrate compliance during operations, including if it intends to differentiate the radon concentration from the plant and the radon concentration from background.

(d) evaluate and provide a description of the member(s) of the public likely to receive the highest exposures from licensed operations consistent with 10 CFR 20.1302.

RAI-74(a)(1) Response

~~AUC recognizes that the methodologies and supporting regulations to factor radon progeny into analyzing potential public dose from operations are currently under evaluation and development. Therefore, rather than rely on current methods and regulations AUC commits to discuss and identify with NRC how AUC will factor radon (radon-222) progeny into analyzing potential public dose from operations consistent with 10 CFR part 20, Appendix B, Table 2 based on the updated methodologies and regulations at the time AUC performs such activity. AUC will provide to the NRC staff, for review and written verification, written procedures for its airborne effluent and environmental monitoring program no later than 30 days before the preoperational inspection.~~

To determine compliance with 10 CFR 20.1301 and 10 CFR 20.1302, AUC will use the 10 CFR 20 Appendix B, Table 2 air concentration limit for Radon-222 with daughters present.

RAI-74(a)(2) Response

The following text has been added to TR Section 5.7.1 identify how radon (radon-222) progeny will be factored into analyzing potential public dose from operations:

"10 CFR 20.1302 requires demonstration by measurement or calculation that the total effective dose equivalent to the individual likely to receive the highest dose from the licensed operation does not exceed the annual dose limit. A dose assessment using a combination of measured and calculated values will be employed by AUC to show compliance with this regulation.

Radtrak monitoring devices will be operated near the locations of the maximally exposed member(s) of the public. (Please see AUC's response to Item (d), below, for information concerning AUC's method of identification of the most highly exposed member of the public.) Annual average radon concentrations as measured by these Radtrak devices will be employed in the annual dose calculations required by 10 CFR 20.1302. The dose limit, radon progeny included, requires measurement of a very small difference between natural background concentration and any excess concentration associated with AUC facility releases. Radon background values, determined using data from AUC air sampler station AM#6 (see TR Figure 2.9-1) will be subtracted from other measured values before determining annual dose to individual(s). Unless this background correction is applied, natural variations in ambient radon concentrations could lead, in error, to reported doses in excess of the public dose limit. The locations of the most-highly-exposed individuals, per current MILDOS calculations using site meteorological data, are also noted in the Reno Creek application Technical Report's MILDOS assessment, Addendum 7-A to the current TR revision.

Radon released from the AUC Central Processing Plant (CPP) and active production areas will be associated with very low relative air concentrations of radon progeny immediately after its release as a gas. (See inset discussion under "Back-calculating radon releases from production units" within AUC's response to NRC Item (b), below.) Background radon, most of which is released from natural soils at relatively large distances from the AUC facility, results in decay products on the AUC site which have had greater time periods to grow toward equilibrium than AUC-released radon decay products. Therefore, background radon progeny will generally be at much higher equilibrium ratios than AUC release-related progeny. Dose calculated using these higher equilibrium fractions would be much higher than dose calculated with the actual equilibrium fractions associated with radon released at the AUC facilities. Therefore, AUC will not assume that its operations-associated radon progeny are in equilibrium with radon at the locations where dose is to be calculated.

However, the actual equilibrium ratio associated with the CPP releases cannot readily be measured in the field at the low radon progeny concentrations required to show compliance with the public dose limits. Even if such measurements were feasible, an unknown and potentially large fraction of the result would be associated with background radon progeny, for the reasons just discussed. It is not possible to separate the two values based on field measurements. A value measured using the modified Kusnetz method would be intermediate between the two, leading to calculation of a dose that may be significantly higher than that associated with AUC's operations.

Therefore, the MILDOS computer code will be used by AUC to calculate the AUC-release-associated radon/progeny equilibrium fractions at the Radtrak monitors and at other locations as required. This combination of measured concentrations and calculated equilibrium ratios defines the most accurate method to determine radon and progeny dose in unrestricted areas.

MILDOS is an appropriate system to use to determine facility-specific equilibrium fractions, given site-specific meteorological data. (Please see the inset discussion, “Comparison of Predicted Rn Concentrations to Measured Rn Concentrations”, found in AUC’s responses to Item b), below, for a summary of measurement data useful in evaluating MILDOS utility in the prediction of radon concentrations in air.) The MILDOS code is currently being revised to add user options and more efficient input of parameters. That version has not yet been released, but the MILDOS methodology used to calculate radon decay product equilibrium fractions has remained the same since its initial development.

The project manager for the MILDOS revision recently confirmed by telephone with AUC consultant staff that, through Version 3.10 of MILDOS, released in February 2012, concentrations of radon decay products and the subsequent working levels are based on calculations described in NUREG/CR-0553, also known as the Uranium Dispersion and Dosimetry Code (UDAD).

In short, the ingrowth of radon decay products is dependent on the radioactive half-lives and the transit time from the release point to the modeled receptor location. As given in the UDAD report eq. 3.2, the concentration of radon daughters is given by:

$$\chi_n(r) = \chi_1(r)\left(\prod_{i=2}^{n} \frac{0.693}{T_i}\right)\left\{\sum_{i=1}^{n}\left[\frac{\exp\ (-0.693\ r/T_i u)}{\prod\limits_{\substack{j=1\\ j\neq i}}^{n} 0.693\left(\frac{1}{T_j}-\frac{1}{T_i}\right)}\right]\right\}$$

for n= 2-7; i is the ith radionuclide in the table below.

Radionuclide	Decay type	Half-life	n	E_n (MeV)	L_n x 10^6 (WL/pCi/m^3)
Rn-222	Alpha	3.8 days	1	5.49	-----
Po-218	Alpha	3.05 min	2	6.00	1.03
Pb-214	Beta	26.8 min	3	-----	5.07
Bi-214	Beta	19.7 min	4	-----	3.73
Po-214	Alpha	10^{-6} min		7.68	Negligible
Pb-210	Beta	22 yrs	5	-----	-----
Bi-210	Beta	5 days	6	-----	-----
Po-210	Alpha	143 days	7	5.31	-----

The Working Level is defined as any combination of short-lived radon daughters in one liter of air that will result in the ultimate emission of 1.3 x 10^5 MeV of alpha energy. Working levels in UDAD eq. 3.3 are determined by:

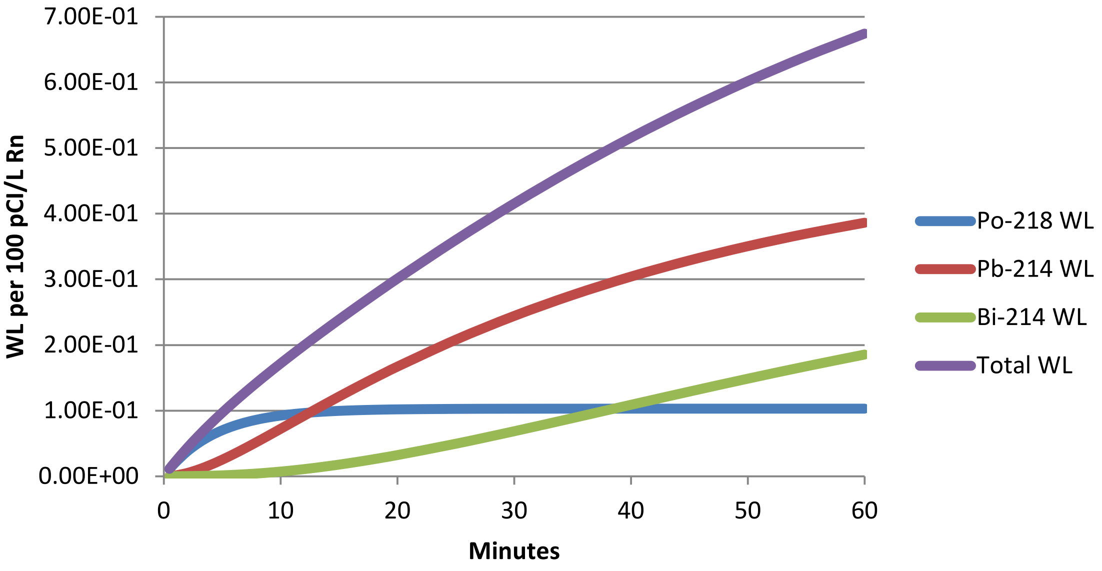
$$WL(r,\theta) = \sum_{n=2}^{4} L_n \chi_n(r,\theta)$$

where X_n is the nth radon daughter concentration calculated by eq. 3.2 and L_n is the working level conversion factor for radon daughter n, given by:

$$L_n = \frac{2.846 \times 10^{-10}}{\lambda_n} \sum_{j=n}^{4} E_n(\alpha) \quad \frac{WL}{pCi/m^3}$$

and $E_n(\alpha)$ is the potential alpha energy for the nth radon daughter as shown in the table above.

Example results are shown in the figure below.



The annual average time of flight of the radon from its release point to a modeled receptor is calculated by MILDOS from annual meteorological data input by the user. Within 60 minutes of the release of radon gas, the total working level reaches nearly 70% of the equilibrium value. For the AUC facility and its average wind speeds, a packet of radon released from either the CPP or any of the proposed production areas would reach the site boundary and nearest residents within average times much shorter than this, indicating that equilibrium fractions much less than unity are appropriate for the facility's dose calculations.

Method Summary:

Because:

1) Radon-associated calculated dose is largely a function of the radon progeny ingrowth fraction.
2) An attempt to directly measure the equilibrium ratio in an environment heavily influenced by natural background values will lead to incorrect results, and
3) Use of an equilibrium ratio approaching unity leads to dose determinations that may be significantly higher than reality

AUC will use MILDOS to calculate source-weighted (see below), location-specific equilibrium fraction(s) for the most-highly-exposed member(s) of the public.

This methodology uses MILDOS to apply site-derived meteorological data and the known radon source locations (the CPP and the currently active production areas), to calculate the sum of the source-specific radon concentrations at each target location. This approach represents an appropriate methodology, since an ISR's radon source term typically arises at widely-separated locations on a site. A single-source estimate (or single-location measurement, if it were useable) of equilibrium fraction is not representative. AUC will determine the equilibrium fraction directly from the MILDOS output.

Dose is not based on MILDOS calculations of radon concentrations using this approach: Radtrak units, operated in accordance with AUC and Landauer protocols to optimize sensitivity and accuracy (see the discussion "Enhanced Radtrak Accuracy" below) provide actual radon concentration data for the dose calculations.

This approach was discussed in some detail in a presentation by Dr. H.R. Meyer at a recent conference in Corpus Christi, Texas. That presentation is being transmitted with this RAI response package as Appendix E.

Using the Radtrak-measured radon concentration, and the MILDOS-calculated, source-weighted equilibrium fractions, doses will be calculated annually for the individual(s) determined to be the most highly exposed member(s) of the public. Occupancy factors will be taken into account for these calculations."

RAI-74(b)(1) Response

~~AUC recognizes that the methodologies and supporting regulations for determining the quantity of the principal radionuclides from all point and diffuse sources will be accounted for are currently under evaluation and development. Therefore rather than rely on current methods and regulations AUC commits to discuss and identify with NRC how AUC will determine the quantity of the principal radionuclides from all point and diffuse sources will be accounted for, and verified by, surveys and/or monitoring based on the updated methodologies and regulations. AUC will provide to the NRC staff, for review and written verification, written procedures for its airborne effluent and environmental monitoring program no later than 30 days before the preoperational inspection to show compliance with 10 CFR 40.65.~~

The following text has been added to TR Section 5.7.7.2 to identify all potential air and gaseous effluent release points for radon:

"AUC expects radon-222 (radon) to be the primary radioactive airborne effluent to be released from the Central Processing Plant (CPP). The Reno Creek CPP will contain columns and tanks that will require venting to atmosphere either in a batch mode or continuously. As discussed in TR Section 4.2, separate, independent ventilation systems consisting of ducting and/or piping attached to the expected points of release will be installed for all indoor, atmospheric, process tanks and vessels where radon could be expected. Additional release points will be in the Production Units. The expected Reno Creek Project processes that may release radon are listed below. In some cases the vented tanks will be connected to the same vent through a manifold.

- Ion exchange columns: The down flow IX columns are under pressure during normal operations. When the resin gets fully loaded, the resin will be transferred from the column to the elution circuit. In order to transfer the resin, the column must be de-pressurized, done by venting the column to atmosphere. All of the columns will be connected to a single vent manifold system.
- The resin will cross a resin shaker for cleaning before entering the elution vessel. Once in the elution vessel the uranium will be stripped from the resin. This part of the process will probably require one vent system. The elution solution is transferred to the precipitation tanks and the stripped resin is returned to an IX column.

- The precipitation tanks will require their own vent system to exhaust CO_2 generated during the precipitation process.
- Processes that use RO permeate to mix chemicals such as the sodium carbonate, sodium chloride and sodium sulfide (for groundwater restoration) make-up tanks will be vented also.
- The waste water and brine tanks will also be vented.
- The precipitated yellow cake will be moved to the filter press and on to the dryer system. Since the uranium will remain wetted until it reaches the vacuum dryer and the dryer system does not produce emissions, no vent monitoring is possible.
- CPP building through the ventilation system.
- Potential radon release points that are distant from the CPP include header houses and well/piping systems within the wellfields."

The following text has been added to TR Section 5.7.7.1 to identify all potential air and gaseous effluent release points for principal particulate radionuclides:

"Potential release points for the principal particulate radionuclides include the following:

- CPP building through the ventilation system.

AUC will quantify the amount of each of the principal radionuclides released to the environment from the CPP and the Production Units as required in 10 CFR 40.65"

RAI-74(b)(2) through (b)(5) Response

AUC has revised the text in TR Section 4.2.2 Reporting Effluent Releases to incorporate the following discussion:

"Emissions of Radon from the General Central Processing Plant Area

Regulatory Guide 8.37, Section C.3.1 states that, when practical, releases of airborne radioactive effluents should be from monitored release points (e.g., monitored stacks, discharges, vents) to ensure that the magnitude of such effluents is known with a sufficient degree of confidence to estimate public exposure. The flow rate(s) from fan(s) is one of several parameters that can be used to calculate and compute potential releases of radioactive material, including radon.

Radon releases resulting from the presence of radon within the overall CPP volume (not within specific tanks, discussed below) will be determined by measuring the average radon concentration within the building, and multiplying that concentration times the building's average exhaust fan flow rate for the six month period of interest. The average radon concentration in the plant will be measured using a Landauer Radtrak integrating radon monitor, employing existing AUC methodologies and recent Landauer modifications to optimize Radtrak sensitivity and accuracy (see "Enhancing Radtrak Accuracy", below). The location of the radon monitor is shown in revised Figure 5-3 provided in response to RAI-45. Figure 5-3, shows the locations of AUC Reno Creek CPP radon and decay product monitors, gamma survey locations, and air particulate sampler locations. The rate of CPP air release from the exhaust fans is determined based on an air balance report to be developed by the system supplier, based on final building design specifications.

The Radtrak device reports average radon concentration in pCi/l. The total activity released can be calculated by multiplying the average concentration in pCi/l by the total air volume exhausted during the six month period, in liters. The result is then divided by 10^{12} pCi/Ci to specify the quantity of radon released during the period, in Curies. AUC will use Radtrak devices to monitor radon concentration, since the devices integrate over the entire period of interest and provide a more accurate measure of released radon than can be provided by the use of active scintillation cells, for example, if used to take occasional radon concentration measurements.

However, and at the direction of the NRC if provided, weekly Lucas cell radon concentration sampling would instead be initially employed by AUC to monitor concentrations in the CPP, rather than Radtrak-based monitoring. After an eventual determination that extended intervals between sampling would be acceptable, in accordance with NRC Regulatory Guide 8.30 and with NRC concurrence, AUC would perform Lucas cell measurements at extended intervals. The average of these radon concentration measurements performed at the specified location (see Figure 5-3) over the six month period, would then be used in place of the average concentration reported by the Radtrak device. Lucas cell measurement is further discussed later in this section. In either case, the six-month-average concentration will be used to specify radon release for the 10CFR40.65 semiannual report, using the ventilation flow rates determined as described in this response.

Exhaust volumes are calculated using exhaust fan flow rates in l/min, multiplied by the number of minutes in a six month period, multiplied by the fraction of the period that the fans were operating. Recording devices will monitor the exhaust fans, providing a record of run time to be used to calculate that fraction. During times when the fans are not operating, an anemometer will be used to measure the exhaust flow. Volumes determined using these flow rates will be added to the release volume calculated for the exhaust fans. In the event that the anemometer is unable to measure the exhaust flow, the manufacturer-specified stall rate (lowest detectable flow rate) of the instrument will be used. The total volume (exhaust fan plus anemometer-monitored volume) will be used to calculate the six-month radon release, in Curies.

Plant Emissions of Radon from Vented Tanks

Releases of radon from vented tanks will be calculated by measuring the concentration of radon being emitted from the exhaust vent, and determining the flow rate of gaseous effluent from the vent. The measured radon concentration in pCi/l, multiplied by the effluent flow rate in l/m, multiplied by the number of minutes during which venting takes place, divided by 10^{12} pCi/Ci, gives the total radon release in Curies for the measured event. Total radon release from vented tanks for the six month 10CFR40.65 reporting period in Curies is calculated by adding the event measurement totals over all measured events that occur during a six month period.

Active scintillation cells (Lucas cells) will be used to measure the concentration of radon within each vent. For continuously vented tanks, concentration measurements will be taken quarterly. For intermittently vented tanks, concentration measurements will be taken at least once per quarter when venting occurs during that quarter, and during the period determined by AUC (see discussion below) to have the highest radon concentrations in effluent gas. For continuously vented tanks, the measured concentrations will be averaged over the six month reporting period to determine the total quantity of radon released from each vent during the period. For intermittently vented tanks, the measured concentration will be multiplied by the total gaseous effluent vented to the outside environment during the specific venting event. This allows calculation of the total quantity of radon released from that vent during that event. Total radon released over a six month period from that vent will be determined by assuming that other, unmonitored venting events (records will be kept by AUC to identify each such event), released the same quantity of radon as the measured quantity for that quarter, or for another representative quarter (a quarter with similar operational status), if monitoring did not occur during the subject quarter. The total quantity of radon released from intermittently vented units is the sum of the radon release quantities, measured and assumed, for the six-month period.

To perform a measurement, the user must actively extract the effluent gas sample from the sampled vent into the Lucas cell. Cells are evacuated using a vacuum pump prior to sampling, in order to draw the gas sample into the cell. Prior to sampling, flow will be drawn through the sampling tube connected to the vent for a period sufficient to ensure that the sample to be taken will be representative of the vent's contents. These periods will be specific to each vent/sampling tube system, and will be determined during final CPP systems design.

Inside the Lucas cell, the extracted volume of radon gas undergoes radioactive decay to its progeny. The decay of radon and its short-lived decay products create alpha particles that strike the scintillator lining of the Lucas cell. These light pulses interact with one or more photomultiplier tubes which convert the light pulses to electrons and greatly amplify the resulting electric current. An electronic pulse counting device records the total number of the resulting electronic pulses. There is a relationship between the number of pulses counted and the activity of the radon gas in the cell; the Lucas cell system can thus provide a measurement of the activity, in pCi, of the radon gas that was drawn into the cell. The relationship between the counts recorded by the system and the activity of the radon sample is determined when the Lucas cell system is sent to a vendor laboratory, for calibration in accordance with NIST methodology.

After sampling a vent and performing the Lucas cell analysis at the AUC facility, the radon activity measurement in pCi is divided by the Lucas cell volume in liters, resulting in a measured radon concentration in pCi/l. This activity is divided by 10^{12} to convert to Ci/l, and the result is multiplied by the average flow rate for the quarter sampled, a flow rate determined by AUC for the specific sampled vent, to calculate the quantity of radon released for the quarter, in Ci. Over the six month 10CFR40.65 reporting period, the totals, all sampling events, all vents, are added together to determine the quantity of radon released, in Curies, for the period. During periods when certain vents are not open to the outdoor environment, AUC will assume that no radon is released from such vents.

The use of scintillation cells to characterize radon concentrations is an approved method, as outlined in Method 115 from 40 CFR 61 Appendix B. While the method describes the use of scintillation cells for underground mining and tailing piles, it can be applied to this application. The use of Radtrak integrating detectors is an accepted monitoring method, used by NRC licensees for the monitoring of radon in the environment to determine radon-related radiation dose to members of the general public. AUC notes that Radtrak use within the CPP to determine average radon concentrations for the purposes of 10CFR40.65 reporting is similar, and therefore appropriate.

As noted, measurements of radon from tank vents will be performed at least once per quarter. Samples will be taken during periods with the highest predicted concentrations.

Highest predicted concentrations will be assumed to occur when all tanks connected to a vent manifold are open for ventilation. To test this latter assumption, multiple measurements during the first two quarters of CPP operation will be made, until AUC determines the period of highest concentration. After significant changes in systems potentially affecting tank venting or flow rate, measurements will be performed to re-validate the determined periods of highest radon concentration.

Reporting Total Released Radon

As noted, radon released quantities from the two sets of sources noted above (general CPP radon emissions, and vented tank radon emissions) will be added together and the resulting total, in Curies, will be reported semiannually per 10 CFR 40.65 requirements. Effluent releases will be compared to design objectives. Results that are significantly above design objectives will be addressed in the semi-annual effluent report.

General Plant Emissions - Particulate Radionuclides

The design basis of the AUC CPP facility includes systems that prevent particulate radionuclide release. A combination of closed circuit vacuum dryer technology, and process wetting where the potential for exposed solid process material exists, will be used by AUC to ensure that airborne particulate radioactive materials will not be present within the plant or emitted from the facility. No vented tank particulate emissions are anticipated.

Nonetheless, AUC will monitor the CPP area for particulate airborne radioactive material, and will report the results of that monitoring, converted to totals of released principal particulate radionuclides, per 10CFR40.65 requirements.

AUC will use methodology similar to that described above within the section *Emissions of Radon from the General Central Processing Plant Area*, substituting measured concentrations of airborne particulate radionuclides for measured concentrations of radon gas in the calculations. Airborne particulate sampling will be continuous, using a pump drawing air through a 47 mm glass fiber filter located near the center of the CPP building (see Figure 5-3). This will provide a representative measure of average airborne concentration in the plant.

The filters will be exchanged weekly to prevent excessive dust loading, and the six-month collection (26 filters) will be analyzed as a single sample by a qualified laboratory. The laboratory will report the total activity in pCi, for uranium, Th-230, Ra-226 and Pb-210. A record of the total operating time for the air filter pump (calibrated annually or per the manufacturer's specification) will be maintained. The laboratory-reported activity for each radionuclide will be divided by the total air flow volume that passed through the filters. The results represent the average CPP air concentration for each radionuclide during the six-month measurement period. The concentrations, in pCi/l, will be multiplied by the total facility air flow (determined in the same manner as for the radon calculations discussed in *Emissions of Radon from the General Central Processing Plant Area,* above) in liters. The result, pCi of each nuclide released from the CPP during the six month period, will be divided by 10^{12} pCi/l to produce a six-month release value, in Curies, for each principal particulate radionuclide. These data will be reported in the six month 10CFR40.65 report to the NRC. Exceedance of AUC's design basis for particulate radionuclide release will be addressed in the report.

Monitoring Production Unit area Releases Outline

During the period that a production unit (containing header houses and well fields) is operating or undergoing groundwater restoration, potential exists for emissions of radon. No particulate principal radionuclides will be released from operations within the production units. Given the very large number of potential radon release points in these areas, most of which have no air flow systems allowing measurement of radon quantity released, an alternative method must be applied to meet 10CFR40.65 semiannual "quantities released" reporting requirements for the production units. To meet these reporting requirements, AUC will monitor radon releases via a system employing sets of 8 Radtrak high-sensitivity monitors uniformly located around the fenced boundaries. Updated measured radon background data, and the MILDOS code, will be applied to these radon concentration data to determine the radon quantity in Curies released from the subject production unit.

Method Details

10CFR40.65 specifies that a licensee authorized to possess and use source material in uranium milling must submit a report within 60 days after January 1 and July 1 each year, specifying the quantity of each of the principal radionuclides released to unrestricted areas in liquid and in gaseous effluents during the previous six months of operation. AUC's report will based on the differences between monitored background radon concentrations, measured at the background monitoring station identified in AUC's associated RAI-20 response as AM#6-2 (see Figure 5-3, attached), and radon concentrations measured by the production unit's perimeter Radtrak monitors. Subtraction of offsite, background concentrations of radon is appropriate because 10CFR40.65 requires specification of the quantity of radionuclide actually released by AUC's operations, not total radon measured in the environment.

As noted, there is no single potential radon release point associated with AUC production units. Instead, potential releases are spread over a large production area which includes header houses, well fields and other systems. It is not technically feasible to monitor most of these potential release points, and monitoring of "smaller potential releases" is neither justified by risk to the public, nor required by 10CFR40.65 which specifically allows estimation of smaller releases. Rather than attempting to monitor a few release points and extrapolate to total released quantities, AUC instead will monitor the total amount of radon released to the unrestricted environment from a production unit, using the methodology described here.

AUC will use Radtrak radon monitoring devices to measure the actual concentrations of radon in the vicinity of this large set of potential release points. These measurements will take place relatively close to the release points, ensuring that the measured radon concentrations will be higher than facility-related radon concentrations near distant members of the public potentially exposed to the releases.

Other radon monitoring points, located near the most-highly-exposed members of the public, and part of the pre-operational/operational environmental air monitoring system, will also use Radtrak devices to monitor for above-background radon levels associated with facility releases. Those measurements, described later in this response, will be used to determine dose to the public, per 10CFR20 requirements and using MILDOS calculations of radon decay progeny concentrations at the calculated dose locations.

Enhancing Radtrak Accuracy

Specification of production area radon release quantities per 10CFR40.65 requirements depends on confidence in the accuracy of Radtrak detectors in AUC's perimeter monitoring ring. AUC employs methods to enhance Landauer's Radtrak integrating radon monitor device accuracy. AUC will employ additional enhancements, recently implemented by Landauer, in future radon monitoring as noted below, to optimize sensitivity and accuracy of the Radtrak monitoring system.

A number of Radtrak system improvements, many of which have already been implemented by AUC, will be applied to the Reno Creek project monitoring program:

- AUC will deploy only Landauer high-sensitivity Radtrak environmental radon monitors. These detectors utilize the same polymer detector elements employed for lower-sensitivity measurements usually performed in areas where radon concentrations are expected to be relatively high. However, the high-sensitivity units are read by Landauer using larger fields of view, increasing the number of tracks counted and improving overall sensitivity. This approach reduces the likelihood of significant measurement error.
- At a recent USNRC workshop held in Bethesda, Landauer staff stated that past problems noted in reported radon concentrations using Radtrak devices may have been related to seal leakage in the radon-proof bags used to store and ship unexposed Radtrak detectors. AUC will employ Radtrak detectors packaged according to Landauer's resulting, recently revised sealing process. This process includes vacuum packaging, such that seal leakage can be easily observed as expanded storage bags, at the point of customer deployment or when Landauer retrieves stored background samples. This process will reduce measurement errors associated with radon tracks inadvertently accumulated during storage/shipment.
- Several years ago, AUC staff noticed an anomalous reading in a data set returned by Landauer for Radtraks deployed at pre-operational Reno Creek air sampling stations. The anomaly involved a negative result (a less-than-zero radon concentration indicated within the data details).

  AUC's discussions with Landauer staff determined that, on occasion, routine subtraction of Landauer's unexposed, background radon detector data could lead to such a reading. Further discussion identified the potential source of the problem; the polymer detector element is subject to surface defect variability from supplier batch to batch. The number of such defects that, after etching, presents as alpha tracks and is thus counted as radon decay progeny alpha particle interactions is small. But, that small number can be relatively large when compared to the small number of actual alpha particle tracks seen in detectors returned from onsite monitoring stations with very low environmental radon concentrations. This is because of the very low radon concentrations often found in AUC's Wyoming pre-operational atmospheric environment.

  When Landauer's stored, unexposed background detector results are subtracted from field samples exposed at low environmental concentrations, the unexposed detectors' count total may exceed the totals from the field sample, leading to negative results. Conversely and more important, an unusually low surface defect rate on a stored background sample, subtracted from a field sample's results, may lead to an incorrect, high reported radon concentration. At the allowable public dose limits specified in 10CFR20, a small error in net counts can lead to an apparent public dose limit violation.

Compounding the problem was the background sample protocol in use by Landauer, involving the averaging of results from the unexposed, background detectors across several batches of the sensitive polymer. An unusually high rate of surface imperfections in one of these batches, when averaged with other unexposed detector data, could increase the likelihood that the subtracted, background values could exceed the total count seen on a field detector exposed to very low radon concentrations. And again, conversely, an unusually low batch could reduce the average background value to be subtracted enough to bias, in error, the field detector's reported result significantly high, leading to regulatory compliance issues.

To resolve this problem, Landauer agreed to compare AUC's field-exposed detectors only to unexposed, background detectors from the same polymer batch. This reduces the likelihood of errors resulting in either high or low radon concentration reported results, for AUC's field measurements. Subtracted background data are now from the same polymer batch.

- At the noted USNRC Bethesda conference covering Radtrak radon monitoring, Landauer staff presented data showing that reported results at very low radon concentrations, such as those often found at the Reno Creek site, are extremely sensitive to very small changes in Radtrak detector measured alpha tracks. This is because only a few net alpha tracks are actually seen on a detector at these very low environmental radon concentrations. It is therefore possible that either measurement or statistical errors could lead to an incorrect reporting of 10CFR20-defined public dose exceedances at the AUC facility. This is because of the very low facility-related radon (progeny) concentration increase that can signal such an exceedance. Therefore, AUC will employ additional methods to reduce the likelihood of such errors. These are discussed in the next bullets.
    - To maximize Radtrak detector sensitivity while conforming to 10CFR40.65 semiannual reporting requirements, AUC will deploy Radtrak devices for six month periods, rather than the usual three-month exposure protocol. This doubles the average number of alpha-particle-related tracks seen on

field-exposed detectors, without necessarily increasing the number of surface-defect-related counts seen on the Landauer-stored, unexposed detectors used for background subtraction. The result is significantly increased sensitivity.

- To conform to 10CFR40.65 requirements to summarize the program quarterly, two sets of Radtrak detectors will be deployed at each operational monitoring location. One of these two sets will be exchanged every three months to meet this separate, summarization requirement, but each set will have been deployed for six months prior to its exchange. This AUC protocol thus provides maximized detector sensitivity while meeting 10CFR40.65 requirements.

- Because a single, statistical or actual, measurement error at a nearest-resident monitoring location could lead to an apparent public dose exceedance, AUC will increase the number of detectors deployed at critical locations around the site. Sets of three high-sensitivity Radtrak monitors will be deployed at maximally-exposed-individual (nearest resident) location(s). Sets of three Radtrak monitors will also be placed at the site's background location (location AM 6-2 as noted in the revised AUC Technical Report). RSO-directed data evaluation and statistical analysis, including the option to exclude a detector exhibiting outlier reported values, will be used to determine the most-valid average concentration for each of these locations. The use of at least three Radtrak detectors at critical locations reduces the likelihood that an individual outlier value will lead to a reported public dose exceedance.

Note: AUC will continue to observe progress made by Landauer and others in the use of Radtrak devices to monitor for very low concentrations of radon. AUC will also continue to work with Landauer to modify protocols as necessary to continue to improve radon monitoring using these devices. AUC is confident that the protocols it currently employs, supplemented by improvements as noted above, will result in accurate Radtrak measurements.

Back-Calculating Radon Releases from Production Units

Given accurate measurement of radon concentrations during a six-month period for which radon release rates are to be reported per 10CFR40.65, the Radtrak-measured data will be used to specify the quantity of radon, in Curies, released from a production unit. The methodology to be used to meet this requirement is described below.

First, to determine the perimeter radon concentrations associated with AUC's releases in a production unit, radon background concentrations, as measured at AM#6-2 during the six month period of interest, will be subtracted from each of the eight perimeter monitor's results. This is because only radon actually released within the production unit is to be reported, for 10CFR40.65 purposes. Net negative values, likely to occur at the very low environmental radon concentrations expected for radon releases from an ISR wellfield, will be treated as real numbers for this purpose, since rounding such values up to zero concentration would result in an overestimate of production unit radon releases.

The following (inset) data discussion, developed from publicly-available records from the Cotter former uranium mill and included tailings area, is inserted here to demonstrate the use of MILDOS to predict radon concentrations at monitoring stations on the perimeter of the relatively small Cotter mill/tailings site. It also shows that reported AUC wellfield radon concentrations are likely to be very low, since concentrations associated with a large uranium tailings impoundment source term are net negative 50% of the time, per this data set (see column "Net", below).

Comparison of Predicted Rn Concentrations to Measured Rn Concentrations

There are two approaches to comparing Rn concentrations at boundary locations, predicted using the MILDOS model, to Rn concentrations measured at those same locations. Both approaches involve calculating ratio of the measured value vs. the predicted value (M/P). An M/P ratio of 1.0 indicates that the model perfectly predicts the measured value. An M/P ratio of 10 indicates that the model greatly underestimates the measured value.

MILDOS does not consider background concentrations. So, to create an M/P ratio, measured values include environmental background radon concentrations, which must be subtracted from the measurements to estimate the influence of the site. This might be called the "net" approach, where both the measurement and the prediction are net of background.

Given the small concentrations of environmental radon actually associated with an ISR site's wellfield radon releases, and the ubiquitous presence of radon at significant concentrations in the natural environment, this "net" approach may result in negative net measured values. MILDOS predictions are always positive, non-zero values; using net values often results in negative M/P ratios, as shown in the table below, using 2013 data from the Cotter uranium milling facility.

Location	**M/P ratio for Rn-222**	
	Net	**Gross**
AS-202	1.75	1.10E+00
AS-203	1.74	1.08E+00
AS-204	3.07	1.26E+00
AS-206	-0.78	9.27E-01
AS-209	-0.56	6.43E-01
Shadow Hills Estates	3.19	1.11E+00
Nearest resident	-4.20	6.61E-01
Oro Verde #3	-11.79	7.87E-01
Lincoln Park #2	4.87	1.13E+00
Mean	-0.30	9.66E-01

Given the dominance of background, the "gross" approach in which background is not subtracted from the measured values and is added onto each MILDOS prediction, yields more useable results in terms of establishing MILDOS predictive accuracy, as shown above. For each modeled location, background radon concentration, measured distant from the Cotter site, was added to the MILDOS prediction. Measured values were not corrected for background. Hence, the calculated M/P ratios do a better job of illustrating the influence of background and the relatively small importance of the site's Rn contribution. On the whole, for the locations shown, the M/P ratio is 0.966. These results indicate that even for the large, exposed radon tailings area at the Cotter former uranium mill site, with some radon monitoring locations very close to the tailings, radon at the site boundary is not significantly in excess of background.

(Reference: Dr. Craig Little, Technical Memorandum: Responses to Sept 11, 2014 letter to Jim Cain from Colorado Department of Public Health and environment. October 23, 2014.)

Next, given net radon concentration results for the 8 wellfield perimeter monitoring locations, MILDOS will be run, initially using a unit release rate (Curies/unit time), to establish relative calculated concentrations at the 8 locations. The release rate will then be adjusted to produce a "best fit" set of concentrations, calculated by MILDOS, for the 8 monitor locations. "Best fit" will be defined as being achieved when the calculated concentration set's average value is within 5% of the measured average net value from the perimeter Radtrak detectors.

Current onsite meteorological station data will be employed for these MILDOS back-calculations: The radon monitoring six-month period being analyzed will determine the six-month period selected to extract meteorological data to be utilized for these MILDOS runs.

MILDOS uses meteorological data via conversion to a "STAR" set: The STAR data array FREQ is used to provide the average fractional occurrence frequency of wind speed, wind direction and atmospheric stability. Data is supplied for the sixteen wind, six wind speed ranges, and six Pasquill atmospheric stability categories. Average morning (DMM) and afternoon (DMA) mixing heights are provided. Note that no meteorological data dates or date ranges are input; a six-month data summary is useable for MILDOS calculations.

Once the best fit MILDOS input parameter set has been determined, the resulting adjusted input value (radon release rate in Curies per unit time) will be multiplied by the release period to specify the total six-month release. The quantity of radon released will be specified, in Curies, based on monitoring data, and will be reported in the semiannual 10CFR40.65 report. Any exceedance of AUC's design objectives will be specifically noted within the report."

RAI-74(c) Response

~~AUC recognizes that methodologies to demonstrate compliance during operations are currently evolving, and therefore commits to provide to the NRC, no later than 30 days before the preoperational inspection, for review and written verification, written procedures to demonstrate use of the selected methodology to demonstrate compliance. Note that AUC does intend to differentiate the radon concentration from the plant vs. the radon concentration from background, when demonstrating compliance.~~

AUC plans to differentiate the radon concentration from the plant vs. background when determining dose for the most highly exposed member of the public, as discussed in this RAI-74 response, Item (a2), above. AUC also plans to correct for background radon concentrations when specifying radon releases from production areas, as discussed in this RAI-74 response, Item (b), above.

Per the methodology described in Item a2 of this RAI-74 response, above, AUC will demonstrate compliance with the 10 CFR 20.1302 public dose limit via radon concentration measurements, combined with MILDOS calculations of the location-specific equilibrium fractions. Please refer to Item (a2), above, for additional discussion.

AUC will comply with the semiannual principal radionuclide release reporting requirements of 10 CFR 40.65 using the methodology described in Item (b) of this RAI-74 response. The methodology uses measurements and gaseous effluent release data to specify radon and particulate radionuclide releases, and a combination of measurements and MILDOS site-specific calculations to specify radon releases from active production areas. Please refer to Item (b), above, for additional discussion.

RAI-74(d) Response

~~The MILDOS code was used to identify members of the public most likely to receive the highest dose from radon and progeny associated with AUC's Reno Creek facility during operations. Best estimates of radon source terms from the CPP and wellfield operations have been used to identify these individuals. The most recent input data sets and MILDOS output, plus a discussion of the methodology, are presented in the Technical Report, Addendum 7-A. Rather than repeat portions of that MILDOS study here, the reader is referred to that section of the Technical Report for a complete discussion.~~

The MILDOS code is used to identify members of the public most likely to receive the highest dose from radon and progeny associated with AUC's Reno Creek facility during operations. Best estimates of radon source terms from the CPP and wellfield operations have been used to identify these individuals prior to operations. The most recent input data sets and MILDOS output, plus a discussion of the methodology, are presented in the Technical Report, Addendum 7-A. Rather than repeat portions of that MILDOS study here, the reviewer is referred to that section of the revised AUC Technical Report to review identification of the most highly exposed individual(s).

Please also see AUC's response to *NRC Information Request a2*, above, for additional information concerning identification of the most highly exposed individuals during facility operations.

Please also see AUC's response to the NRC RAI-20, contained within this overall response package. The RAI-20 response provides a map of proposed operational air sampling stations, including monitors for air particulate, radon and gamma radiation. Monitoring station AM#8 is placed close to the nearest ranch building, determined via the MILDOS output noted above to be the location of the most highly exposed individual(s) during much of the facility operational period.

In addition, during facility operations and using MILDOS with then-current data, AUC will re-evaluate the location(s) of the most highly exposed members of the public at least annually. The first such re-evaluation will occur during the first three months of facility operation, to take into account updated meteorological and monitoring data. If an individual other than the above-identified ranch house resident is determined during such re-evaluation to potentially be the most highly exposed individual, dose calculations will be performed using conservative input. Immediate NRC notification will be performed if an exceedance of the 10CFR20.1302 public dose limit is indicated, and actions to reduce dose to ALARA levels will be immediately initiated.

7 ADMINISTRATIVE

RAI ADMIN-1

Several references in the application have clerical and other errors and omissions (for specific references, see "RAI" heading below).

Staff is required to verify that information presented in an application is accurate and complete in order to derive a finding of reasonable assurance in the safety evaluation.

Citations in the SRP guiding staff's review of references include the following:

- *In Section 2.1.4, "review and to verify the general aspects of the submitted materials … [r]eferences are cited appropriately";*
- *In Section 2.2.2, "Data sources should be referenced";*
- *In Section 2.6.2, "to determine if [the discussion of regional geology and stratigraphy] is adequately referenced"; and*
- *In Section 2.7.3, "methods or standards used to analyze pumping test data should be described and referenced".*

The above guidance is provided to ensure the applicant provides a clear demonstration how requirements and objectives in 10 CFR Part 40 Appendix A are met pursuant to 10 CFR 40.31(h).

Please revise or clarify the source for the following references in the application:

- *The reference to Hotchkiss and Levings (1986) on page 2.7-20, 2.7-23, the applicant uses an incorrect date of 1985 and on figures in Addendum 2.7B, the applicant uses an incorrect date of 1983.*
- *Please include references for the source of information in the first two paragraphs of Section 2.6.1.1 (page 2.6-2)*
- *Please correct the reference to (Sharp et al., 1964) on Page 2.6-3 in the reference list. If the authors are listed correctly in the reference list, then the date of the document is listed incorrectly.*
- *Please confirm that reference to (Feathers, 1981) on page 2.7-20 is correct (at the minimum should be (Feathers et al., 1981).*
- *On page 3-3, please verify that the page (i.e., p.3-29) referenced to the GEIS is correct.*

ADMIN-1 Response

AUC has made the following revisions in the application:

(a) The Hotchkiss and Levings reference has been revised to reflect the correct date (Hotchkiss and Levings, 1986) in the following locations:

- TR Sec. 2.7.2.1 on pages 2.7-20 and 2.7-23;
- TR Addendum 2.7-B on figures 2.7B-2 through 2.7B-5; and
- ER Sec. 3.4.2.1 on pages 3.4-21 and 3.4-23.

(b) The correct reference of (Sharp, et. al., 1964), has been added to each of the first two paragraphs in both TR Sec. 2.6.1.1 and ER Sec. 3.3.1.1;

(c) The reference list at the conclusion of TR Sec. 2.6 and ER Sec. 10 (References) have both been revised to reflect the correct reference and now read:

“Sharp, et. al., 1964, *Geology and Uranium Deposits of the Pumpkin Buttes Area…*”;

(d) The 21 references in both TR Sec 2.7 and ER Sec. 3.4 have all been revised to reflect the correct reference. Each of them now reads:

“… (Feathers, et. al., 1981).”

(e) The reference on TR page 3-3 has been revised to reflect the correct reference to the GEIS and now reads:

“Based on AUC analysis and a review of the ISR GEIS, Sec. 3.3 (NRC 2009), the Proposed Action’s ore body closely resembles the rollfront deposits assessed previously by NRC in the Wyoming East Region, which includes the Proposed Project area, as well as those in all of the other ISR GEIS regional analyses.”

RAI ADMIN-2

On the bottom of page 2.6-2, please clarify how the outcrop geologic mapping supports this statement: "The Tullock Member of the Fort Union marks the first evidence of basin downwarp and synorogenic filling (outcrop geology shown on Figure 2.6A-1)."

ADMIN-2 Response

In clarification of TR RAI ADMIN-3, the last sentence was referring only to where outcrop geology of the Tullock is depicted on Figure 2.6A-1. Outcrop mapping was not meant as supporting the evidence of structural downwarp. Wording proposed to clarify the last sentence of the last paragraph on page 2.6-2 as shown below:

"Following a long period of stability during the Mesozoic, tectonic forces of late Paleocene to early Eocene ushered in mountain building events related to the Laramide orogeny. Uplift began to affect the western continental margin and modify the landscape of central and eastern Wyoming (Seeland, 1988). As a result of these tectonic forces, the PRB was the site of active subsidence surrounded by orogenic uplifts (Big Horn Mountains, Laramie Mountains, Black Hills, etc). The Tullock Member of the Fort Union marks the first evidence of basin downwarp and synorogenic filling. Outcrop geology of formations represented in the Pumpkin Buttes Uranium District of the PRB is shown on Figure 2.6A-1)."

RAI ADMIN-3

In paragraph 1 in Section 2.6.2.1 (page 2.6-5), please clarify how Figure 2.6A-2 confirms the northwesterly dip at the proposed project area.

ADMIN-3 Response

AUC has revised Section 2.6.2.1 to clarify the northwesterly dip at the proposed project area as shown below:

"The Proposed Project area lies within a portion of the PRB that has a regional dip to the southwest at approximately 100 feet per mile based on structure contour mapping on the top of the Fox Hills Sandstone (Figure 2.6A-2). The Fox Hills Sandstone lies at a depth of approximately 6,500 feet in the Proposed Project Area. However, based on AUC's mapping (Figure 2.6A-6) using historic and recent geophysical and lithologic logs covering the Proposed Project area, the mineralized host sandstone exhibits a dip ranging from 35 to 60 feet per mile to the northwest."

RAI ADMIN-4

Page number for Tables in Section 2.5 should include the prefix "2.5"

ADMIN-4 Response

AUC has revised the Table of Contents for TR Sec. 2.5 to include the correct prefix '2.5' for page numbers for all listings. It is anticipated that many of the Tables of Contents will be updated for the final application based on RAI revisions.

RAI ADMIN-5

The first paragraph in Section 2.7.1.1 (page 2.7-1) ends with the following two sentences: "All drainages within the Proposed Project area are ephemeral in nature. However, CBM wells contribute co-produced water to these drainages." Please clarify these statements. Does the CBM contribution make the streams perennial?

ADMIN-5 Response

AUC has revised the last two sentences of the first paragraph of TR Sec. 2.7.1.1 and ER Sec. 3.4.1.1 to clarify the effects of produced water on the ephemeral nature of streams within the project area as shown below:

"All drainages within the Proposed Project area are ephemeral in nature. Historically, CBM wells contributed co-produced water to these drainages; however, all CBM activity within and adjacent to the project area has ceased and is not anticipated to resume. If CBM activity was to resume, CBM co-produced water would not change the ephemeral nature of the project's drainages."

RAI ADMIN-6

The first paragraph in Section 2.7.1.2 (page 2.7.-3) states that all streams within the two-mile buffer have a Classification of 3B and references the GEIS. This statement is incorrect. The Upper Belle Fourche River has a Classification of 2ABww. Furthermore, the proper reference should be to the State of Wyoming and not the GEIS.

ADMIN-6 Response

The classification of 3B is correct for all streams within the project area and two mile review area. As presented in Figure TR 2.7A-1, the drainages found within the Proposed Project Area and two mile review area include:

- Belle Fourche Drainage / Upper Belle Fourche / Mud Spring Creek /All Night Creek (3B)
- Cheyenne River Drainage / Antelope Creek / Lower Antelope Creek / Upper Porcupine Creek (3B)
- Cheyenne River Drainage / Antelope Creek / Lower Antelope Creek / Spring Creek (3B)
- Cheyenne River Drainage / Antelope Creek / Upper Antelope Creek / Little Bates Creek (3B)
- Cheyenne River Drainage / Antelope Creek / Upper Antelope Creek / Upper Bates Creek (3B)

The reference found in TR Section 2.7.1.1 has been changed from the GEIS to:

"WDEQ, Water Quality Division, Surface Water Standards, Wyoming Surface Water Classification List, Updated July 26, 2013"

The list can be found at the following location:

http://deq.state.wy.us/wqd/watershed/surfacestandards/Downloads/Standards/Wyoming_Surface_Water_Classification_List_07262013.pdf

RAI ADMIN-7

The second sentence in the first paragraph under Heading Caballo Creek starts with the phrase "Caballo Creek is". To avoid confusion, the phrase should be "The Caballo Creek gaging station is".

ADMIN-7 Response

AUC has revised the second sentence of the first paragraph in the Caballo Creek heading in TR Sec. 2.7.1.2 and ER Sec. 3.4.1.2 which now reads:

"The Caballo Creek gaging station is located northeast of the Proposed Project boundary, and is 0.9 miles to the northwest of the confluence with the Belle Fourche River as shown on Figure 2.7A-2 in TR Addendum 2.7-A."

RAI ADMIN-8

The first sentence in the first paragraph under Heading Coal Creek contains several grammatical errors.

ADMIN-8 Response

AUC has revised the first sentence of the first paragraph in the Coal Creek heading in TR Sec. 2.7.1.2 and ER Sec. 3.4.1.2 which now reads:

"The Coal Creek gaging station near Piney is located 24.4 miles northeast of the Proposed Project boundary and 2.1 miles south of the confluence with the Belle Fourche River."

RAI ADMIN-9

The second sentence in the first paragraph in Section 2.7.1.3 (page 2.7.-5) begins with the phrase "According to NUREG-1910". While correct, the placement of the sentences in that paragraph suggests that NUREG-1910 specifically discusses drainages within the proposed project, which is incorrect. NUREG-1910 contains generic information on the various districts. It is incumbent upon an applicant to describe the site conditions based on site-specific information and then to conclude that it is consistent or not consistent with the generic information in NUREG-1910.

ADMIN-9 Response

AUC has revised the first paragraph of TR Sec. 2.7.1.3 and ER Sec. 3.4.1.3 which now reads:

"All drainages in the Proposed Project area are ephemeral in nature. The predominant source of surface water is from summer thunderstorms and spring snowmelt. When there is flow in channels it occurs for a very short duration and is directly related to these surface runoffs as a result of the local precipitation events. This is consistent with the findings in NUREG-1910 (GEIS Sec. 3.3.4.1). The watershed hydrology within the Proposed Project area includes man-made reservoirs or stock ponds and WYPDES discharge sites from CBM de-watering activities. There are two watersheds within the Proposed Project boundary; the Upper Belle Fourche Basin and the Antelope Creek Basin."

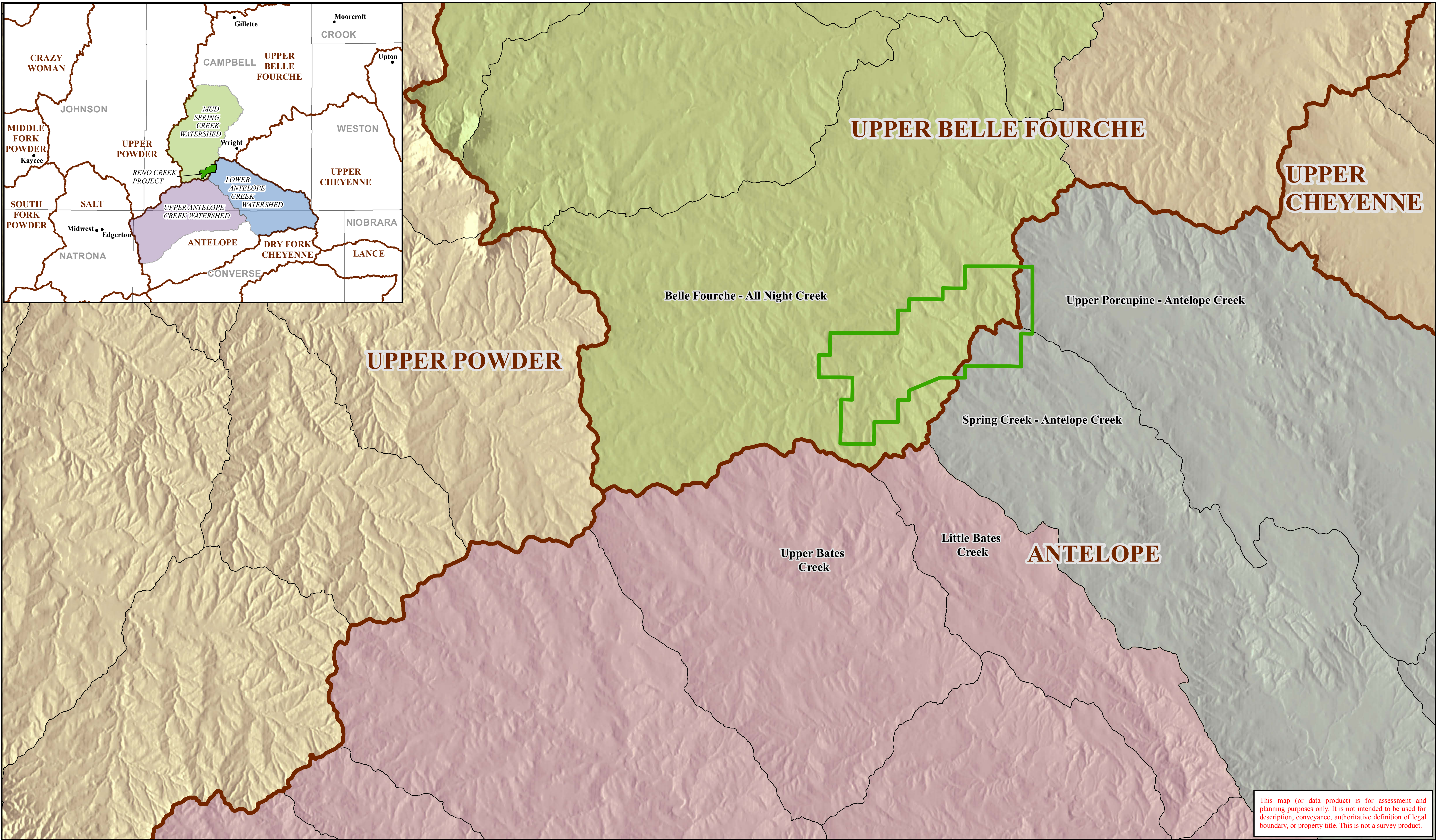
RAI ADMIN-10

Under the Upper Belle Fourche Basin heading (page 2.7-5), the application describes Mud Spring Creek watershed. However, the Mud Spring Creek Watershed and its sub-watersheds are not clearly delineated on any figure.

ADMIN-10 Response

AUC has revised Figure 2.7A-1 to clearly delineate the Mud Spring Creek and Lower Antelope Creek watersheds and their subwatersheds. A figure reference has been added to page 2.7-5, section 2.7.1.3 "Drainage Basin Description" shown below:

"There are two watersheds within the Proposed Project Boundary; the Upper Belle Fourche Basin and the Antelope Creek Basin as shown in Figure 2.7A-1 in TR Addendum 2.7-A."



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

AUC LLC
LAKEWOOD, CO

PROPOSED RENO CREEK PROJECT
CAMPBELL COUNTY, WY

TREC, Inc.
Engineering & Environmental Management

900 Werner Court
Suite 150
Casper, WY 82601
Phone (307) 265-0696
Fax (307) 265-2498
www.treccorp.com

Legend

- 🟩 Proposed Reno Creek Project Boundary
- 🟫 Drainage Basin (HUC 8)
- ◯ Minor Basins (HUC 12)
- 🟩 Mud Spring Creek Watershed
- 🟦 Lower Antelope Creek Watershed
- 🟪 Upper Antelope Creek Watershed

1:125,000

0 0.5 1 2 3 4 Miles

N W E S

DRAWN BY: RHK

CHECKED BY: RMD

APPROVED BY: JEY

Drainages

REV #	DESCRIPTION	BY	DATE	FIGURE
0	Draft for Review	RHK	09/24/11	2.7A-1
1	Final	RHK	10/21/11	
2				

Path: O:\WY_Projects\2010-100_AUC_Reno_Creek\Project_MXD\Submittal\RAI_NRC_r1\Drainages.mxd

RAI ADMIN-11

In the first paragraph under Section 2.7.1.4, the application states "...were determined by the NRC Regulatory Guide 3.8". By using the passive tense, one could infer that the runoff for the site was determined by the regulatory guide. The reference should state that the analysis by the applicant was consistent with methods in the regulatory guide.

ADMIN-11 Response

AUC has revised the first paragraph in TR Sec. 2.7.1.4 and ER Sec. 3.4.1.4 which now reads:

"The total project is approximately 6,057 acres and is comprised of 29 watershed basins, either in whole or partial. For design purposes however, 37 watersheds were analyzed which includes areas upstream from the Proposed Project boundary. These were included to determine the most realistic runoff from the site. The design basis was developed using methods consistent with NRC Regulatory Guide 3.8 and WDEQ Guideline 8- Hydrology Coal and Non-coal."

RAI ADMIN-12

In the first paragraph under Section 2.7.1.4.1 (page 2.7-6), the application states that the "HEC-HMS is also listed as an approved program in both NUREG-1623 and WDEQ guidelines." NUREG-1623 discusses only HEC-1 and HEC-2 programs.

ADMIN-12 Response

The commenter is correct in NUREG-1623 does not list HEC-HMS as an approved program. HEC-HMS and HEC-RAS are the next generation successor of the HEC-1 and HEC-2 programs thus the appropriate application to use for this study. AUC has revised the first paragraph of TR Sec. 2.7.1.4.1 and ER Sec. 3.4.1.4.1. The sentence now reads:

"HEC-HMS is listed as an approved program in WDEQ guidelines."

RAI ADMIN-13

The first sentence in the first paragraph under Section 2.7.1.5 contains grammatical errors.

ADMIN-13 Response

AUC has revised the first sentence in the first paragraph of TR Sec. 2.7.1.5 and ER Sec. 3.4.1.5 which now reads:

"Flood frequency is analyzed to determine the potential impact of flooding within the Proposed Project area from adjacent rivers and creeks."

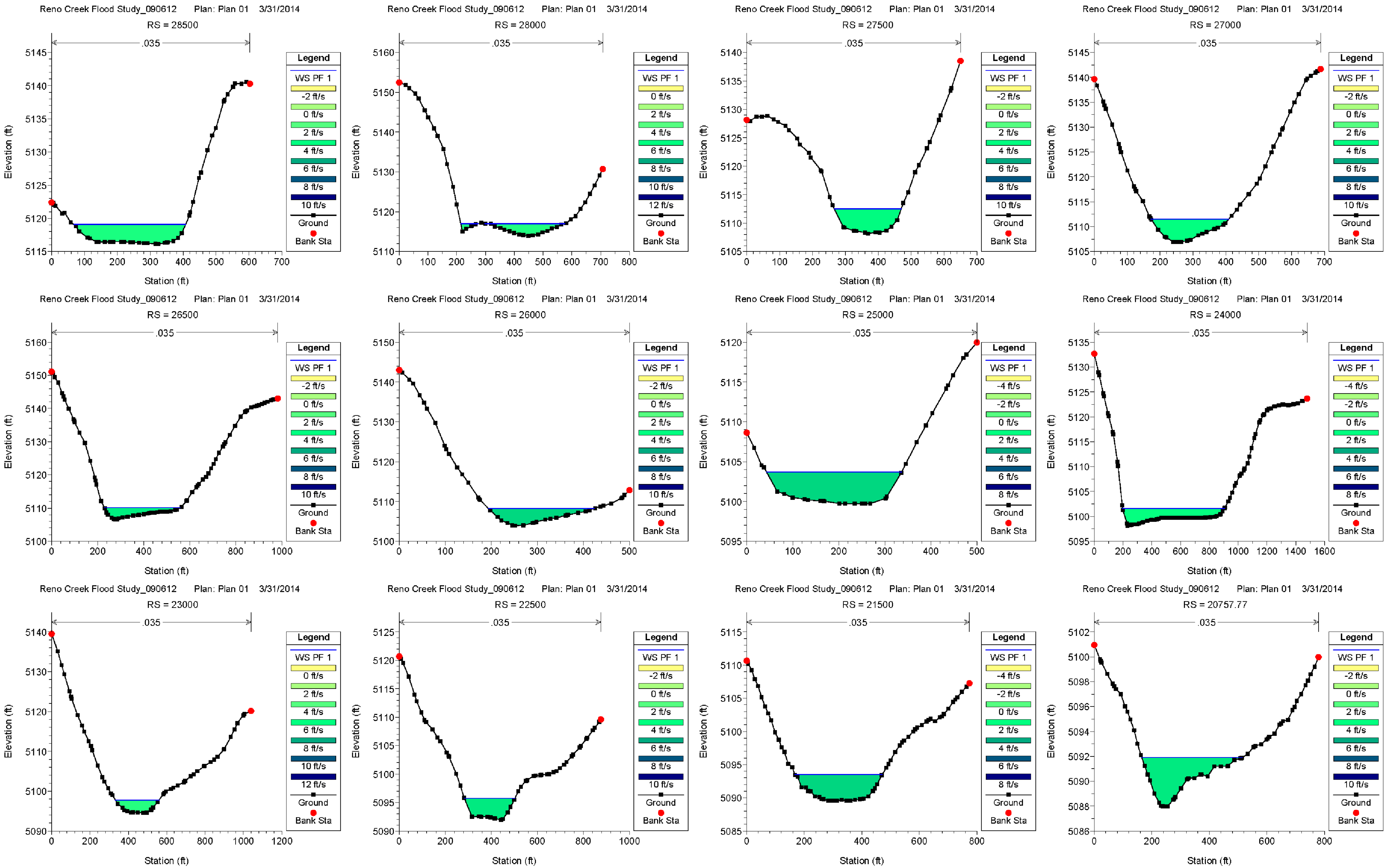
RAI ADMIN-14

The last sentence in the first paragraph under Section 2.7.1.5.2 states "Figure 2.7A-5 provides cross-section views for each of the 49 cross-sections"; however, Figure 2.7A-5 includes only 12 cross-sections. Furthermore, locations of the 49 cross-sections are not depicted on any figure.

ADMIN-14 Response

The missing cross-sections have been added to TR Addendum 2.7-A as Figures 2.7A-5a through 2.7A-5d. In addition, AUC has revised the first paragraph in TR Sec. 2.7.1.5.2 and ER Sec. 3.4.1.5.2 to ensure correct references to these additional figures. Both paragraphs now read:

"HEC-RAS results are presented in TR Addendum 2.7-A. Flow depths generally range from three feet deep in the wide floodplain sections and five feet deep in the narrow floodplain sections. Table 2.7A-10 provides detailed tabulation of results for each of the Belle Fourche floodplain cross-sections, including interpolated cross-sections. Figures 2.7A-5a through 2.7A-5d provide cross-section views for each of the 49 cross-sections (non-interpolated) to illustrate section geometry and flow depth."



PREPARED FOR

AUC LLC
LAKEWOOD, CO

PROPOSED RENO CREEK PROJECT
CAMPBELL COUNTY, WY

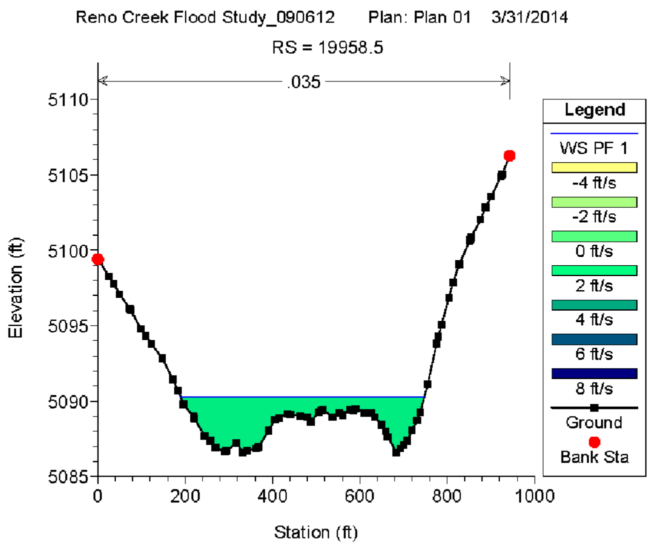
TREC, Inc.
Engineering & Environmental Management
900 Werner Court
Suite 150
Casper, WY 82601
Phone (307) 265-0696
Fax (307) 265-2498
www.treccorp.com

DRAWN BY: MAM
CHECKED BY: RHK
APPROVED BY: JEY

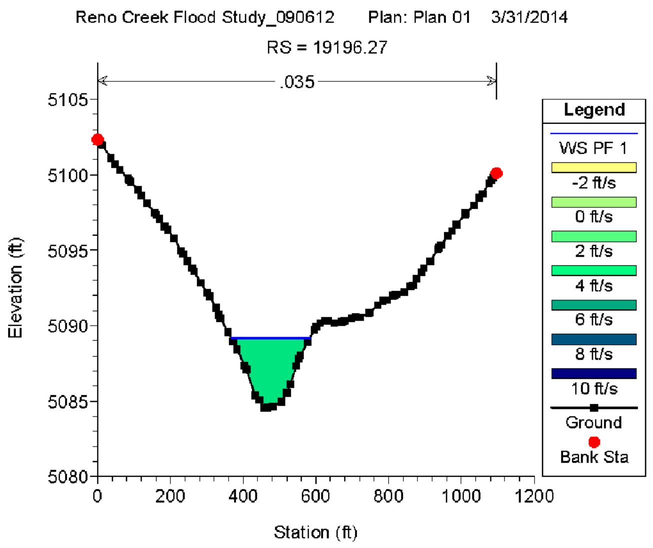
HEC-RAS Cross Sections

REV #	DESCRIPTION	BY	DATE	FIGURE
0	Draft for Review	MAM	12/14/2011	2.7A-5a
1	Final	MAM	01/24/2012	
2				

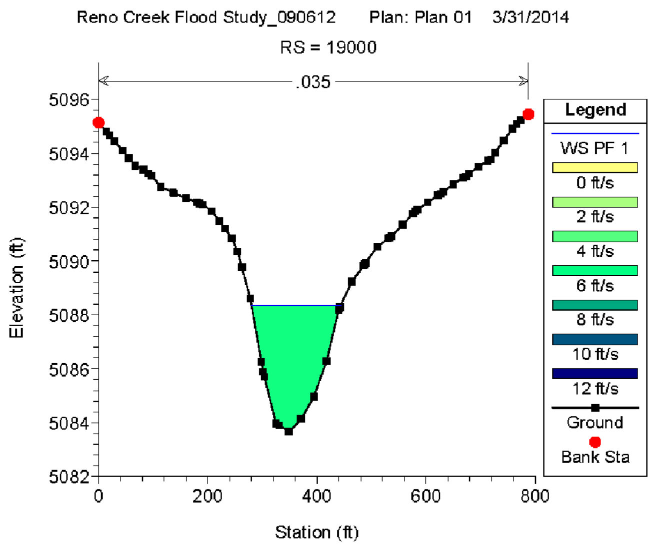
Path: O:\WY_Projects\2010-100_AUC_Reno_Creek\Project_MXD\Submittal\RAI_NRC_r1\HEC-RAS_2.7A-5a.mxd


Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014

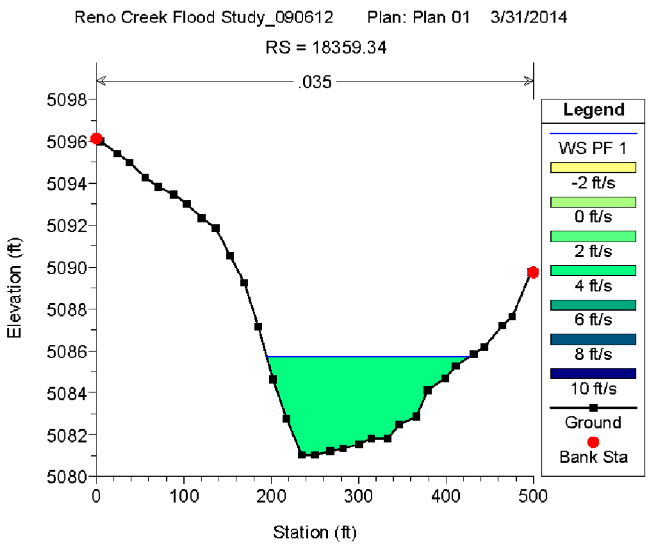
RS = 19958.5


Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014

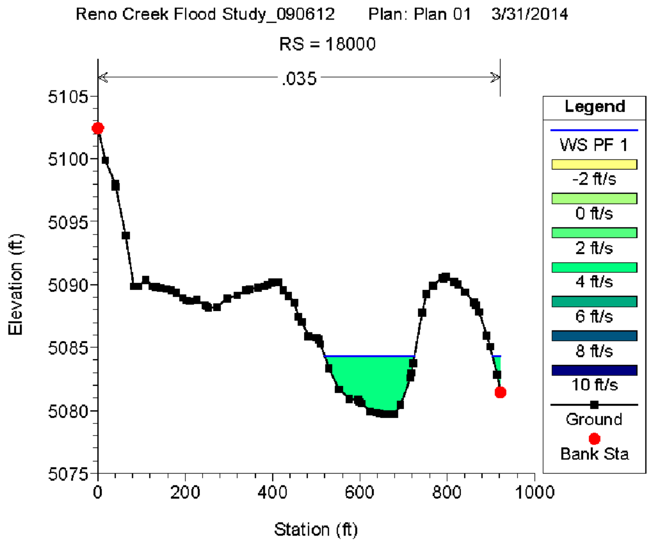
RS = 19196.27


Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014

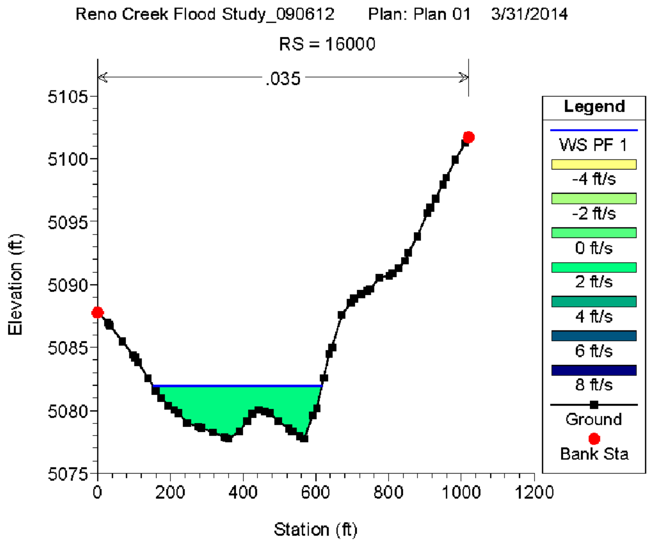
RS = 19000


Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014

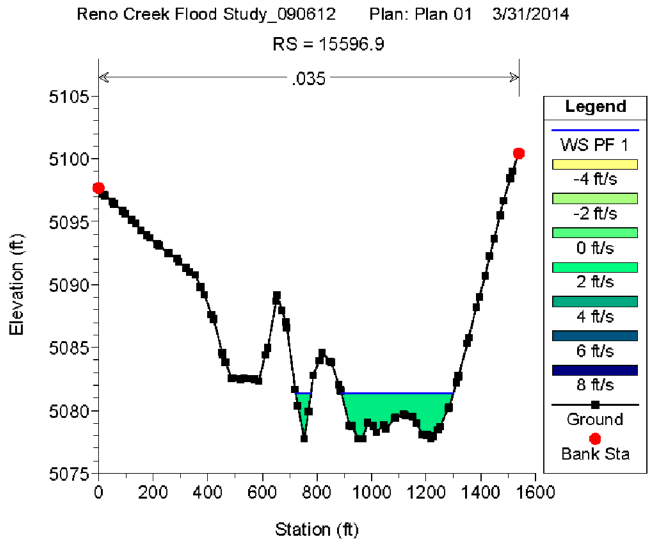
RS = 18359.34


Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014

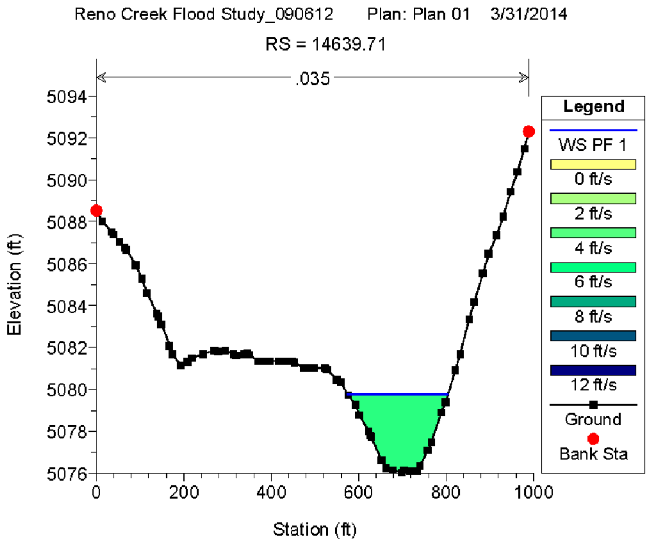
RS = 18000


Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014

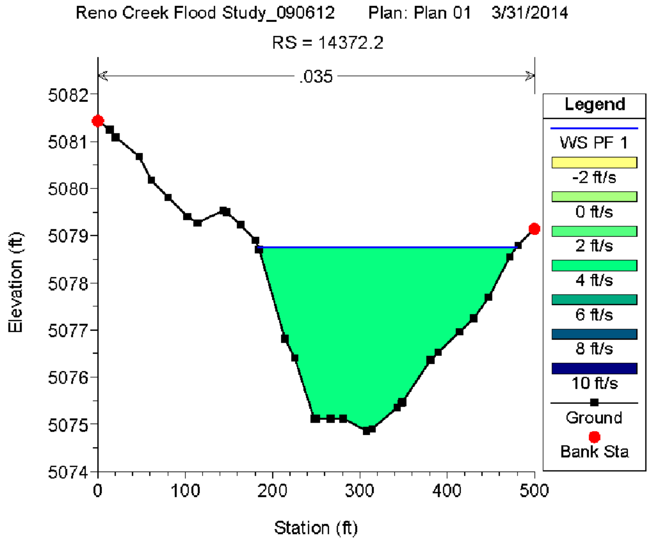
RS = 16000


Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014

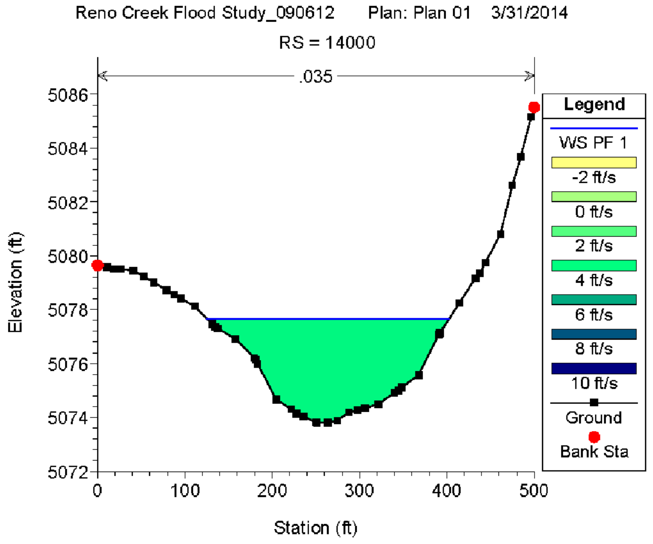
RS = 15596.9


Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014

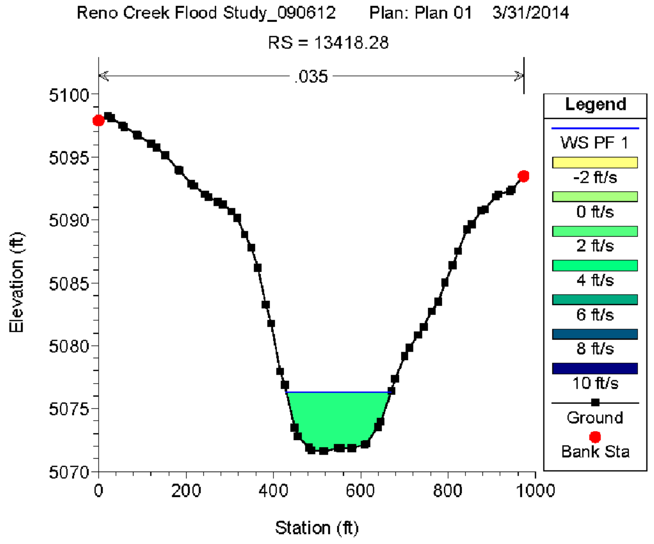
RS = 14639.71


Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014

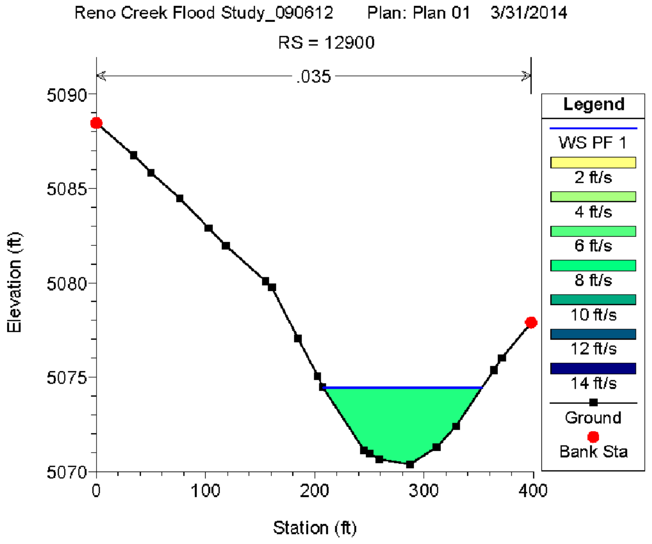
RS = 14372.2


Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014

RS = 14000


Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014

RS = 13418.28


Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014

RS = 12900

PREPARED FOR

AUC LLC
LAKEWOOD, CO

PROPOSED RENO CREEK PROJECT
CAMPBELL COUNTY, WY

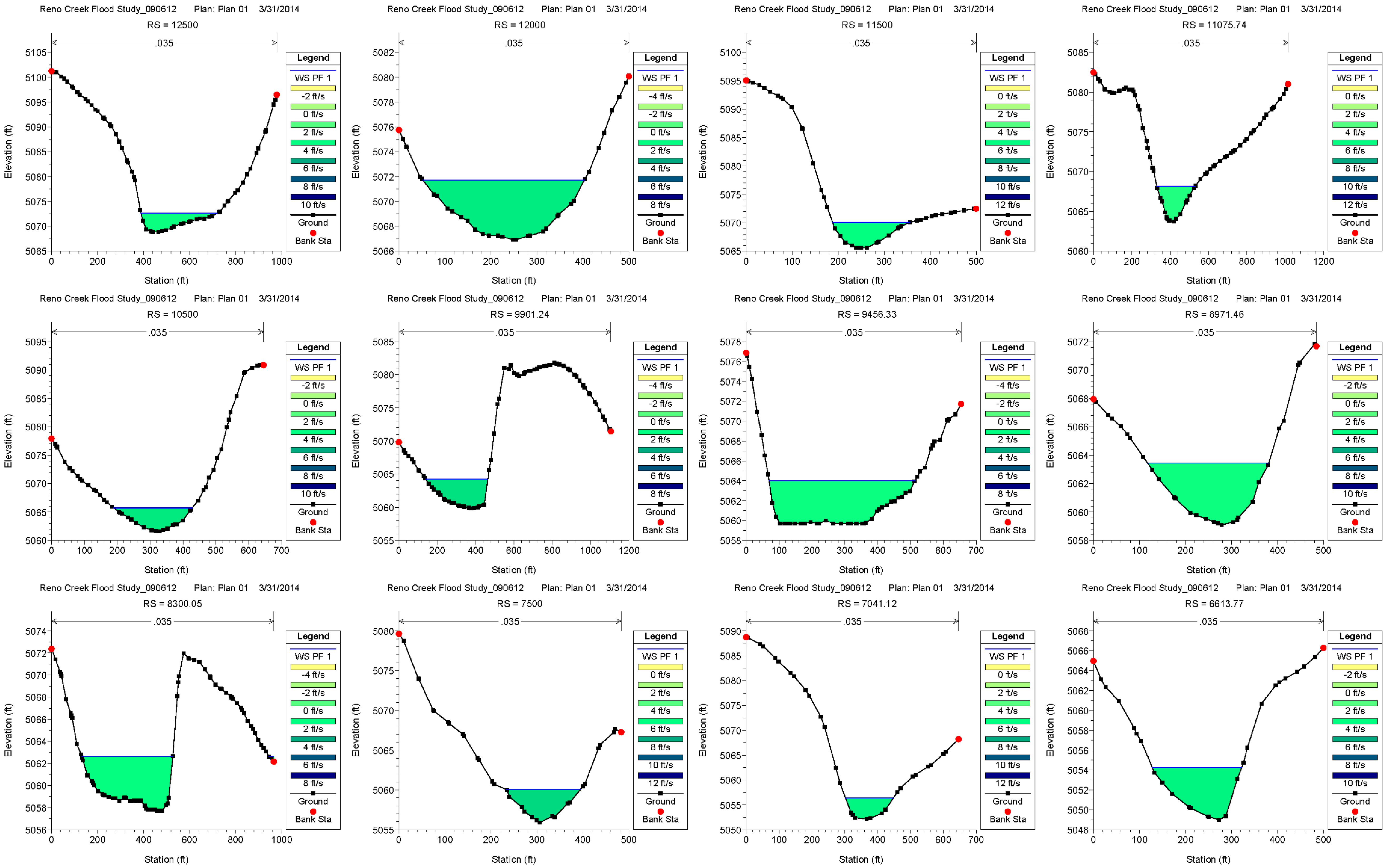
TREC, Inc.
Engineering & Environmental Management
900 Werner Court
Suite 150
Casper, WY 82601
Phone (307) 265-0696
Fax (307) 265-2498
www.treccorp.com

DRAWN BY: MAM
CHECKED BY: RHK
APPROVED BY: JEY

HEC-RAS Cross Sections

REV #	DESCRIPTION	BY	DATE	FIGURE
0	Draft for Review	MAM	12/14/2011	2.7A-5b
1	Final	MAM	01/24/2012	
2				

Path: O:\WY_Projects\2010-100_AUC_Reno_Creek\Project_MXD\Submittal\RAI_NRC_r1\HEC-RAS_2.7A-5b.mxd


Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014 RS = 12500

Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014 RS = 12000

Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014 RS = 11500

Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014 RS = 11075.74

Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014 RS = 10500

Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014 RS = 9901.24

Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014 RS = 9456.33

Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014 RS = 8971.46

Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014 RS = 8300.05

Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014 RS = 7500

Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014 RS = 7041.12

Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014 RS = 6613.77

PREPARED FOR

AUC LLC
LAKEWOOD, CO

PROPOSED RENO CREEK PROJECT
CAMPBELL COUNTY, WY

TREC, Inc.
Engineering & Environmental Management

900 Werner Court
Suite 150
Casper, WY 82601
Phone (307) 265-0696
Fax (307) 265-2498
www.treccorp.com

DRAWN BY: MAM

CHECKED BY: RHK

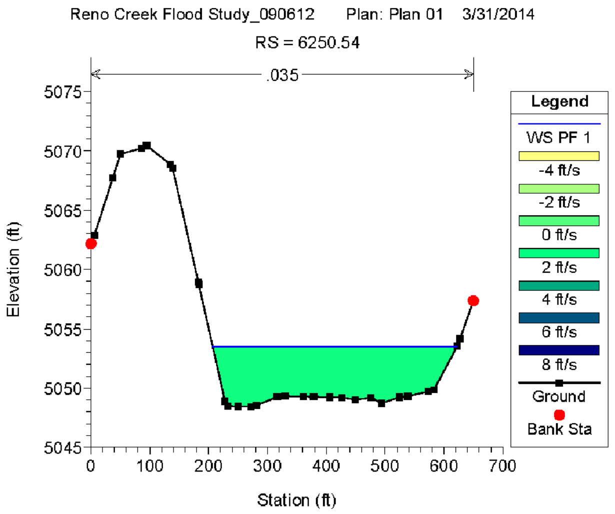
APPROVED BY: JEY

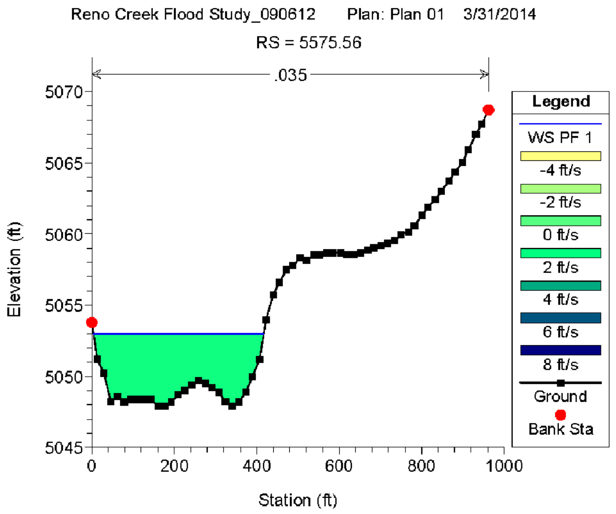
HEC-RAS Cross Sections

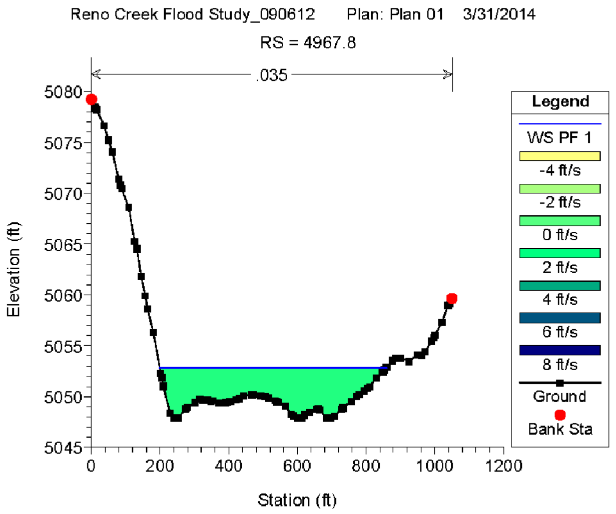
REV #	DESCRIPTION	BY	DATE
0	Draft for Review	MAM	12/14/2011
1	Final	MAM	01/24/2012
2			

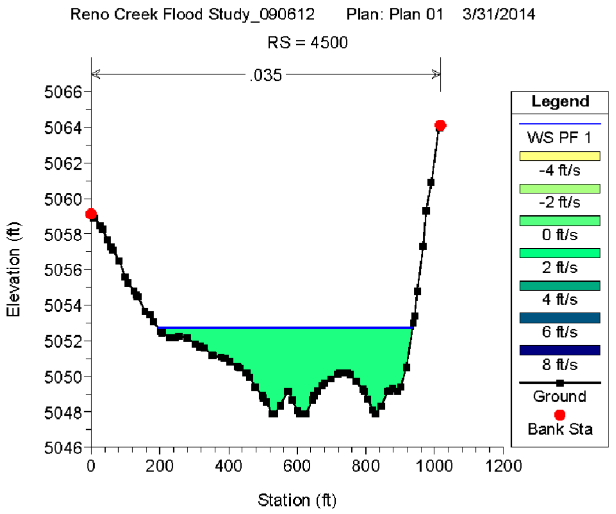
FIGURE 2.7A-5c

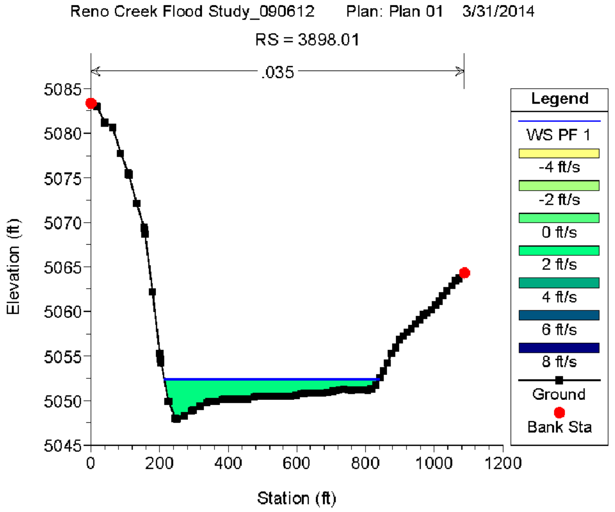
Path: O:\WY_Projects\2010-100_AUC_Reno_Creek\Project_MXD\Submittal\RAI_NRC_r1\HEC-RAS_2.7A-5c.mxd

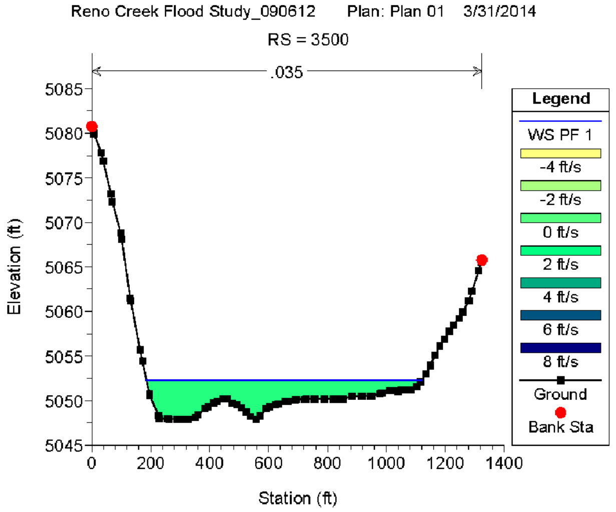

Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014
RS = 6250.54

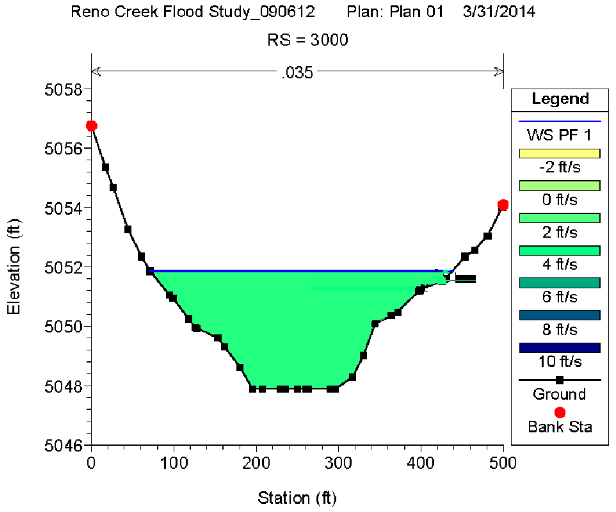

Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014
RS = 5575.56

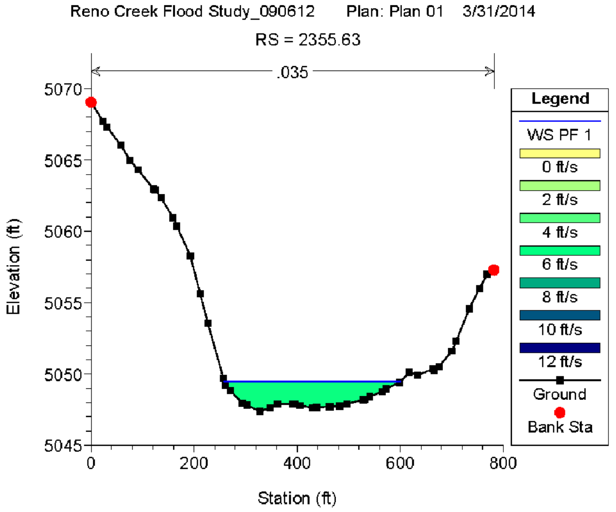

Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014
RS = 4967.8

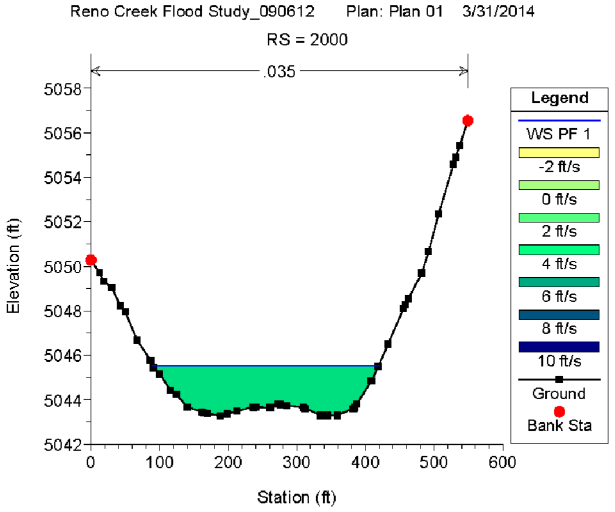

Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014
RS = 4500

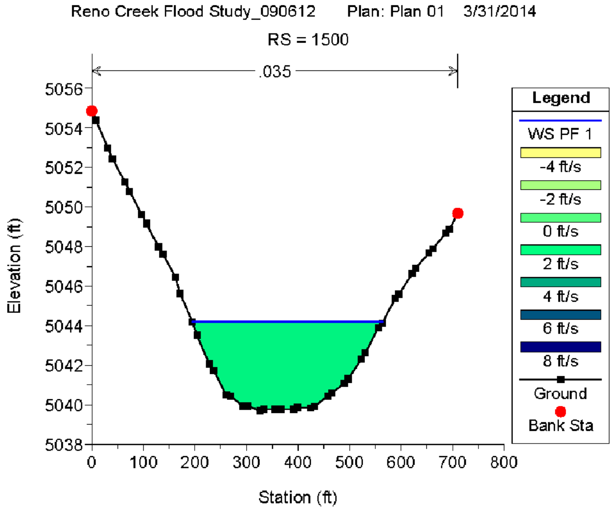

Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014
RS = 3898.01

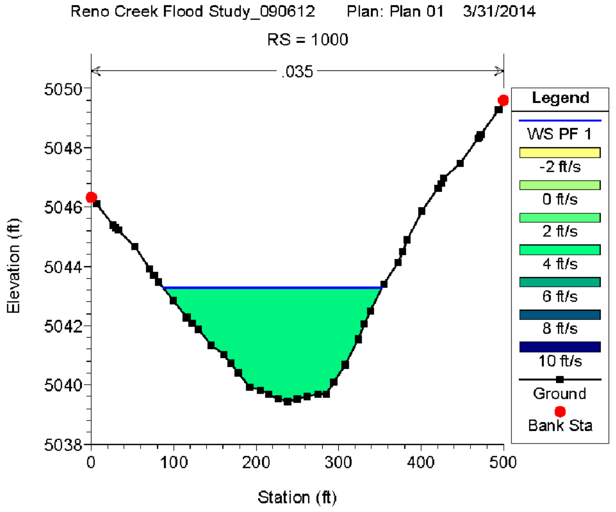

Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014
RS = 3500

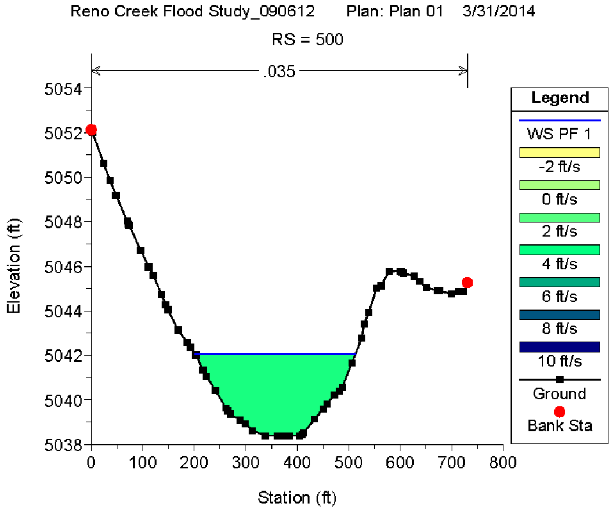

Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014
RS = 3000

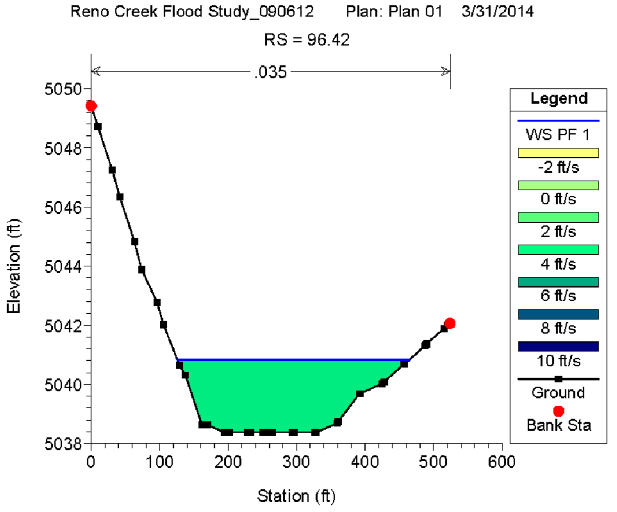

Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014
RS = 2355.63


Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014
RS = 2000


Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014
RS = 1500


Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014
RS = 1000


Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014
RS = 500


Reno Creek Flood Study_090612 Plan: Plan 01 3/31/2014
RS = 96.42

PREPARED FOR
AUC LLC
LAKEWOOD, CO

PROPOSED RENO CREEK PROJECT
CAMPBELL COUNTY, WY

TREC, Inc.
Engineering & Environmental Management
900 Werner Court
Suite 150
Casper, WY 82601
Phone (307) 265-0696
Fax (307) 265-2498
www.treccorp.com

DRAWN BY: MAM
CHECKED BY: RHK
APPROVED BY: JEY

HEC-RAS Cross Sections

REV #	DESCRIPTION	BY	DATE
0	Draft for Review	MAM	12/14/2011
1	Final	MAM	01/24/2012
2			

FIGURE
2.7A-5d

Path: O:\WY_Projects\2010-100_AUC_Reno_Creek\Project_MXD\Submittal\RAI_NRC_r1\HEC-RAS_2.7A-5d.mxd

RAI ADMIN-15

The first paragraph under Section 2.7.1.7 references Figure 2.7A-7 to depict small water bodies within the Project Area. The scale on Figure 2.7A-7 is too small to delineate the water bodies. Do the water bodies depicted on Figure 2.7A-9 represent all those in the Project Area?

ADMIN-15 Response

The surface water features presented in Figure 2.7A-9 are the same as shown in Figure 2.7A-7. The surface water features displayed in the map are part of the National Hydrography Dataset (NHD) based on USGS Digital Line Graph (DGL) hydrography data, integrated with reach-related information from the U.S. EPA Reach File 3.0 (RF3).

All surface waters, including those shown in figures 2.7A-7 and 2.7A-9, are ephemeral in nature and are only present during high precipitation events or due to surface discharge (e.g. stock wells).

RAI ADMIN-16

In the second paragraph on Page 2.7-15, the application states that the "permits can be found"; however, the phrase should state "pertinent information for the permits can be found".

ADMIN-16 Response

AUC has revised the second paragraph on page 2.7-15 of TR Sec. 2.7.1.9.2 and on page 3.4-15 of ER Sec. 3.4.1.9.2 which now reads:

"There are 63 Wyoming Pollutant Discharge Elimination System (WYPDES) permits within two miles of the Proposed Project area (Figure 2.7A-7). Nine of these permits are located within the Proposed Project area. All nine are operated by Williams Production RMT Company. Pertinent information for these nine permits and other nearby WYPDES permits can be found in Table 2.7A-16 in TR Addendum 2.7-A. All permits are associated with either oil and gas production or CBM production. The associated outfall discharge points are also shown in Figure 2.7A-7 in Addendum 2.7-A. WYPDES effluent limitations and discharge concentrations for the facilities are shown in Table 2.7A-17 in Addendum 2.7-A."

RAI ADMIN-17

On Figure 2.7A-8, the datum reference is NAD 1983 and it should be NAD 27.

ADMIN-17 Response

The reviewer requests that Figure 2.7A-8 be displayed using the NAD27 datum. However, AUC has chosen to store and display spatial data using the NAD83 datum as it provides greater horizontal accuracy than NAD27. Additionally, the NAD27 datum is not capable of supporting GPS technologies for current or future GPS data collection, whereas NAD83 is. AUC has made no change to the datum in Figure 2.7A-8 as a result of the RAI.

RAI ADMIN-18

In Section 3.1, the applicant proposes to include wells with diameters down to 2 inches. Please elaborate when the use of 2-inch diameter wells will be used.

ADMIN-18 Response

As noted in TR Section 4.3.5.2, AUC anticipates installing piezometer/leak detection wells in the development of the monitoring network related to the backup storage ponds. New text has been added to end of the third paragraph of TR Section 3.1.3.1 as follows:

"AUC anticipates using 2-inch diameter piezometer/leak detection wells in the development of the monitoring network related to the backup storage ponds."

RAI ADMIN-19

Section 3.2.1.1, the application references "^{226}Rn" in several paragraphs. However, ^{226}Rn is not a naturally occurring isotope for radon and it is likely a typographical error for ^{222}Rn.

ADMIN-19 Response

AUC has reviewed the application and revised the erroneous reference of ^{226}Rn to reflect the correct isotope of ^{222}Rn. The first two paragraphs in TR Sec. 3.2.1.1 now read:

"AUC will utilize pressurized down-flow IX columns. The uranium-bearing solution, or pregnant lixiviant, recovered from the wellfield will be piped to the pressurized down-flow IX circuit in the CPP for extraction of the uranium using specialized IX resin. With this ion exchange circuit the ^{222}Rn present in the lixiviant is forced back underground in re-fortified groundwater which thereby provides for significantly reduced potential for occupational and/or public exposure to ^{222}Rn and its progeny. More specific emission details are discussed in Sections 4 and 7 of this TR.

NUREG-1910 notes pressurized down-flow IX circuits contain most of the ^{222}Rn present in the lixiviant. Thus, use of this type of IX circuit allows for more effective control of ^{222}Rn which will only be released during resin transfer and routine maintenance. Use of a pressurized, down-flow IX system enables AUC to control where the ^{222}Rn can go during maintenance and resin transfer, in turn allowing for a reduction in ^{222}Rn emissions relative to other available IX technologies. Use of this type of system also represents a specific emission control method which reduces emissions to levels that are as low as reasonably achievable (ALARA) and complies with requirements of 10 CFR Part 40, Appendix A, Criterion 8. Use of engineering controls, such as pressurized, downflow IX columns, along with independent tank and area ventilation systems will ensure that exposures to ^{222}Rn and its progeny are maintained ALARA. Vents on individual IX vessels are connected to a manifold which is exhausted outside the CPP in the event small amounts of ^{222}Rn are released."

RAI ADMIN-20

The applicant provides a summary of the former Reno Creek R&D operations in Addendum 1-A. Figure 1A-1 depicts the location of the former operations; however the locations of various wells depicted on that figure are inconsistent with Rocky Mountain Energy Company "Pilot Plan Site Plan" on page Addendum 1A-64 or with the coordinates listed on Table 1A-1.

ADMIN-20 Response

The locations of Pattern 2 (also referred to as Pattern II) wells depicted on revised Figure 1A-1 are inconsistent with Rocky Mountain Energy Company "Pilot Plant Site Plan" on page Addendum 1A-64.

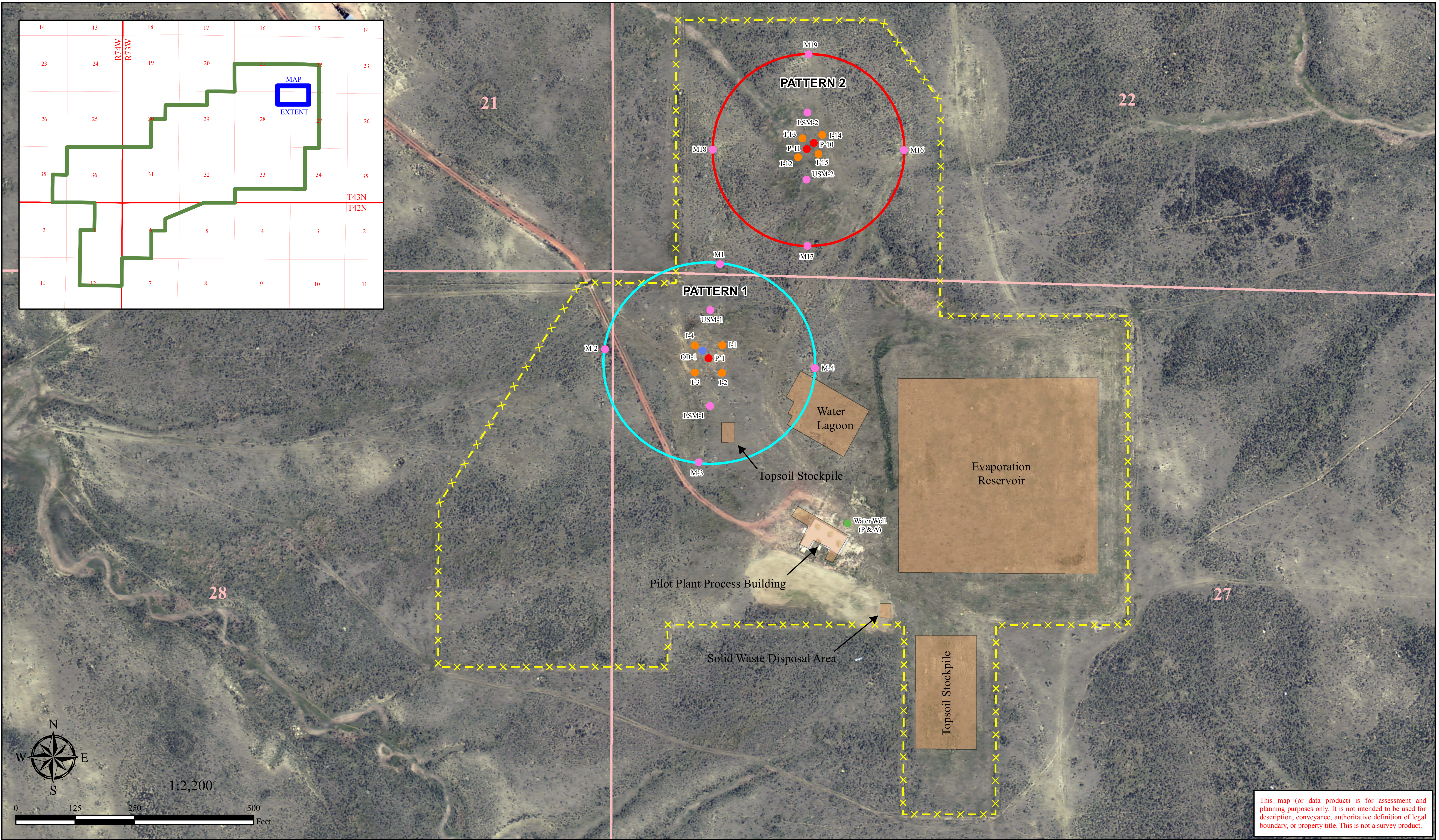
Review of RME's "Pilot Plant Site Plan" map on page Addendum 1A-64 revealed that the RME map has three errors:

1. Wells I-12 and I-14 are reversed.
2. I-12 should plot at the location of I-14 and vice versa.
3. USM-1 is mislabeled and should be USM-2.

After correcting these errors AUC's revised Figure 1A-1 is now consistent with RME's historic map. Revised Figure 1A-1 is shown below.

In addition, AUC revised text in Addendum 1-A to clarify the annotation to the RME map as shown below:

"The building which housed the R&D ion exchange facility, the evaporation pond, and the in-situ leaching test wells for Pattern 1 were located in the northwest corner of Section 27, Township 43 North, Range 73 West on property currently controlled by AUC LLC. Pattern 2 is located approximately 500 feet northeast of Pattern 1 in the southwest corner of Section 22, Township 43 North, Range 73 West. Figure 1A-1 displays the site layout for the historical RME R&D facility. Note that well locations in Pattern 2, Figure 1A-1 are different at three well sites as shown by the Rocky Mountain Energy Company "Pilot Plan Site Plan" on page Addendum 1A-64. RME's map has been annotated to show the correct well numbers."



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.

Path: O:\WY_Projects\2010-100_AUC_Reno_Creek\Project_MXD\Submittal\Plan_A\RME Site Layout_r1.mxd

PREPARED FOR

AUC LLC
LAKEWOOD, CO

PROPOSED RENO CREEK PROJECT
CAMPBELL COUNTY, WY

TREC, Inc.
Engineering & Environmental Management

900 Werner Court
Suite 150
Casper, WY 82601
Phone (307) 265-0696
Fax (307) 265-2498
www.treccorp.com

Legend

- 🟩 Proposed Reno Creek Project Boundary
- ▨ RME Features
- × – Fenced Area

Well Type

- ● Injection
- ● Monitor
- ● Observation
- ● Production
- ● Water Well

ISR Pattern

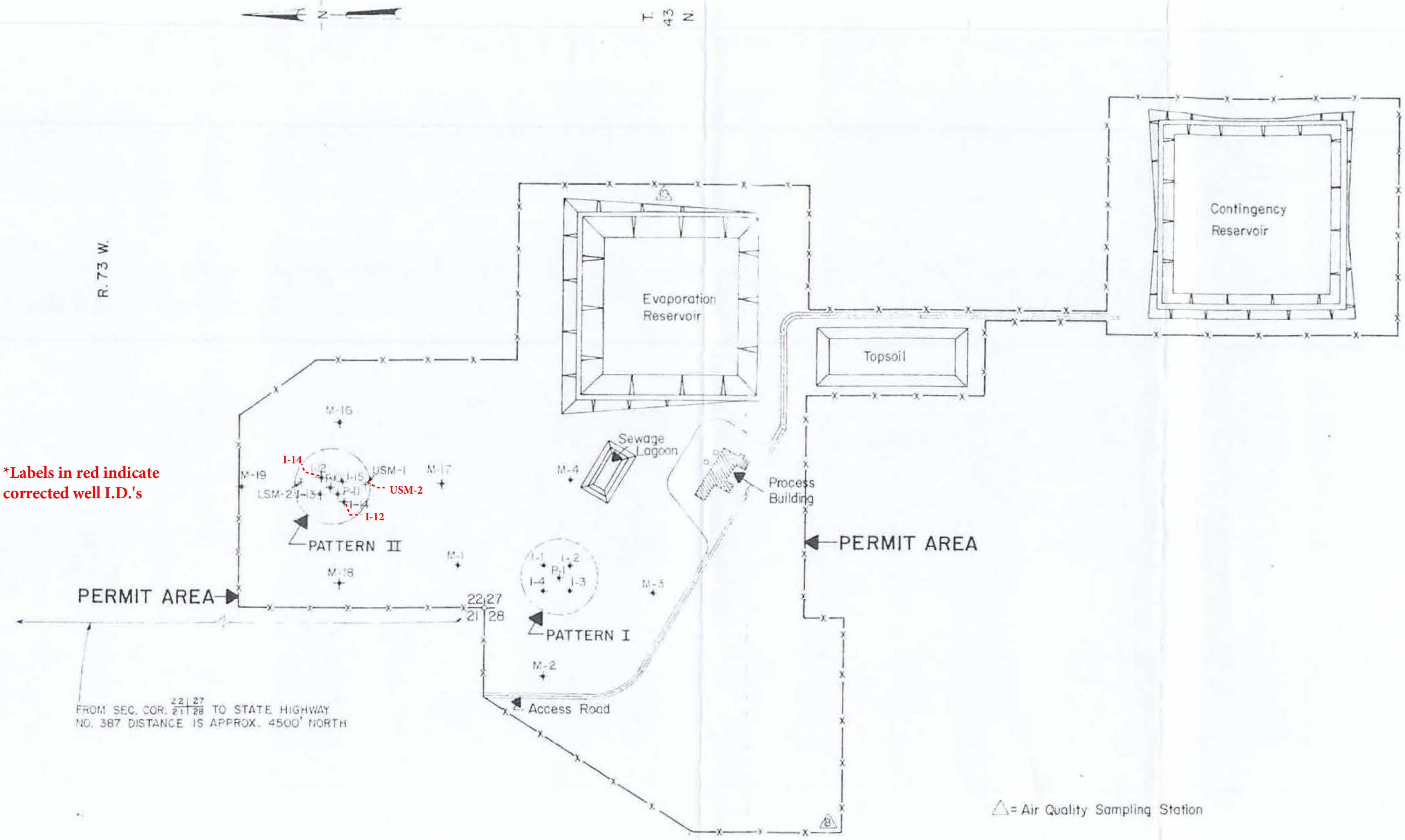
- — Pattern 1
- — Pattern 2

DRAWN BY: RHK
CHECKED BY: RMD
APPROVED BY: JEY

Historical RME Site Layout

REV #	DESCRIPTION	BY	DATE	FIGURE
0	Draft for Review	RHK	01/06/12	1A-1
1	Final	RHK	01/09/12	
2	Revised per RAI	EGS	04/03/14	

RC-C-001



*Labels in red indicate corrected well I.D.'s

REVISIONS					
NO	DESCRIPTION	BY	CHKD	APPD.	ISSUED
1	MONITOR WELL ADDITION (USM & LSM)	S.J.	M.N.		7-17-80
2	ADD TIE FROM SEC. TO HWY.	S.J.	M.N.		5-8-81

REFERENCE DRAWINGS	
DWG. NO.	TITLE

ISSUED	DATE	SCALE: 1" = 200'	
CONSULT.		DRAWN SLS	DATE 4/21/80
BIDS		CHECKED	
CONST.		APPROVED	

ROCKY MOUNTAIN ENERGY COMPANY
CASPER, WYOMING

PROJECT

TITLE RENO CREEK URANIUM
PILOT PLANT
SITE PLAN

PROJECT DWG. NO.
RC-C-001
2

RAI ADMIN-21

The narrative in the application states that sampling was performed at 21 sites. Table 2.7A14 lists 22 water sampling locations including a sample collected from ID SW20 on 6/23/2011 and "n/a" for other events. Table 2.7A-13 lists sample results from all ID's on Table 2.7A-14 except SW20.

ADMIN-21 Response

Following the initial and only sampling event of SW-20 on 6/23/2011, AUC determined further sampling from SW-20 was not necessary due to its discovered connectivity to SW-19 via a drainage pipe. The continued sampling of both points would have resulted in a duplication of the surface water feature. AUC has removed sample SW20 from Table 2.7A-14 (shown below) which now lists the same 21 samples found in Table 2.7A-13.

Table 2.7A-14: Surface Water Samples Within the Proposed Project Area

ID	Q1	Q2	Q3	Q4
SW1	Dry	Dry	3/15/2011	6/13/2011
SW2	Dry	Dry	3/17/2011	Dry
SW3	9/21/2010	Dry	3/16/2011	Dry
SW4	Dry	Dry	3/15/2011	Dry
SW5	Dry	Dry	Dry	Dry
SW6	Dry	Dry	Dry	Dry
SW7	Dry	Dry	3/16/2011	6/22/2011
SW8	Dry	Dry	3/16/2011	Dry
SW9	Dry	Dry	3/16/2011	6/22/2011
SW10	Dry	Dry	3/15/2011	6/22/2011
SW11	9/21/2010	12/29/2010	3/15/2011	6/22/2011
SW12	Dry	Dry	3/16/2011	Dry
SW13	Dry	Dry	3/17/2011	6/23/2011
SW14	Dry	Dry	3/17/2011	6/23/2011
SW15	Dry	Dry	3/17/2011	Dry
SW16	9/21/2010	12/29/2010	3/17/2011	6/28/2011
SW17	Dry	Dry	3/17/2011	6/28/2011
SW18	9/21/2010	12/29/2010	3/16/2011	6/22/2011
SW19	6/23/2011	8/18/2011	10/6/2011	Dry
SW21	6/23/2011	Dry	Dry	Dry
SW22	6/23/2011	8/18/2011	10/6/2011	1/12/2012

APPENDIX A

Memorandum of Agreement with Uranerz Energy Corporation

(RAI-11)

modify any of the covenants or conditions of this Agreement or any right, interest or obligation of the Parties under this Agreement.

IN WITNESS WHEREOF, this Agreement is made and executed as of the date first set forth above.

AUC, LLC

By: James Viellenave

Title: President

October 2, 2012
Date

URANERZ ENERGY CORPORATION

Glenn Catchpole
By: Glenn Catchpole

Title: President and CEO

OCT. 2, 2012
Date

ACKNOWLEDGEMENTS

State of Wyoming)
) ss.
County of Natrona)

The foregoing instrument was acknowledged before me this 2 day of October, 2012, by Glenn Catchpole as President and CEO, of Uranerz Energy Corporation, on behalf of said corporation.

IN WITNESS WHEREOF, I have set my hand an affixed my notarial seal this 2 day of October ; 2012.

Tamara L Carlen 10/16/2014

Notary Public

NOTARY PUBLIC
TAMARA L. CARLEN
STATE OF WYOMING
COUNTY OF NATRONA
My Commission Expires Oct 16, 2014

State of Colorado)
) ss.
County of Park)

The foregoing instrument was acknowledged before me this 2 day of October, 2012, by James Viellenave, President of AUC, LLC, on behalf of said corporation.

IN WITNESS WHEREOF, I have set my hand an affixed my notarial seal this 2 day of October, 2012.

Susan Pruitt 11/25/12

Notary Public

SUSAN PRUITT
Notary Public
State of Colorado

EXHIBIT C

MEMORANDUM OF RECIPROCAL MONITOR WELL AGREEMENT

THIS MEMORANDUM OF RECIPROCAL MONITOR WELL AGREEMENT ("Memorandum") is made effective the 2nd day of October, 2012 by and between AUC LLC ("AUC"), with offices at 1536 Cole Blvd, Lakewood, Colorado 80401, and Uranerz Energy Corporation ("Uranerz"), with offices at 1701 East "E" Street, P.O. Box 50850, Casper, WY 82605 (each a "Party" and collectively the "Parties"), their successors and assigns, with respect to the following real property:

> W½ of Section 27; W½ of Section 28; S½ of Section 29; SE¼ of Section 30; N½ of the SE½ of Section 31; and the NE¼ of Section 33; all in T43N, R73W, 6th Principal Meridian, Campbell County, Wyoming (the "AUC Property")
>
> S½ of Section 21; SW¼ of Section 22; E½ of Section 28; NE¼ and S½ NW¼ of Section 29; NE¼ Section 31; and SW½ of Section 33; all in T43N, R73W, 6th Principal Meridian, Campbell County, Wyoming (the "Uranerz Property")

In consideration of Ten Dollars ($10.00) and other valuable consideration set forth in the terms and conditions of that certain RECIPROCAL MONITOR WELL AGREEMENT effective the 2nd day of October, 2012 ("Agreement"), the Parties granted, and the Parties hereby grant, to each other the right to install, operate, plug, reclaim and abandon Monitor Wells on the other Party's property in locations established by applicable statutes, regulations and permits, in accordance with the terms and provisions set forth in the Agreement.

The Agreement is expressly binding on the Parties and their respective successors and permitted assigns. Nothing contained within this Memorandum shall amend, limit or affect the rights and duties of the Parties under the Agreement. Information regarding all of the terms and conditions of the Agreement may be obtained from the Parties at the addresses set forth above.

APPENDIX B

Subsurface Exploration and Geotechnical Engineering Report

(RAI-39)

Subsurface Exploration and Geotechnical Engineering Report

Prepared for:

AUC LLC
1536 Cole Boulevard, suite 330
Lakewood, CO 80401

Reno Creek Project
Campbell County, Wyoming

July 9, 2012

16216-CX

Prepared by:

INBERG-MILLER ENGINEERS
1120 East "C" Street
Casper, WY 82601

INBERG-MILLER ENGINEERS

Quality Solutions Through Teamwork

July 9, 2012

16216-CX

PDF PAGES EMAILED: lhuffman@auc-llc.com
ORIGINAL MAILED

Mr. Leland Huffman
AUC LLC
1536 Cole Boulevard, Suite 330
Lakewood, CO 80401

RE: SUBSURFACE EXPLORATION AND
GEOTECHNICAL ENGINEERING REPORT
RENO CREEK PROJECT
CAMPBELL COUNTY, WYOMING

Dear Mr. Huffman:

Enclosed are the original and one PDF copy of our Subsurface Exploration and Geotechnical Engineering report for the above-referenced project. The work described in this report has been completed in accordance with our Service Agreement dated May 31, 2012.

It has been a pleasure participating in this project. We are available to provide additional services at your request. Services we could provide include:

- additional field exploration
- environmental assessment
- surveying
- construction materials testing
- observation of excavations and earthwork

If you have any questions or comments, please contact us at 307-577-0806.

Sincerely,

INBERG-MILLER ENGINEERS

Ben Hauser, P.E., G.I.T.
Geotechnical Engineer

BH:llm\16216-CX\geotech\16216-CX rpt

Enclosures as stated

124 East Main Street
Riverton, WY 82501
307-856-8136
307-856-3851 (fax)
riverton@inberg-miller.com

1120 East "C" Street
Casper, WY 82601
307-577-0806
307-472-4402 (fax)
casper@inberg-miller.com

350 Parsley Boulevard
Cheyenne, WY 82007
307-635-6827
307-635-2713 (fax)
cheyenne@inberg-miller.com

428 Alan Road
Powell, WY 82435
307-754-7170
307-754-7088 (fax)
powell@inberg-miller.com

193 West Flaming Gorge Way
Green River, WY 82935
307-875-4394
307-875-4395 (fax)
greenriver@inberg-miller.com

TABLE OF CONTENTS

SUMMARY

Based on information obtained from our subsurface exploration and laboratory testing of recovered samples, it is our opinion that the site is suitable for construction of the proposed Reno Creek Project, subject to considerations for site preparation and foundations described in this report. Our field exploration included 15 test borings to maximum depths of 21.5 feet. Soils encountered include sandy clay and sand overlying weathered sedimentary bedrock. Groundwater was not observed within the borings during drilling observations.

Laboratory test results indicate the claystone bedrock underlying the proposed site at variable elevations exhibits potential for an increase in volume with associated swell pressures with an increase in moisture content. Swell pressures on the order of 1,800 to 2,400 psf were observed. Consequently, a deep foundation system consisting of drilled piers and grade beams is considered appropriate to support all wall and roof loads of the proposed buildings and major equipment.

We understand that the final site-grading plan has not been completed as of the date of this report. It is possible that a more cost effective foundation system could be considered for the site, depending on the geology and/or fill thicknesses that are expected to be exposed at final grade. Therefore, alternative foundation systems, including but not limited to conventional continuous and spread footing bearing on improved subgrades, post-tensioned slabs-on-grade, and helical piers could be considered as alternatives at your request, and at additional cost.

SCOPE OF SERVICES

The purpose of this study was to explore subsurface conditions at the site of the proposed Reno Creek Project, and to provide geotechnical recommendations for design and construction. Specific recommendations and information are provided about foundation types, bearing capacity, groundwater conditions, consolidation-swell potential of foundation soils, earthwork, and other pertinent foundation and construction requirements.

PROJECT INFORMATION

Project information was provided by Leland Huffman with AUC LLC. We understand the project will consist of constructing a processing facility for in-situ uranium mining. The proposed project consists of a central processing plant, administration and shop building, and one pond with the potential to expand to a second pond.

Detailed information on the structural loads was not available at the time this report was prepared. However, based on information provided, we assume that the proposed buildings will have low to moderate loads. These assumptions include maximum wall loads on the order of three kips per linear foot and maximum isolated columns loads on the order of 60 kips. Some recommendations provided in this report will not be appropriate for buildings with loads in excess of those described above.

It is important to note that we have assumed that some minor grading will be required, and cut and fill depths will be less than 3 feet. If cuts and fills in excess of these assumptions are planned, we should be provided plans and our recommendations should be reviewed for conformance with the planned site configuration. The importance of understanding the final grading plan as a consideration in determining an appropriate foundation type as it relates to the geology exposed at final grade cannot be over-emphasized.

FIELD EXPLORATION

The fieldwork was performed using a CME 85 truck-mounted drilling rig at the site on June 13-14, 2012. Fifteen test borings were advanced to depths of 11.5 to 21.5 feet. Drilling was performed using 4-inch diameter solid flight augers. The augers are withdrawn at each sample depth to allow sampling tools access to the bottom of the hole for sampling undisturbed soils.

Drilling and field sampling were performed according to the following standard specifications:

1. "Standard Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling," ASTM D6151.

2. Sampling with a 2-inch O.D., split-barrel (split-spoon) sampler per ASTM D1586, "Penetration Test and Split-Barrel Sampling of Soils." 92 such tests were performed. Standard penetration test blow counts were obtained by driving a 2.0-inch-diameter split-spoon sampler into the soil using an automatic hammer that drops a 140-pound hammer a distance of 30 inches. The SPT N-value is the blow count for 12 inches of sampler penetration. N-values are correlated to soil relative density, hardness, strength and a variety of other parameters.

3. Sampling with a 2.5-inch I.D., thick-wall, ring-lined, split-barrel, drive sampler per ASTM D3550. Seven such samples were obtained.

The soil samples were field classified by the geologist and geotechnical engineer, sealed in containers to prevent loss of moisture, and returned to our laboratory. A field log was prepared for each boring during drilling.

Test boring locations were located by surveyors who determined location and elevation using survey instruments.

LABORATORY TESTING PROGRAM

Upon return to the office, samples were classified visually in accordance with ASTM D2488. In order to better classify the recovered samples and determine their engineering properties, the following laboratory soil tests were performed:

		TESTS
1.	Moisture Content (ASTM D2216)	92
2.	Atterberg Limits (ASTM D4318)	9
3.	Sieve Analysis (#4 to #200) (ASTM C136 and C117)	9
4.	Water Soluble Sulfate	3
5.	Consolidation-Swell Test (ASTM D2435)	4

A final log for each boring was prepared containing the work method, samples recovered, and a description of soils encountered. The sieve analyses and consolidation-swell tests are presented graphically in Appendix C. All other test results are arrayed on the final logs bound into Appendix B.

SITE CONDITIONS

The site is located approximately 1/4 mile northwest of the intersection of Clarkelen Road and WY Highway 387. The site is vegetated with sparse native grass and sage brush. The topography at the site is relatively flat to moderately steep. A site location map, site observation sheet, and test boring location plan in Appendix A describe the site in more detail.

SUBSOIL CONDITIONS

The subsoil classified in the 15 test borings performed at the site generally consists of unconsolidated sandy clay and sand overlying weathered to competent sedimentary bedrock. Due to the variable nature of the soil strata and geology at the site the soil descriptions below are for a general overview only and the boring logs should reviewed for specific soils conditions in each area.

The topsoil consists of 0 to 4 inches of sandy clay. The organic content of the soils appears to be low.

Over the approximate interval of 0 to 10 feet, sandy clay was encountered. Laboratory testing indicates minus number 200 sieve fractions of 55 percent to 90 percent and plasticity indexes of 13 to 43 percent indicating low to medium high plasticity. Standard Penetration Test blow counts (N-values) indicate that the soil is in a firm to hard condition.

Over the approximate interval of 10 to 20 feet, sedimentary bedrock with variable amounts of weathering was encountered. The weathering ranged from nearly complete (hard or dense soil) to severely weathered.

Consolidation-swell tests are summarized in the following table. Testing was performed on relatively undisturbed, drive-tube samples using one-dimensional test equipment. Samples were placed into the equipment at native moisture content and loaded to a nominal vertical confining pressure of 1,000 psf prior to wetting. Following wetting, the vertical confining pressure was increased incrementally to a maximum vertical pressure of 8,000 psf and then reduced incrementally to determine a rebound curve. The test results indicate that the claystone has moderate swell pressure when wetted.

SAMPLE			TEST RESULTS		
Soil Description	Boring No.	Depth (Feet)	Volumetric Swell (%)	Swell Pressure (psf)	Compression Index, Cc
Claystone	1	7.5	1.23	1,800	0.218
Claystone	4	10	0.81	2,400	0.069
Very Fine Sand	6	5	-0.10	N/A	0.104
Claystone	7	10	-	N/A	0.116

GROUNDWATER CONDITIONS

Groundwater was not observed in any of the test borings during drilling operations. Groundwater observations were made in each test boring at the completion of drilling. This information, along with cave-in depths of the drill holes, is recorded on the final logs in Appendix B. Test borings were backfilled at the completion of the field work for practical and safety reasons. Therefore no subsequent readings were performed.

We have noted groundwater occurrences within claystone on numerous occasions at other sites with similar geology. Typically, the groundwater is observed within discontinuous fractures of the claystone bedrock. Groundwater could be present at this site within the fractures based on our observation of iron oxide staining within them even though no groundwater was observed.

In addition, groundwater conditions could change with seasonal or long-term changes in climatic conditions and post-construction changes in irrigation and surface water runoff. Generally, developed sites have a significantly greater volume of water available to percolate into the ground due to irrigation and storm water runoff from hard surfaces. Localized, perched groundwater tables may develop above clay layers or bedrock or within the foundation backfill zone.

RECOMMENDATIONS

EARTHWORK

1. Prior to construction on the site, all vegetation and organic surface matter should be stripped from the surface. Based on the test borings, it appears that stripping depths of approximately 0 to 4 inches may be required.

2. Demolition of existing structures and utilities (if any) must include complete removal of below grade concrete and old fill.

3. After excavation to desired site grades (including any overexcavation required), and prior to placing fill or erection of forms for foundations and slabs, we recommend the site surface be compacted. This compaction densifies the native subgrade and soils loosened by excavation. This compaction effort should be performed in the presence of the geotechnical engineer so that soft or loose zones can be properly identified and improved. Alternatively, the geotechnical engineer can observe proof rolling with a heavily loaded wheeled vehicle. If loose or soft zones are encountered that do not improve with repeated compaction, they should be removed and replaced with properly compacted, approved fill, as described in Item 5 below.

4. Fill material requirements are provided in the following table:

Use	**Fill Material**
Beneath structures	Structural fill meeting Envelope A
Beneath Slabs	
Bottom of slab to 6 inches	WYDOT Grading W aggregate base
Deeper than 6 inches below slab	Structural fill meeting Envelope A or supported on piers
Road and pavement subgrades	Scarified and compacted native soil
Trench backfill	Native site soils or Structural fill meeting Envelope A
General site fill in landscaped areas	Native site soils

Native and fill soils should be free of debris and particles larger than 6 inches in diameter.

5. Imported fill specifications are provided below:

Structural Fill Envelope A	
Sieve	**Percent Finer**
1½"	100
#4	50-100
#8	30-90
#30	15-75
#50	10-60
#200	0-20
Liquid Limit < 40, PI < 15	

WYDOT Grading W Crushed Aggregate Base	
Sieve	**Percent Finer**
1½"	100
1"	90-100
½"	60-85
#4	45-65
#8	33-53
#200	3-12
Liquid Limit < 25, PI < 3	

6. Fill should be placed in horizontal lifts not exceeding 8 inches in loose thickness and compacted at moisture contents ranging from 4 percent below to 2 percent above the optimum moisture content for engineered fill and optimum moisture content to 2 percent above for native site soils. The contractor's equipment and procedures should produce a uniformly mixed and compacted lift. In-place density and water content of each lift of fill materials should be tested and approved.

The following table is our recommended soil compaction requirement for earthwork. All compaction requirements are based on Standard Proctor maximum dry density (ASTM D698).

	Minimum % Compaction
Native Subgrade	
Scarified and compacted subgrade soils beneath footings, slabs-on-grade, pavement, and structural fill	95
Fill Soils	
Beneath foundations	95
Beneath slabs-on-grade	95
Beneath pavements	95
Embankments and backfill in non-structural areas	90

6. If construction takes place during cold weather, care should be taken to prevent construction on frozen soils. In addition, fill materials should not contain snow and/or ice and should not be placed in a frozen condition.

FOUNDATIONS

Drilled pier foundations are intended to transfer structural loads through potentially swelling surficial soils to a competent underlying stratum beneath the zone of anticipated moisture change. The embedment depth of the pier into the bedrock is intended to provide both resistance to gravity loads and resistance to uplift forces from swelling soils surrounding the top portion of the pier. The load capacity of the pier is provided by the bottom surface of the pier bearing on bedrock and by friction between bedrock and sidewalls of the piers. Resistance to uplift is provided by friction between the bedrock and sidewalls of the piers over the length of piers beneath the zone of moisture change.

Building column loads are transferred from the columns to a single pier or a group of drilled piers connected by a concrete cap. Wall loads are transferred to grade beams, which are supported by the piers. Grade beams are normally underlain by a void space created by a cardboard void form to prevent uplift pressures on the walls from swelling soils.

1. Structural loads for the proposed structures may be founded on straight-shaft, reinforced concrete, cast-in-place drilled piers and grade beams to support all wall and roof loads. Grade beams should be designed to span between pier locations while carrying the imposed loads.

2. Piers should be founded with a five-foot minimum penetration into an acceptable, sedimentary, bedrock stratum defined as having a minimum N-Value of 50 blows per foot. A minimum pier diameter of 18 inches is recommended to allow proper cleaning and observation of the pier hole. Structures bearing on drilled piers, founded as described above, may experience up to 0.5 inches of total vertical settlement and up to 0.25 inches of differential vertical settlement.

3. Design parameters for drilled piers are provided in the following table.

Layer	Allowable End Bearing	Allowable Skin Friction – Compression (psf)	Allowable Skin Friction – Tension (psf)
A-Sandy clay/Clayey Sand	N.A.	100	N.A.
B-weathered claystone and sandstone	20,000	1,000	500

The allowable skin and end bearing capacities are based on considerations of soil type and strength and incorporate an approximate factor of safety of two. Refer to the test boring logs for applicable layer depth/thickness information at specific locations.

4. Drilled piers are frequently required to resist lateral forces. Laterally loaded piers are analyzed using software that models deflection, shear, bending moment, and soil response with respect to depth in nonlinear soils. In our experience, LPile by Ensoft, Inc is the most common analyses tool. The following table lists LPILE input parameters for a generalized soil profile of the site.

Layer	A	B
LPILE Material Type[a]	3	7
Total Unit Weight (pcf)[b]	120	125
Friction Angle (deg)	-	-
Undrained Cohesion c (psi)	20	-
Unconfined Compressive Strength (psi)	40	300
Static Soil Modulus, k (pci)	1000	-
Young's Modulus, (psi)	-	70,000
Strain, k_m	-	0.0003
Rock Quality Designation (RQD %)	-	0

   a. LPILE material types: 1-soft clay, 2-stiff clay with free water, 3-stiff clay w/o free water, 4-sand, 5-strong rock, 6-silt, 7-weak rock
   b. LPILE requires an effective unit weight for soil. Below the water table Effective Unit Weight = Total unit weight – 62.4 pcf.

5. Drilled piers should be spaced a minimum of four pier diameters apart (measured center to center) in order to be considered as acting independently and not as a group. If piers are spaced closer than four pier diameters apart, individual pier capacities are reduced according to a rational formula.

6. The foundation driller should be equipped with appropriate drilling equipment, and be prepared for any difficulties resulting from drilling into hard sedimentary bedrock deposits as well as for sloughing of overlying cohesionless fine sandy soils. We anticipate that casing may be required in some pier excavations.

7. We do not anticipate that free groundwater will be encountered in the pier excavations within the proposed foundation excavation depths. However, the contractor should be prepared to dewater and/or case pier excavations if it becomes necessary. Concrete should not be poured into a pier excavation in which more than two inches of standing water is present without the geotechnical engineer's review of proposed procedures and equipment. It will sometimes be necessary to pump concrete to the bottom of the pier hole and fill the hole with concrete while maintaining the discharge end of the pump hose below the concrete/water interface. The purpose of this procedure is to minimize the mixing of fresh concrete and groundwater.

8. All loose soils and cuttings that accumulate in the bottom of the pier excavation should be removed prior to concrete placement. The importance of achieving clean pier excavation bottoms prior to concrete placement cannot be overemphasized.

9. Once drilling and cleaning is complete, the pier excavations should be observed by the geotechnical engineer, or his representative. If any additional drilling, cleaning, and/or dewatering are recommended by the geotechnical engineer, it should be performed prior to concrete placement. If pier excavations cannot be cleaned to the satisfaction of the geotechnical engineer, or his representative, the recommended allowable end bearing pressures may no longer be valid at those foundation locations.

10. Once drilling, cleaning, and/or dewatering of the excavations are sufficiently complete according to Item 8 above, concrete should be placed immediately.

11. Cast-in-place concrete piers should fill the entire hole. Falling concrete should be directed so that it does not come in contact with the sidewall of the excavation and so that it has minimal contact with reinforcing steel. Concrete may need to be placed with a tremie or concrete pump.

12. Concrete placed in pier excavations should have a slump of 6 to 8 inches, while at the same time maintaining minimum 28-day strength requirements. The concrete piers should fill the entire hole. If casing is used, it should be left in place until it has been filled with a sufficient head of concrete to prevent water infiltration, soil sloughing or creation of voids when it is withdrawn.

13. A 6-inch air void should be provided beneath all grade beams and pier caps to prevent uplift loads on the structure from swelling soils.

    Air voids beneath grade beams and pier caps can be provided by using commercially-available, collapsible, cardboard forms, "J voids", or "Sure-void." Consequently, grade beams and pier caps should be designed to carry all loads imposed upon each span between pier foundations.

14. The top portion of all piers should not be allowed to have "mushroom" tops. The contractor shall provide forms or sono-tube casing that match pier diameters for the top two feet (minimum) of piers if the top diameter of piers at the ground surface increases six inches or more due to loose soil sloughing.

LATERAL EARTH PRESSURES

1. Lateral load parameters are provided in the following table. All of the parameters assume the structure and soils are above the water table. The following parameters do not include a factor of safety. A minimum factor of safety of 2.0 is recommended for horizontal loading.

	Native sandy clay	**Grading A Fill**
Active Lateral Soil Pressure – for structures that can deflect without restraint by other structures. (equivalent fluid unit weight, pcf)	70	40
At-Rest Lateral Soil Pressure - for structures which have significant restraint against deflection. (equivalent fluid unit weight, pcf)	90	60
Passive Lateral Soil Pressure – resistance of soil abutting a structure. (equivalent fluid unit weight, pcf)	200	400
Coefficient of Friction between foundation and underlying soil	0.33	0.5
Soil Density, wet soil (pcf)	120	135

2. Where possible, foundations should be backfilled and compacted evenly on all sides to prevent horizontal movement. Foundation walls should be adequately braced prior to backfilling. Fill placed against retaining walls or basement walls should be carefully compacted with appropriate equipment to prevent excessive lateral pressures that may displace or damage the structure.

3. Surcharge loads, on the uphill side of the wall, due to ground slope, soil stockpiles, equipment, and structures, may significantly increase lateral forces on the wall and need to be fully evaluated.

4. Drains should be installed behind retaining walls or other confined areas where surface precipitation and runoff water can collect. Drains should be designed to prevent the build-up of hydrostatic pressures behind the retaining structures due to trapped water.

FLOOR SLABS

We understand that uranium-processing facilities are typically constructed in a manner such that the floors slab and stem walls are interconnected to serve as a containment area within the plant. Consequently, the floor slab system is sensitive to heave and cracking. We have included two options for a floor slab system within the processing plant. We anticipate the office will be much less sensitive to up heave; therefore, the floor slab can be supported on structural fill.

Structural fill support

1. The processing plant floor slab should be supported on a minimum of 36 inches of structural fill meeting the material and compaction requirements outlined in the Earthwork section above.

2. The office floor slab should be supported on a minimum of 24 inches of structural fill meeting the material and compaction requirements outlined in the Earthwork section above.

3. The top 6 inches of this fill (immediately beneath the floor slab) should be crushed aggregate base course (WYDOT Grading W) to provide a stable construction surface and to provide uniform slab support. The base course will not provide an effective capillary break of moisture rise to the slab.

4. For structural design of slabs-on-grade constructed as recommended in Item 1 above, a modulus of subgrade reaction, k, of 225 pci may be used.

Drilled pier supported structural slab

If a cost analysis determines additional drilled piers to be more efficient than hauling select fill to the remote location, then the floor slab can be supported on drilled piers. If the slab is supported on piers, a minimum 6-inch void should be constructed below the slab to prevent uplift.

Regardless of the pre-construction soil-moisture content, there is a potential for problematic infiltration of moisture upwards through the slab-on-grade floor. In this semi-arid climate, the moisture content of soil beneath buildings generally increases following construction. This is due to the reduction of evapotranspiration from the ground surface and the concentration of water around the building from irrigation and runoff from hard surfaces. Post-construction moisture infiltration through the slab may result in damage to flooring materials or may support growth of mold or other biologic materials in areas of poor ventilation. Installation of a moisture barrier beneath the slab should be considered by the building design professionals in light of the long-term service requirements for the building.

GENERAL

1. The measured water-soluble sulfate contents of 0 to greater than 2,000 ppm indicates that the soils are variable but can be very reactive with portland cement. According to American Concrete Institute (ACI) and Portland Cement Association (PCA) guidelines, concrete mixes should use Type V or equivalent cement and be formulated with a water/cementitious material ratio of less than 0.45.

   Sulfate attack is a chemical reaction between sulfates (SO4) and the cement, and can result in extensive cracking and disintegration of the concrete. Sulfate attack on concrete can occur where soil and groundwater have high concentrations of sulfate and measures have not been taken to employ a sulfate resistant concrete mix.

2. Percolation tests were performed on six test holes within the planned drained field. Performing six tests allows the designer to use the average percolation rate for the drain field rather than the minimum. The average percolation rate was determined to be 2.41 minutes per inch of drop. The percolation rates ranged from 2.0 minutes per inch to 3.5 minutes per inch.

3. Rainwater discharge from the building roofs, parking, and drive areas should be directed toward collection points and disposed of away from the building and pavement in an adequate and efficient manner.

4. In order to promote drainage away from the building, we recommend that final exterior grades slope away from the building at a slope of 5 percent for a minimum distance of 10 feet.

5. In order to reduce the presence of moisture near the structure, landscaping should utilize plants and vegetation adjacent to the building that do not require much irrigation. Furthermore, sprinkler heads should not be placed closer than 10 feet from the structure.

6. In accordance with the International Building Code (IBC), 2003 Edition, Table 1615.1.1, we recommend site Class C for determination of design spectral response acceleration parameters per IBC. This class is based on Standard Penetration Resistance blow count numbers (N-values) per ASTM D1586 and the assumption that the subsurface soil conditions encountered in the test borings can be projected deeper into the earth to describe the average soil conditions for the top 100 feet. Class C describes the average soil properties for the top 100 feet as very dense soil and soft rock (Standard Penetration Test blow count, N > 50 or unconfined shear strength > 2,000 psf).

   Inberg-Miller Engineers should review final plans and specifications in order to determine whether the intent of our recommendations has been properly implemented. In addition, we should be retained as the geotechnical engineer and construction materials testing agency to provide the following services:

   a) Observe excavations to determine if subsurface conditions revealed are consistent with those discovered in the exploration.

   b) Identify if the proper bearing stratum is exposed at proposed foundation excavation depths.

   c) Observe that foundation excavations are properly prepared, cleaned, and dewatered prior to concrete placement.

   d) Test compaction of subgrades and fills.

   e) Perform field and laboratory testing of concrete and other materials as required by project specification and/or building code.

f) Observe drilled pier construction to identify suitable bearing strata and to observe pier construction including cleaning of pier bottoms and concrete placement.

CONSTRUCTION CONSIDERATIONS

No major difficulties are anticipated for conventional equipment during earthwork construction at the proposed site. We do not anticipate that groundwater will be encountered at the proposed foundation depths during construction. However, excavations should be protected from surface water run-off, whenever possible. Water accumulation within excavations should be promptly removed. If excavation bottoms become wet, excavation of soils beyond the minimum required depth may be necessary to provide a firm base for fill placement.

In all borings, drilling in sedimentary bedrock was difficult at times. Consequently, difficult pier drilling is expected in these strata during foundation installation operations. In addition, sloughing of the upper overburden will likely occur in pier excavations. The drilling contractor should be prepared to case all pier excavations full-depth and dewater holes in order to achieve recommended depths. Regardless of the pier drilling conditions, the importance of achieving adequate foundation stratum penetration for the capacities provided cannot be overemphasized. The pier-drilling subcontractor should be prepared with the appropriate equipment (adequate size and torque) to construct the foundations as recommended. Since the foundation construction is early in the sequence of events, which must take place to facilitate the construction schedule, the importance of retaining a qualified foundation drilling subcontractor for the project cannot be overemphasized. We recommend specific clauses be included in the project specifications requiring the foundation-drilling subcontractor to collect whatever additional information the foundation drilling subcontractor deems necessary to provide an informed bid.

Excavations should be sloped, benched, shored, or made safe for entry by use of trench boxes as required by the standards of 29 CFR Part 1926. As a safety measure, it is recommended that all vehicles and soil piles be kept a minimum lateral distance equal to the slope height, from the crest of the slope. The contractor is solely responsible for designing and constructing stable excavations. Furthermore, the contractor's "responsible person" should continuously evaluate the soil exposed in the excavations, the geometry of the excavation slopes, and the protective equipment and procedures employed by his forces. For the sole purpose of project planning, we recommend that sandy clay to depths of approximately 10 feet be considered an OSHA Type A soil. Excavations, including utility trenches, extending to depths of greater than 20 feet are required to have side slopes, trench boxes, or shoring designed by a professional engineer.

CLOSURE

This report has been prepared for the exclusive use of our client, AUC LLC, for evaluation of the site, design, and construction planning purposes of the described project. All information referenced in the Table of Contents, as well as any future written documents that address comments or questions regarding this report, constitute the "entire report". Inberg-Miller Engineers' conclusions, opinions, and recommendations are based on the entire report. This report may contain insufficient information for applications other than those herein described. Our scope of services was specifically designed for and limited to the specific purpose of providing geotechnical recommendations for the design of the proposed Reno Creek project. Consequently, this report may contain insufficient information for applications other than those herein described.

The scope of services for this project does not include any environmental or biological assessment of the site. If requested, we would be pleased to assist you with developing a scope of services for environmental assessment for the subject site. Wherever structures are in contact with soil, there is potential that soil moisture may penetrate the building and provide an opportunity for mold growth. While this report identifies soil moisture/groundwater conditions and may provide geotechnical recommendations for drainage and construction, the design of drains, water proof/resistant building elements, equipment to remove moisture from the building, or additional measures to prevent the growth of mold are beyond the scope of our geotechnical services. Implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent the growth of mold in or on the proposed building.

We appreciate participating in your project. We can offer services under a separate contract to provide environmental engineering services, review final plans and specifications, perform construction surveying, field and laboratory construction materials testing, and observe excavations, as may be required. Please call us at 307-577-0806 if you have any questions regarding this report.

INBERG-MILLER ENGINEERS

Ben Hauser, P.E., G.I.T.
Geotechnical Engineer

REVIEWED BY:

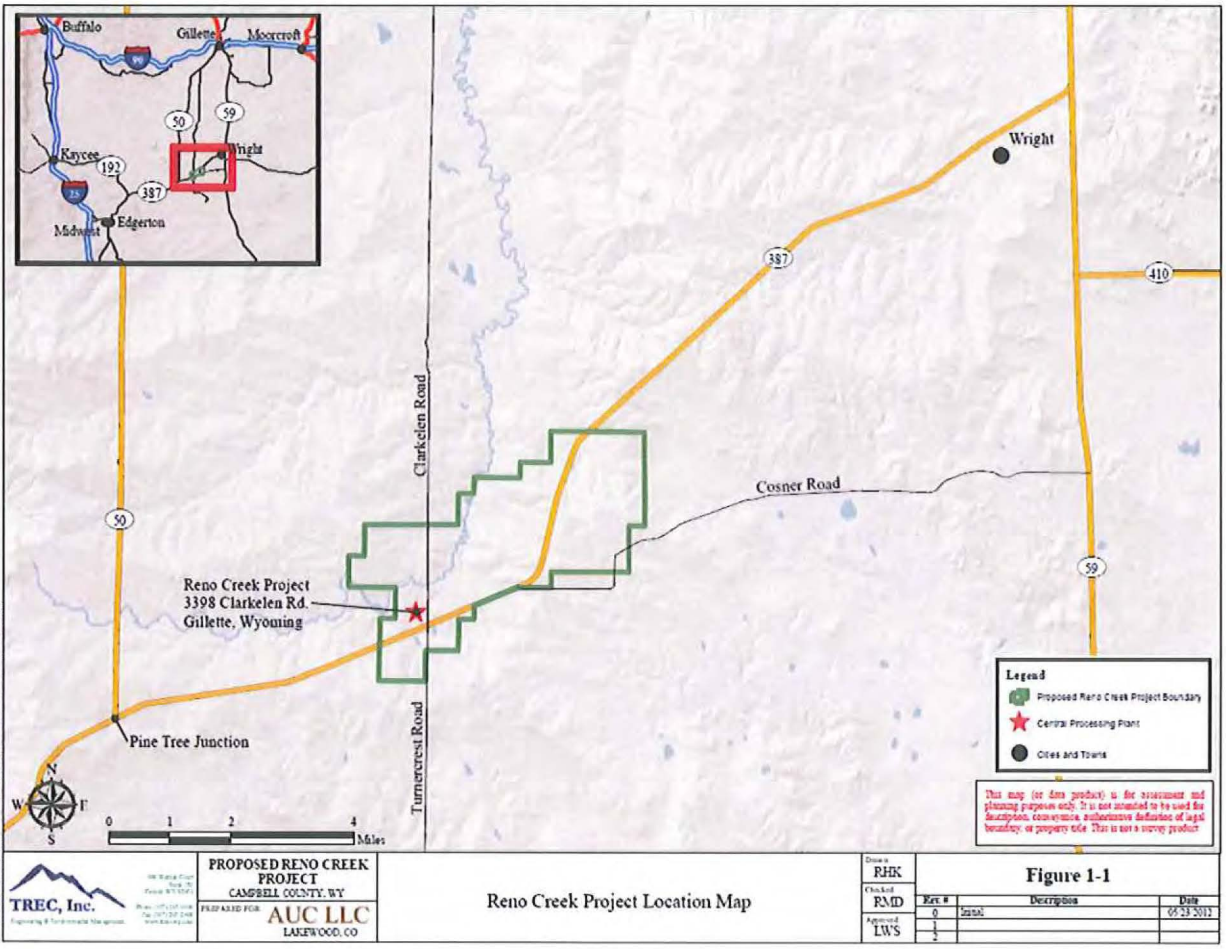
Derek J. Baker, P.E., P.G.
Geological Engineer

BH:llm\16216\Geotech\16216 CX rpt

Professional Engineer (Civil)
BEN HAUSER
13592
Date 7/9/12
WYOMING

APPENDIX A

Site Location Map

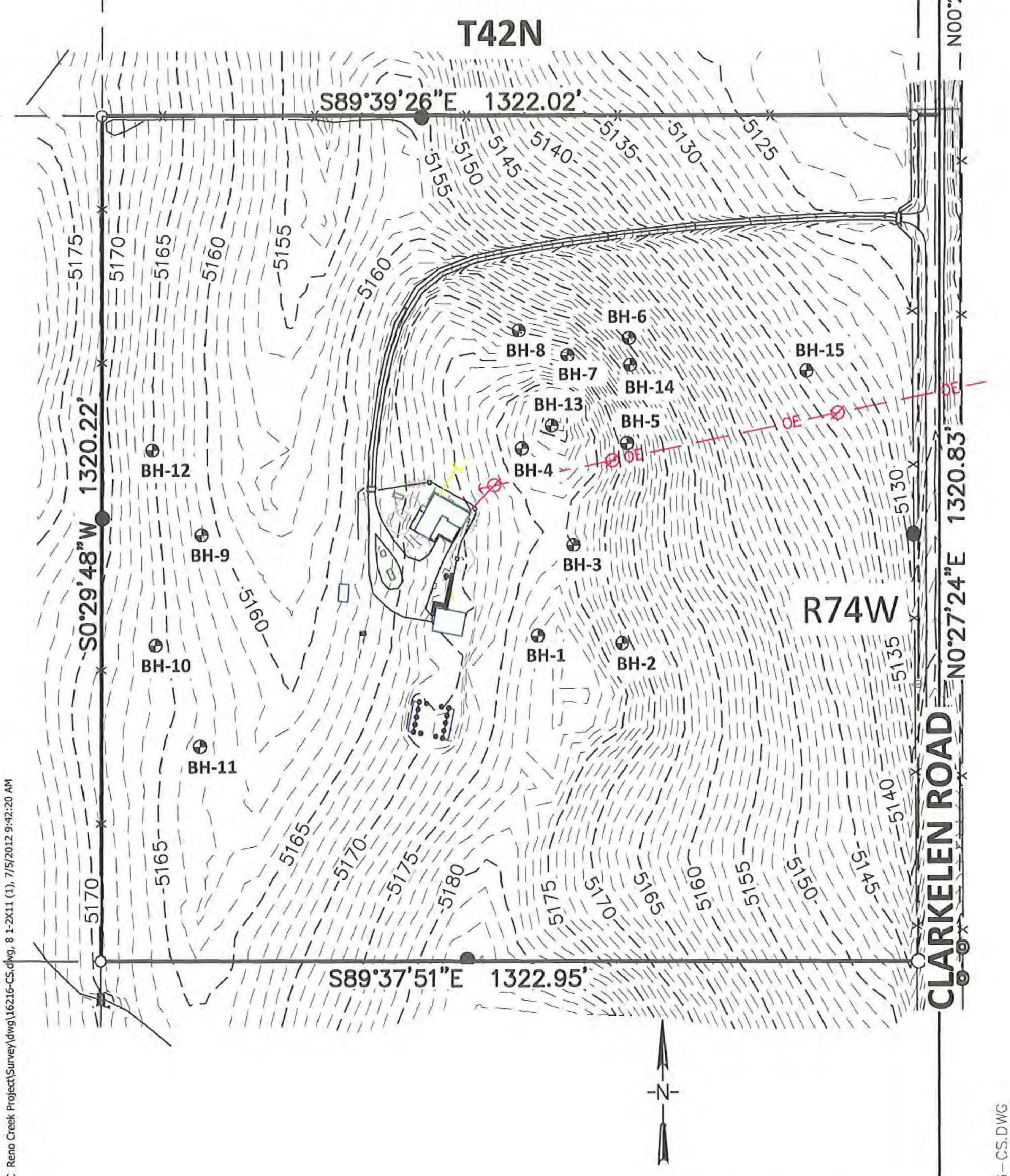


Source: TREC, Inc.

Site Observations

1.	Location of Site:	Approximately 1/4 mile northwest of the Clarkelen Road and WY Highway 387 intersection
2.	County/state:	Campbell County, Wyoming
3.	Slope of Ground Surface:	6H to 1V at the steepest location
4.	Downhill Direction:	The CPP is proposed for the top of a hill so all directions are down
5.	Est. Change of Surface Elevation:	Total across site 55 feet
6.	Bodies of Water Nearby:	None
7.	Topsoil Type:	Sandy clay
8.	Vegetation:	Sparse grass and sage brush
9.	Rock Outcrops:	Claystone outcrop noted between CPP and office
10.	Est. Depth to Bedrock:	Surface to approximately 20+ feet
11.	Artificial Fills:	None noted
12.	Type and Depth:	N/A
13.	Nearby Land Features:	None noted
14.	Present Site Improvements:	Currently a residence and welding shop occupy a portion of the site
15.	Buried Utilities On Site:	Water, septic, possibly gas
16.	Nearby Buildings:	Shop, shed, house
17.	Cond. of Nearby Foundations:	Good
18.	Cond. of Nearby Driveways/Walks:	Fair
19.	Buried Obstructions Encountered:	None
20.	History of Land Use:	Rangeland and industrial
21.	Existing Drainage Features:	Natural
22.	Overhead Utilities Crossing Site:	Electric
23.	Geologic Description of Site:	Completely weathered sediments to severely weathered bedrock of the tertiary Wasatch formation.

BORING LOCATION MAP



16216-CX AUC Reno Creek Project\Survey\dwg\16216-CS.dwg, 8 1-2X11 (1), 7/5/2012 9:42:20 AM

INBERG-MILLER ENGINEERS
QUALITY SOLUTIONS THROUGH TEAMWORK

INBERG-MILLER ENGINEERS

124 East Main Street
Riverton, WY 82501
307-856-8136

1120 East C Street
Casper, WY 82601
307-577-0806

350 Parsley Boulevard
Cheyenne, WY 82007
307-635-6827

428 Alan Road
Powell, WY 82435
307-754-7170

193 West Flaming Gorge Way
Green River, WY 82935
307-875-4394

SCALE HORZ 1"=200'		VERT
DRN. MDH	BK: 1135	JOB NO. 16216-CS
CHK. BH	PAGE: 11+	DATE: 7/5/12

FILE: 16216-CS.DWG

APPENDIX B

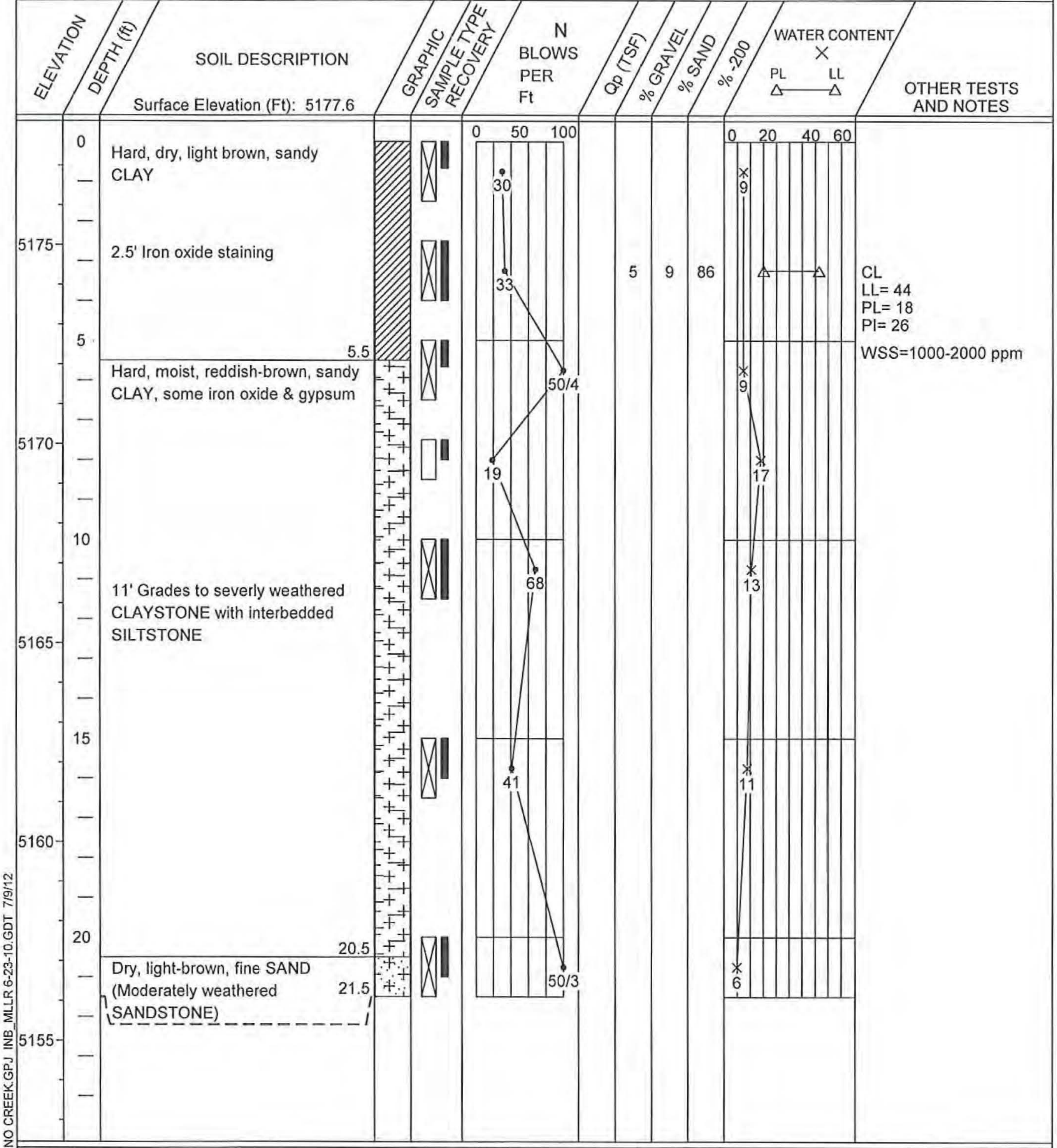
INBERG-MILLER ENGINEERS
IME
QUALITY SOLUTIONS THROUGH TEAMWORK

TEST BORING B1

Page 1 of 1

Project: Reno Creek
Location: WY State Plane 1145655, 518277

Job No.: 16216-CX
Client: AUC LLC



Hard, dry, light brown, sandy CLAY

2.5' Iron oxide staining

CL
LL= 44
PL= 18
PI= 26

WSS=1000-2000 ppm

Hard, moist, reddish-brown, sandy CLAY, some iron oxide & gypsum

11' Grades to severly weathered CLAYSTONE with interbedded SILTSTONE

Dry, light-brown, fine SAND (Moderately weathered SANDSTONE)

Remarks:

Date Begun: 6/13/12
Date Completed: 6/13/12
Termination Depth (ft): 21.5
Crew: ETG,BWH,JLH
Rig: CME-85
Method: Solid-Stem Auger
Benchmark/Datum (Ft):

SAMPLE TYPES

☒ Standard Penetration Test
☐ Drive Sampler, 2.41-I.D.

WATER LEVEL OBSERVATIONS

▽ While Drilling (ft)	None
▼ End of Drilling(ft)	None

Depth to Cave In (Ft): 20.9

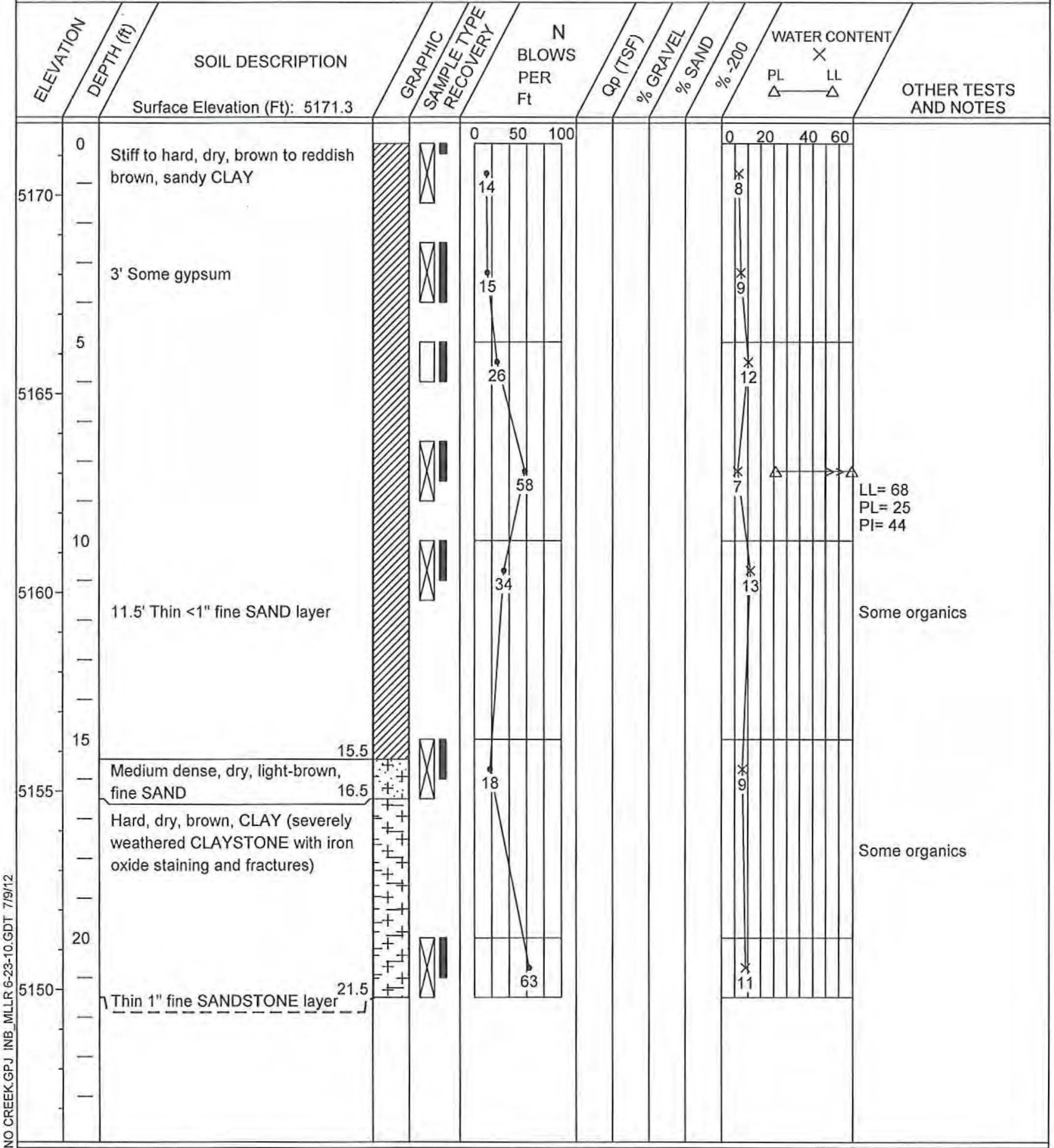
INBERG-MILLER ENGINEERS
QUALITY SOLUTIONS THROUGH TEAMWORK

TEST BORING B2

Page 1 of 1

Project: Reno Creek
Location: WY State Plane 1145642, 518410

Job No.: 16216-CX
Client: AUC LLC



Surface Elevation (Ft): 5171.3

Stiff to hard, dry, brown to reddish brown, sandy CLAY

3' Some gypsum

11.5' Thin <1" fine SAND layer

15.5

Medium dense, dry, light-brown, fine SAND

16.5

Hard, dry, brown, CLAY (severely weathered CLAYSTONE with iron oxide staining and fractures)

21.5

Thin 1" fine SANDSTONE layer

LL= 68
PL= 25
PI= 44

Some organics

Some organics

Remarks:

Date Begun:	6/13/12
Date Completed:	6/13/12
Termination Depth (ft):	21.5
Crew:	ETG,BWH,JLH
Rig:	CME-85
Method:	Solid-Stem Auger
Benchmark/Datum (Ft):	

SAMPLE TYPES

☒ Standard Penetration Test

☐ Drive Sampler, 2.41-I.D.

WATER LEVEL OBSERVATIONS

▽ While Drilling (ft)	None
▼ End of Drilling(ft)	None

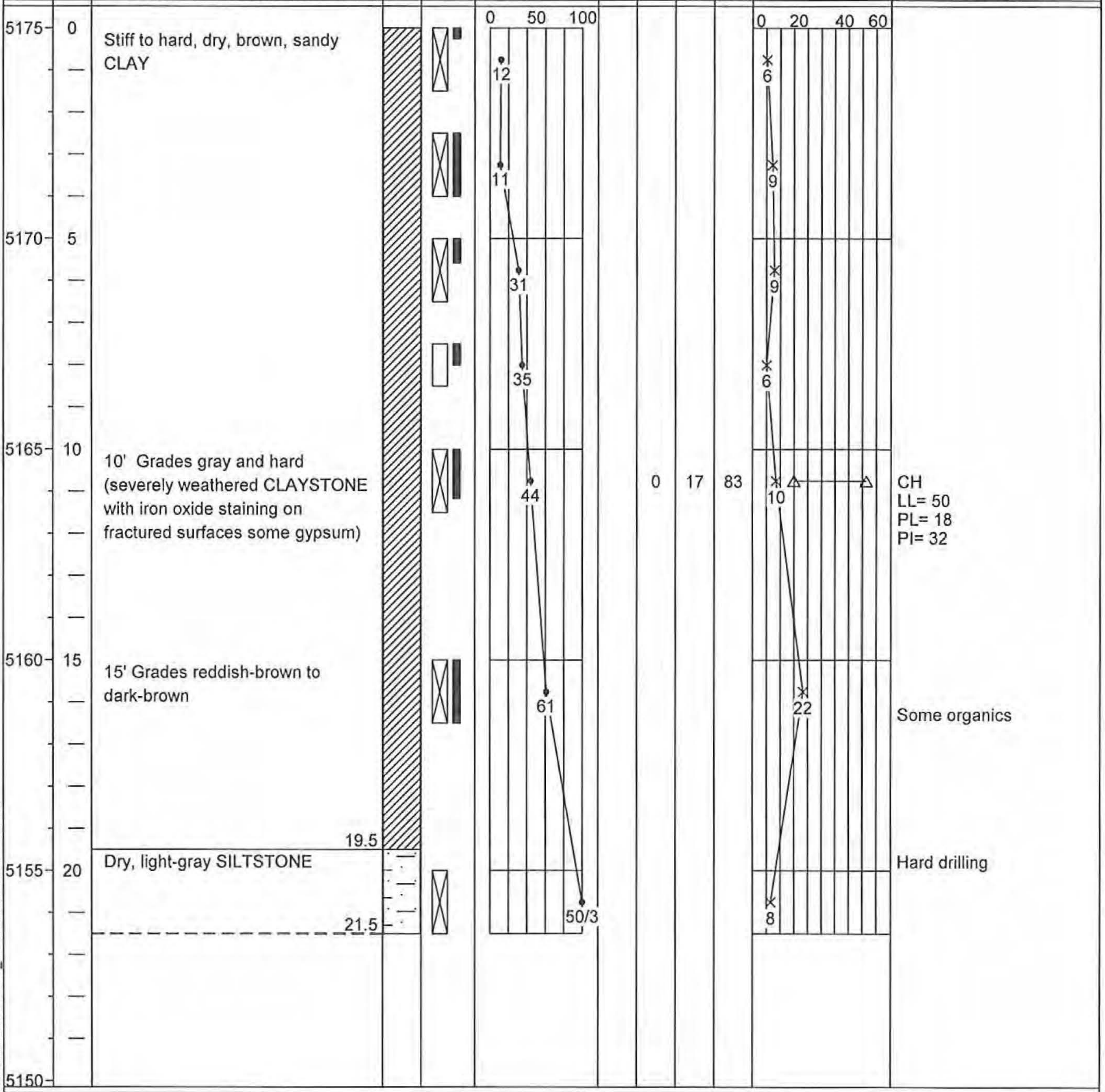
Depth to Cave In (Ft): 21.9

INBERG-MILLER ENGINEERS
QUALITY SOLUTIONS THROUGH TEAMWORK

TEST BORING B3

Project: Reno Creek
Location: WY State Plane 1145795, 518334

Job No.: 16216-CX
Client: AUC LLC



Surface Elevation (Ft): 5175.0

ELEVATION	DEPTH (ft)	SOIL DESCRIPTION	SAMPLE TYPE	N BLOWS PER Ft	Qp (TSF)	% GRAVEL	% SAND	% -200	WATER CONTENT	OTHER TESTS AND NOTES
5175	0	Stiff to hard, dry, brown, sandy CLAY	☒	12					6	
			☒	11					9	
5170	5		☒	31					9	
			☐	35					6	
5165	10	10' Grades gray and hard (severely weathered CLAYSTONE with iron oxide staining on fractured surfaces some gypsum)	☒	44		0	17	83	10	CH LL= 50 PL= 18 PI= 32
5160	15	15' Grades reddish-brown to dark-brown	☒	61					22	Some organics
	19.5	Dry, light-gray SILTSTONE								Hard drilling
5155	20		☒	50/3					8	
	21.5									
5150										

Remarks:

Date Begun: 6/13/12
Date Completed: 6/13/12
Termination Depth (ft): 21.5
Crew: ETG,BWH,JLH
Rig: CME-85
Method: Solid-Stem Auger
Benchmark/Datum (Ft):

SAMPLE TYPES
☒ Standard Penetration Test
☐ Drive Sampler, 2.41-I.D.

WATER LEVEL OBSERVATIONS

▽ While Drilling (ft)	None
▼ End of Drilling(ft)	None

Depth to Cave In (Ft): 20.0

INBERG-MILLER ENGINEERS
IME
QUALITY SOLUTIONS THROUGH TEAMWORK

TEST BORING B4

Page 1 of 1

Project: Reno Creek
Location: WY State Plane 1145947, 518254

Job No.: 16216-CX
Client: AUC LLC

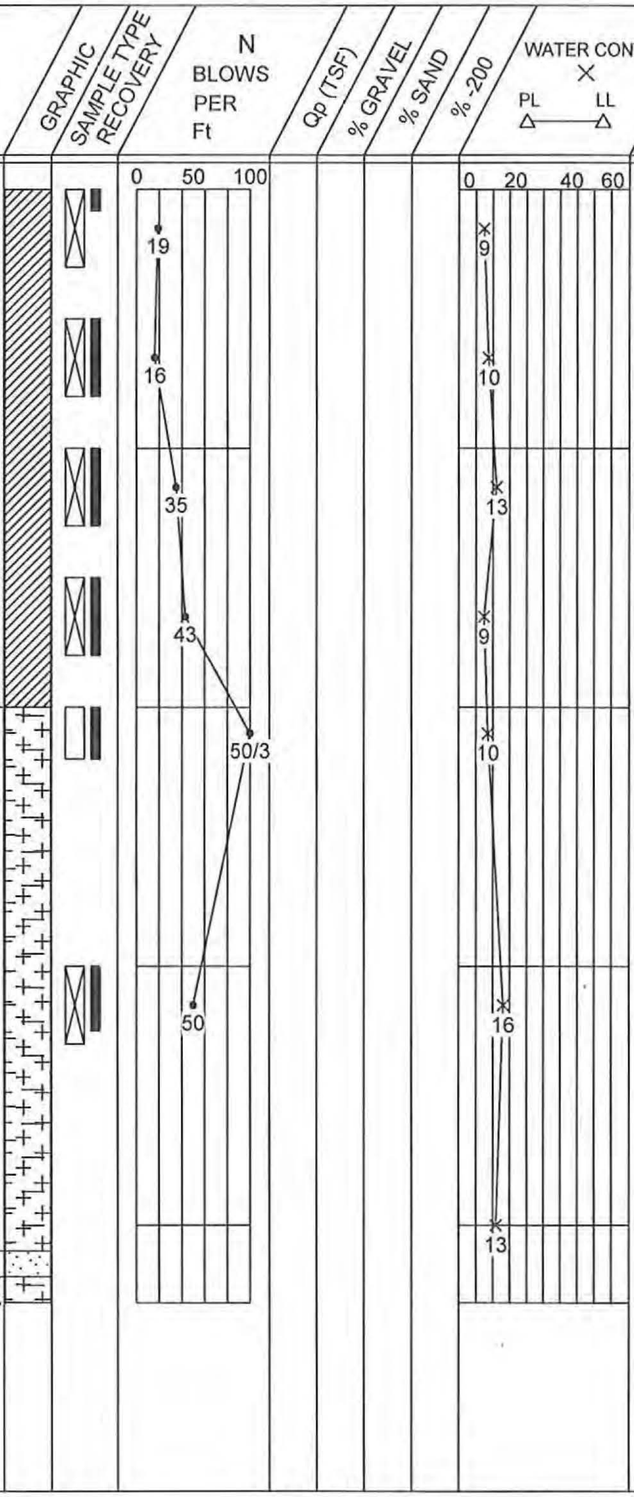
ELEVATION

DEPTH (ft)

SOIL DESCRIPTION

Surface Elevation (Ft): 5177.7

5175	0	Very stiff to hard, dry, brown, sandy CLAY
5170	5	
	10	10
5165	10	Hard, dry, gray to reddish brown, sandy CLAY (severely weathered organic rich CLAYSTONE)
5160	15	
	20	20.5
		Dry, light-brown, very fine SAND 21
5155		Moist, gray CLAYSTONE 21.5



OTHER TESTS AND NOTES

Remarks:

Date Begun:	6/13/12
Date Completed:	6/13/12
Termination Depth (ft):	21.5
Crew:	ETG,BWH,JLH
Rig:	CME-85
Method:	Solid-Stem Auger
Benchmark/Datum (Ft):	

SAMPLE TYPES

☒ Standard Penetration Test

☐ Drive Sampler, 2.41-I.D.

WATER LEVEL OBSERVATIONS

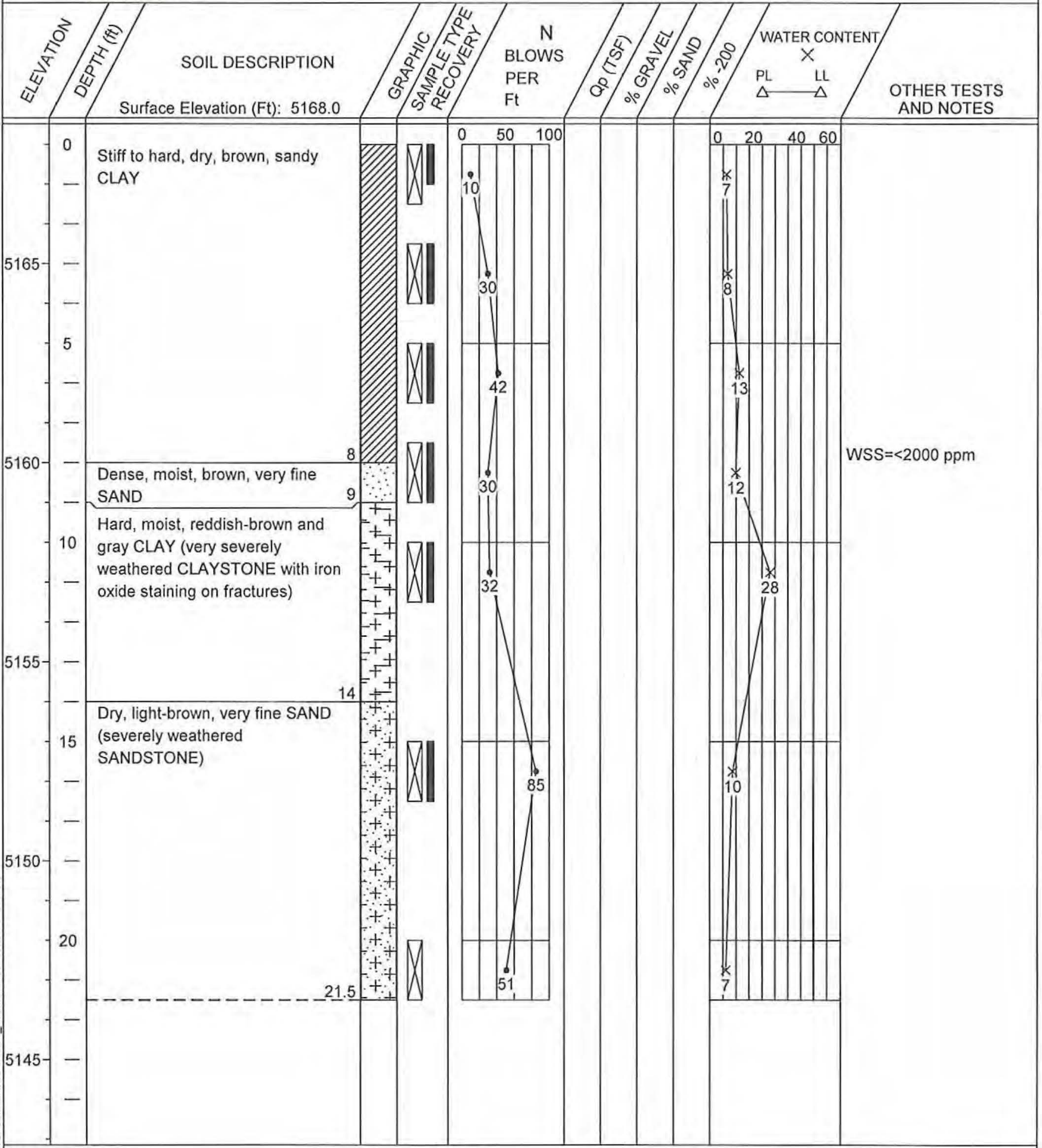
∇ While Drilling (ft)	None
▼ End of Drilling(ft)	None

Depth to Cave In (Ft): 21.7

TEST BORING B5

Page 1 of 1

Project: Reno Creek
Location: WY State Plane 1145954, 518421
Job No.: 16216-CX
Client: AUC LLC



Stiff to hard, dry, brown, sandy CLAY

Dense, moist, brown, very fine SAND

Hard, moist, reddish-brown and gray CLAY (very severely weathered CLAYSTONE with iron oxide staining on fractures)

Dry, light-brown, very fine SAND (severely weathered SANDSTONE)

WSS=<2000 ppm

Remarks:

Date Begun: 6/13/12
Date Completed: 6/13/12
Termination Depth (ft): 21.5
Crew: ETG,BWH,JLH
Rig: CME-85
Method: Solid-Stem Auger
Benchmark/Datum (Ft):

SAMPLE TYPES

☒ Standard Penetration Test

WATER LEVEL OBSERVATIONS

⊻ While Drilling (ft)	None
⊻ End of Drilling(ft)	None

Depth to Cave In (Ft): 21.9

INBERG-MILLER ENGINEERS
QUALITY SOLUTIONS THROUGH TEAMWORK

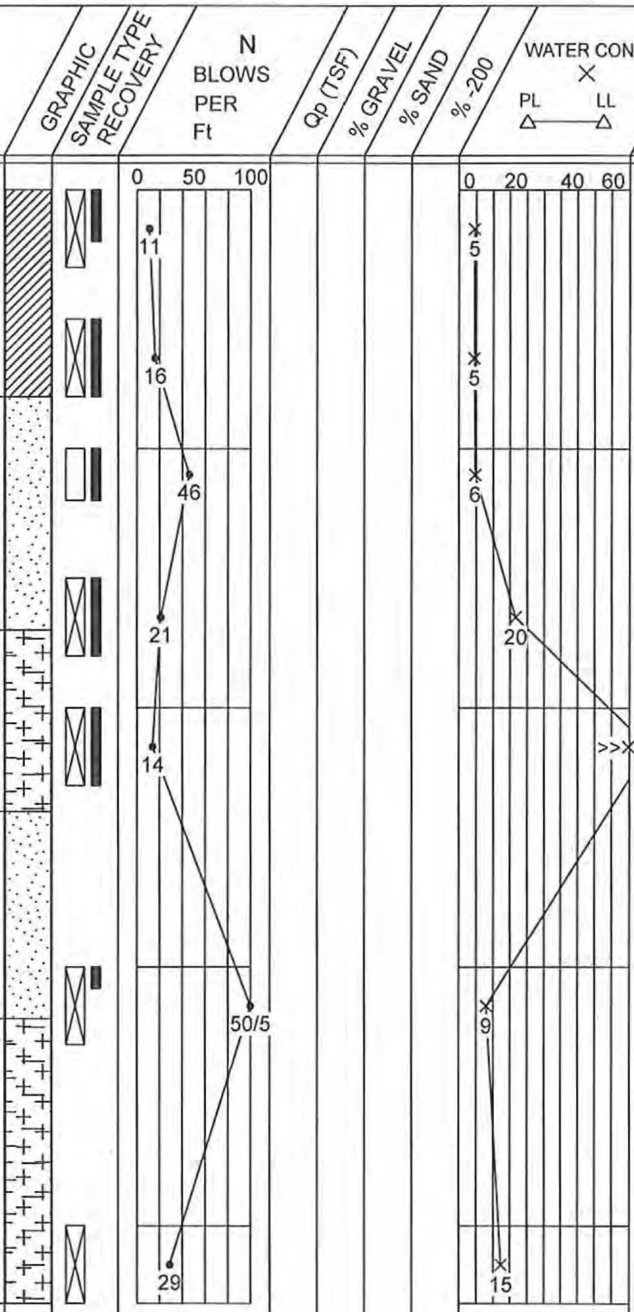
TEST BORING B6

Page 1 of 1

Project: Reno Creek
Location: WY State Plane 1146119, 518424
Job No.: 16216-CX
Client: AUC LLC

Surface Elevation (Ft): 5154.3

ELEVATION	DEPTH (ft)	SOIL DESCRIPTION
	0	Stiff to very stiff, dry, brown, sandy CLAY
	4	
5150	5	Medium dense to dense, brown, moist, very fine SAND
	8.5	
5145	10	Very stiff, dry, brown, CLAY with iron oxide staining and some organics Lignite
	12	
		Dense, dry, light-brown, very fine SAND
5140	15	
	16	
		Hard, moist, gray, CLAY (severely weathered CLAYSTONE with iron oxide staining on fractures)
5135	20	
	21.5	
5130		



OTHER TESTS AND NOTES

Remarks:

Date Begun: 6/13/12
Date Completed: 6/13/12
Termination Depth (ft): 21.5
Crew: ETG,BWH,JLH
Rig: CME-85
Method: Solid-Stem Auger
Benchmark/Datum (Ft):

SAMPLE TYPES

☒ Standard Penetration Test

☐ Drive Sampler, 2.41-I.D.

WATER LEVEL OBSERVATIONS

▽ While Drilling (ft)	None
▼ End of Drilling(ft)	None

Depth to Cave In (Ft): 21.5

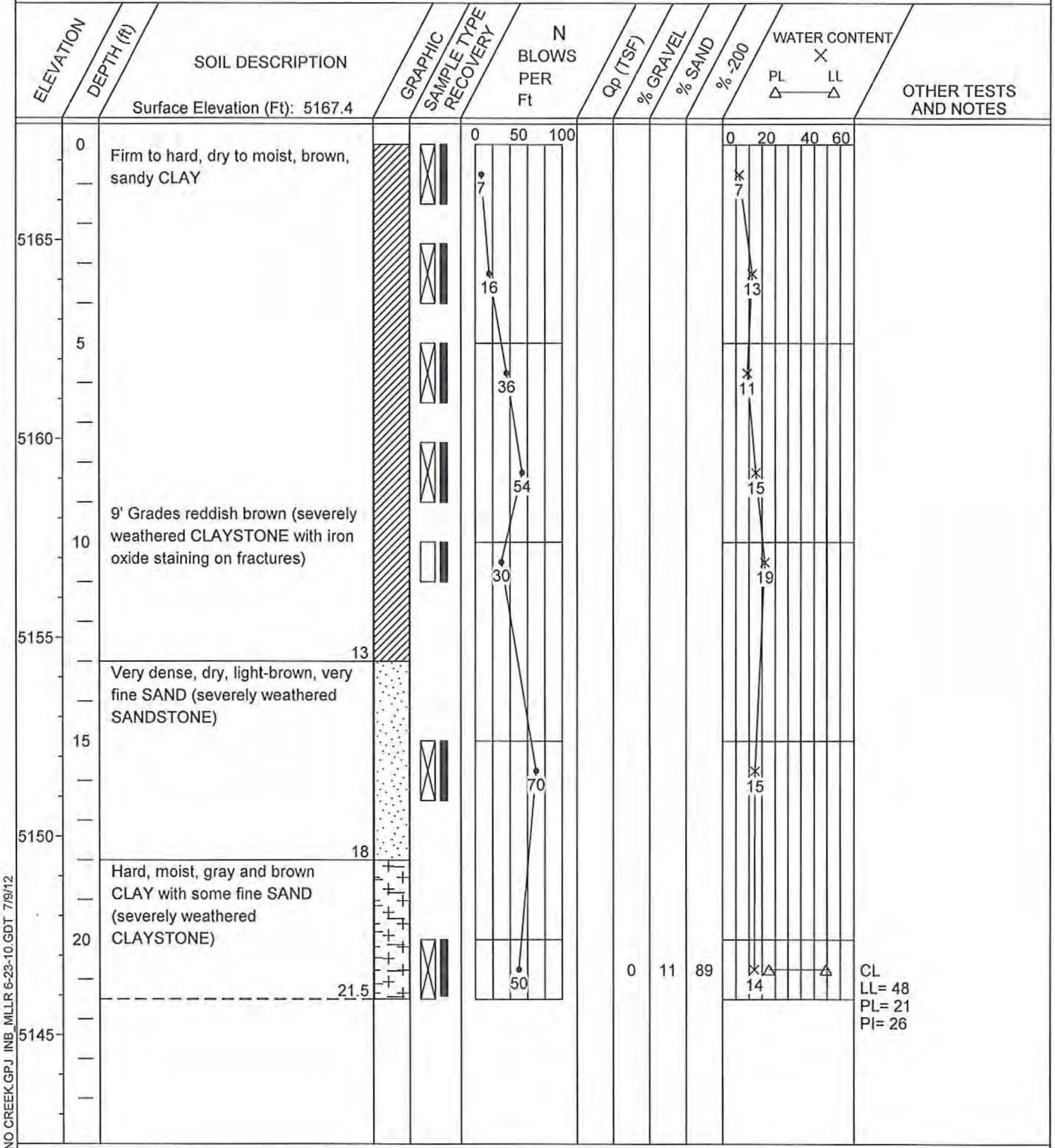
INBERG-MILLER ENGINEERS
IME
QUALITY SOLUTIONS THROUGH TEAMWORK

TEST BORING B7

Page 1 of 1

Project: Reno Creek
Location: WY State Plane 1146092, 518327

Job No.: 16216-CX
Client: AUC LLC



Depth (ft)	Soil Description
0	Firm to hard, dry to moist, brown, sandy CLAY
	9' Grades reddish brown (severely weathered CLAYSTONE with iron oxide staining on fractures)
13	Very dense, dry, light-brown, very fine SAND (severely weathered SANDSTONE)
18	Hard, moist, gray and brown CLAY with some fine SAND (severely weathered CLAYSTONE)
21.5	

N	Qp (TSF)	% GRAVEL	% SAND	% -200	Water Content	Other Tests and Notes
50		0	11	89	14	CL LL= 48 PL= 21 PI= 26

Remarks:

Date Begun: 6/13/12
Date Completed: 6/13/12
Termination Depth (ft): 21.5
Crew: ETG,BWH,JLH
Rig: CME-85
Method: Solid-Stem Auger
Benchmark/Datum (Ft):

SAMPLE TYPES

☒ Standard Penetration Test
☐ Drive Sampler, 2.41-I.D.

WATER LEVEL OBSERVATIONS

▽ While Drilling (ft)	None
▼ End of Drilling(ft)	None

Depth to Cave In (Ft): 21.0

INBERG-MILLER ENGINEERS

QUALITY SOLUTIONS THROUGH TEAMWORK

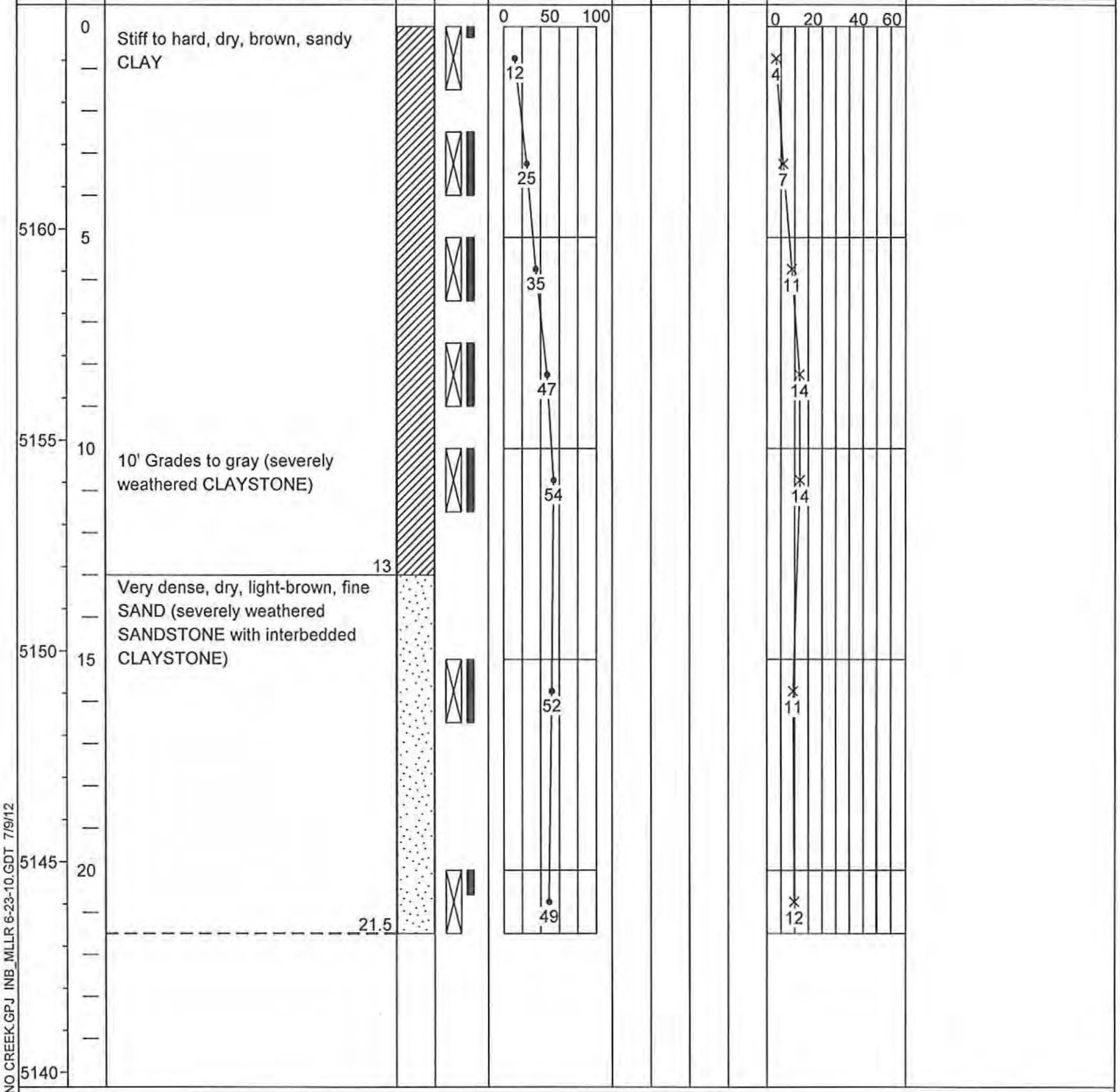
TEST BORING B8

Project: Reno Creek
Location: WY State Plane 1146131, 518250

Job No.: 16216-CX
Client: AUC LLC

ELEVATION | DEPTH (ft) | SOIL DESCRIPTION | GRAPHIC | SAMPLE TYPE RECOVERY | N BLOWS PER Ft | Qp (TSF) | % GRAVEL | % SAND | % -200 | WATER CONTENT × PL △—△ LL | OTHER TESTS AND NOTES

Surface Elevation (Ft): 5164.8



Stiff to hard, dry, brown, sandy CLAY

10' Grades to gray (severely weathered CLAYSTONE)

Very dense, dry, light-brown, fine SAND (severely weathered SANDSTONE with interbedded CLAYSTONE)

Remarks:

Date Begun: 6/13/12
Date Completed: 6/13/12
Termination Depth (ft): 21.5
Crew: ETG,BWH,JLH
Rig: CME-85
Method: Solid-Stem Auger
Benchmark/Datum (Ft):

SAMPLE TYPES

☒ Standard Penetration Test

WATER LEVEL OBSERVATIONS

▽ While Drilling (ft)	None
▼ End of Drilling(ft)	None

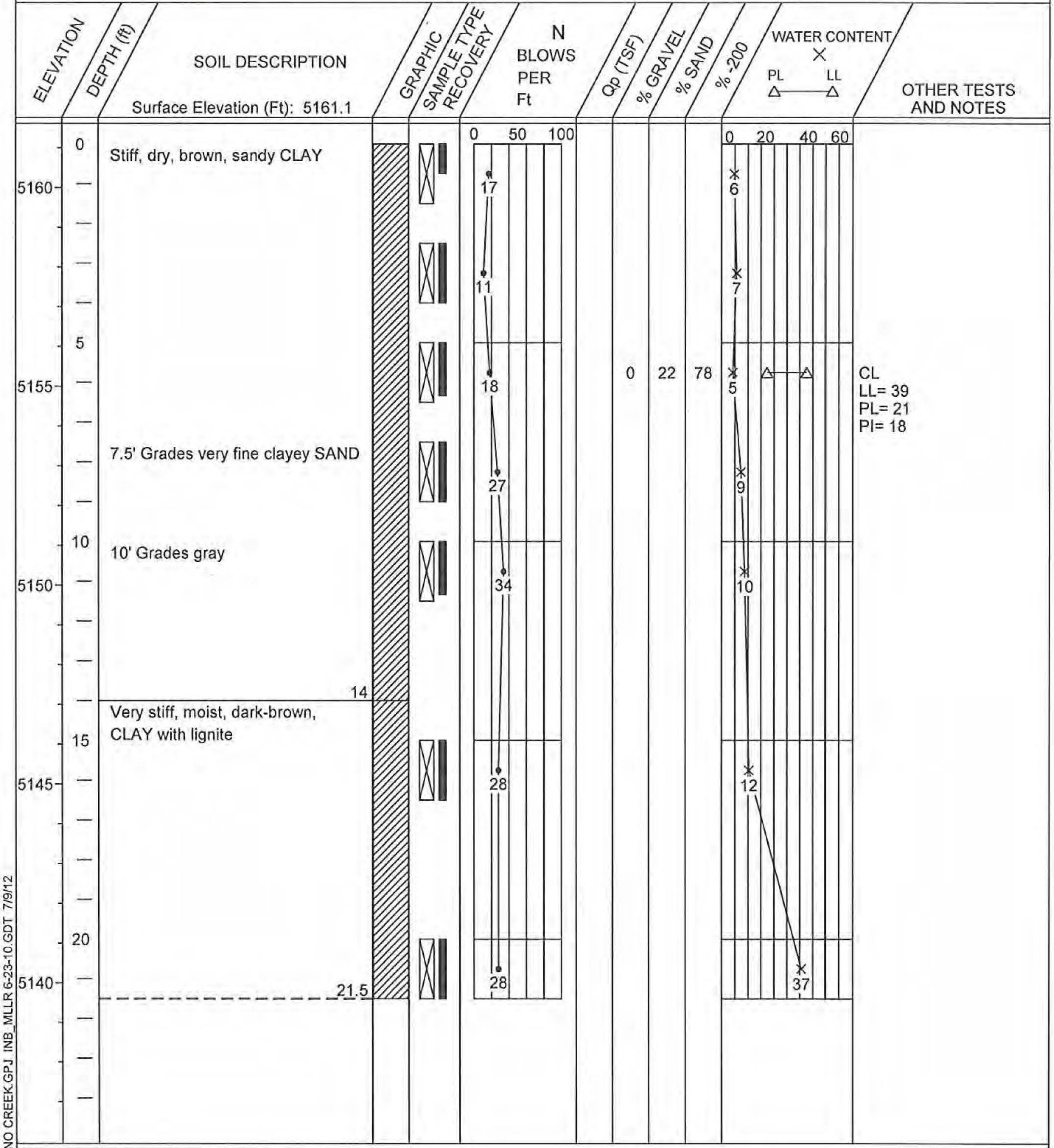
Depth to Cave In (Ft): 21.9

INBERG-MILLER ENGINEERS
QUALITY SOLUTIONS THROUGH TEAMWORK

TEST BORING B9

Project: Reno Creek
Location: WY State Plane 1145815, 517746
Job No.: 16216-CX
Client: AUC LLC

Surface Elevation (Ft): 5161.1



Stiff, dry, brown, sandy CLAY

7.5' Grades very fine clayey SAND

10' Grades gray

Very stiff, moist, dark-brown, CLAY with lignite

CL
LL= 39
PL= 21
PI= 18

Remarks:

Date Begun: 6/13/12
Date Completed: 6/13/12
Termination Depth (ft): 21.5
Crew: BH,BWH,JLH
Rig: CME-85
Method: Solid-Stem Auger
Benchmark/Datum (Ft):

SAMPLE TYPES

☒ Standard Penetration Test

WATER LEVEL OBSERVATIONS

▽ While Drilling (ft)	None
▼ End of Drilling(ft)	None

Depth to Cave In (Ft): 21.3

INBERG-MILLER ENGINEERS
IME
QUALITY SOLUTIONS THROUGH TEAMWORK

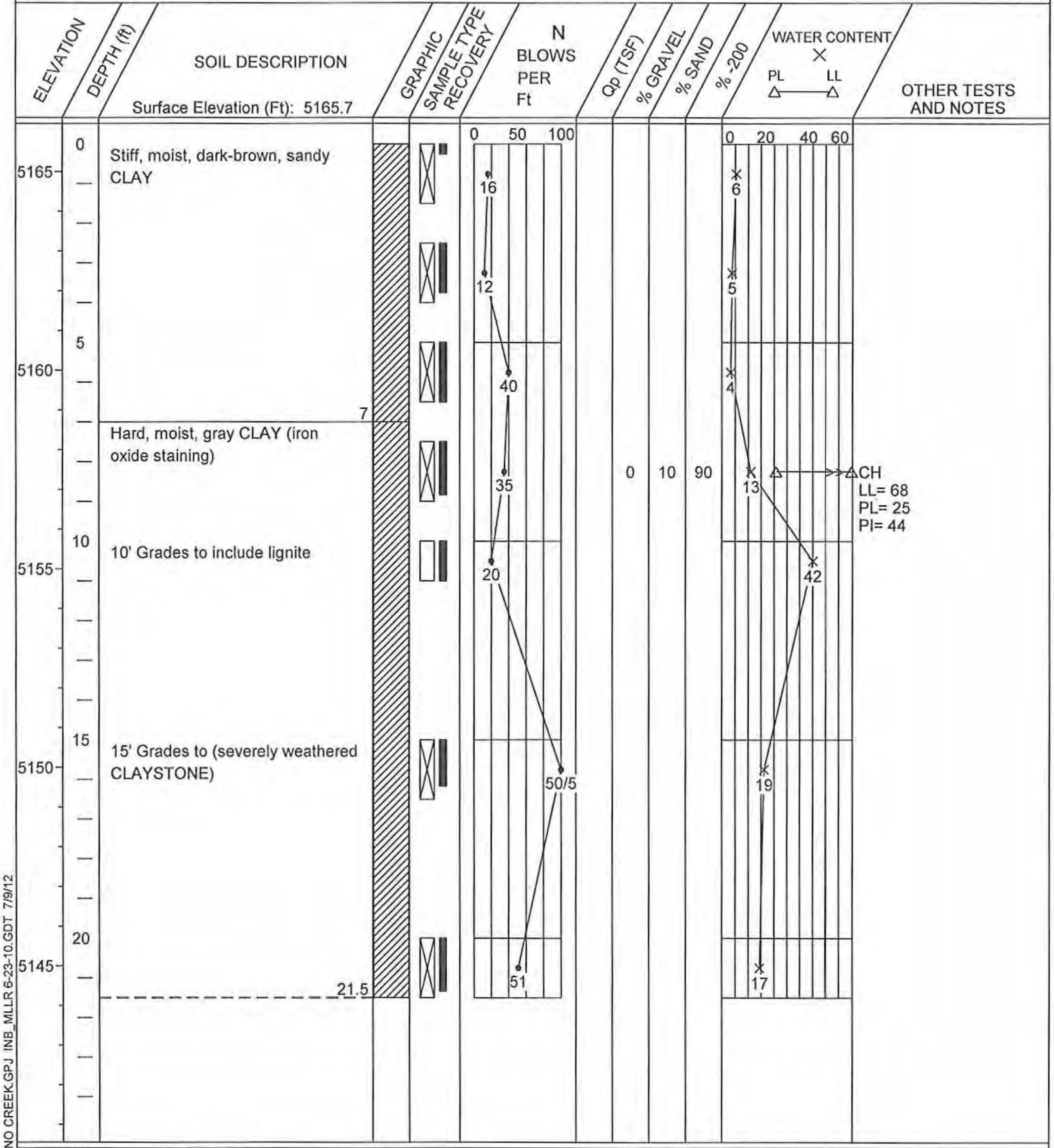
TEST BORING B10

Page 1 of 1

Project: Reno Creek
Location: WY State Plane 1145643, 517672
Job No.: 16216-CX
Client: AUC LLC

Surface Elevation (Ft): 5165.7

ELEVATION	DEPTH (ft)	SOIL DESCRIPTION
5165.7	0	Stiff, moist, dark-brown, sandy CLAY
	7	Hard, moist, gray CLAY (iron oxide staining)
	10	10' Grades to include lignite
	15	15' Grades to (severely weathered CLAYSTONE)
	21.5	



Remarks:

Date Begun:	6/14/12
Date Completed:	6/14/12
Termination Depth (ft):	21.5
Crew:	BH,BWH,JLH
Rig:	CME-85
Method:	Solid-Stem Auger
Benchmark/Datum (Ft):	

SAMPLE TYPES

- ☒ Standard Penetration Test
- ☐ Drive Sampler, 2.41-I.D.

WATER LEVEL OBSERVATIONS

∇ While Drilling (ft)	None
▼ End of Drilling(ft)	None

Depth to Cave In (Ft): 21.0

INBERG-MILLER ENGINEERS

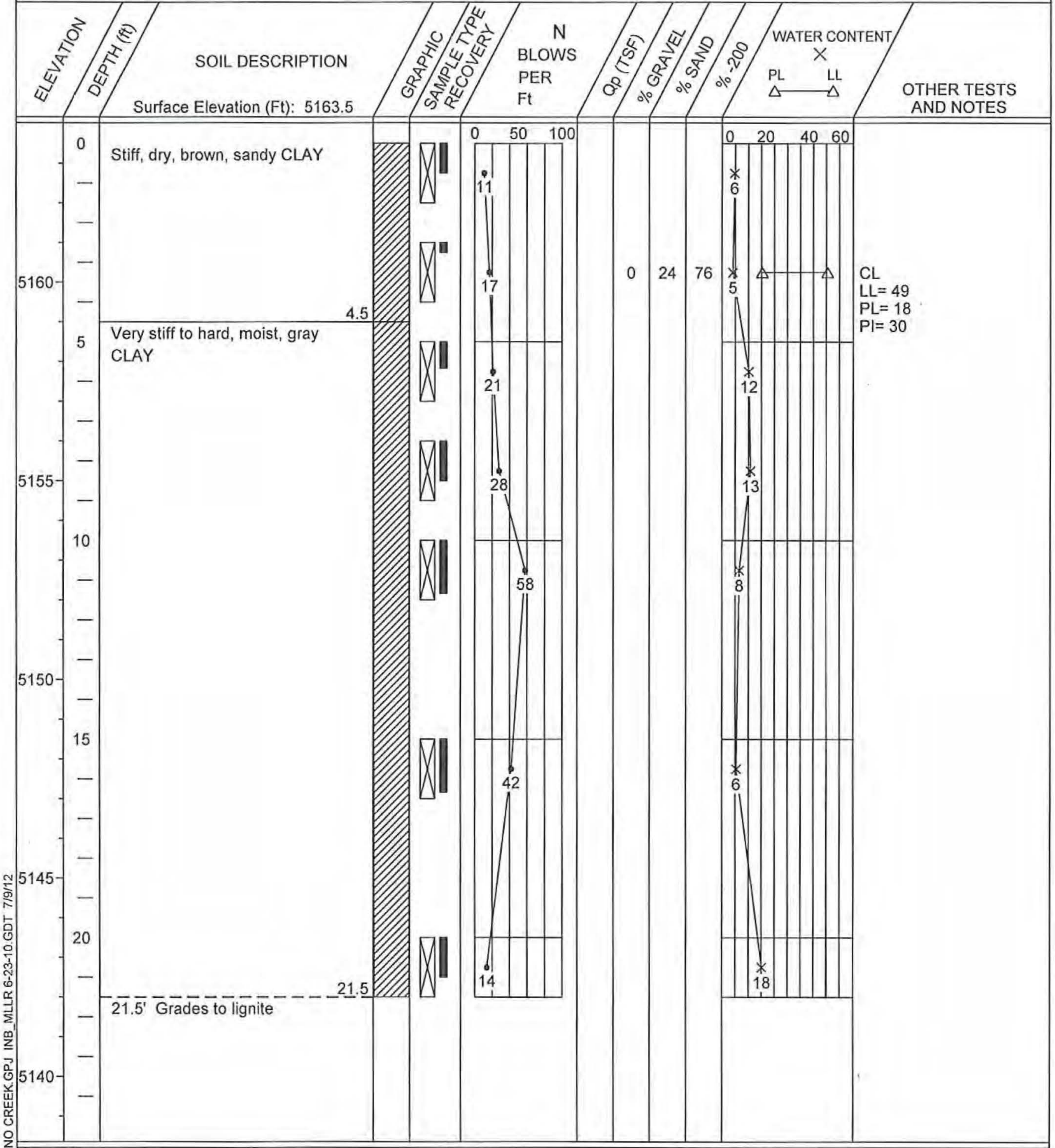
QUALITY SOLUTIONS THROUGH TEAMWORK

TEST BORING B11

Page 1 of 1

Project: Reno Creek
Location: WY State Plane 1145485, 517741

Job No.: 16216-CX
Client: AUC LLC



Remarks:

Date Begun: 6/14/12
Date Completed: 6/14/12
Termination Depth (ft): 21.5
Crew: BH,BWH,JLH
Rig: CME-85
Method: Solid-Stem Auger
Benchmark/Datum (Ft):

SAMPLE TYPES

☒ Standard Penetration Test

WATER LEVEL OBSERVATIONS

⊻	While Drilling (ft)	None
⊻	End of Drilling(ft)	None

Depth to Cave In (Ft): 21

INBERG-MILLER ENGINEERS
QUALITY SOLUTIONS THROUGH TEAMWORK

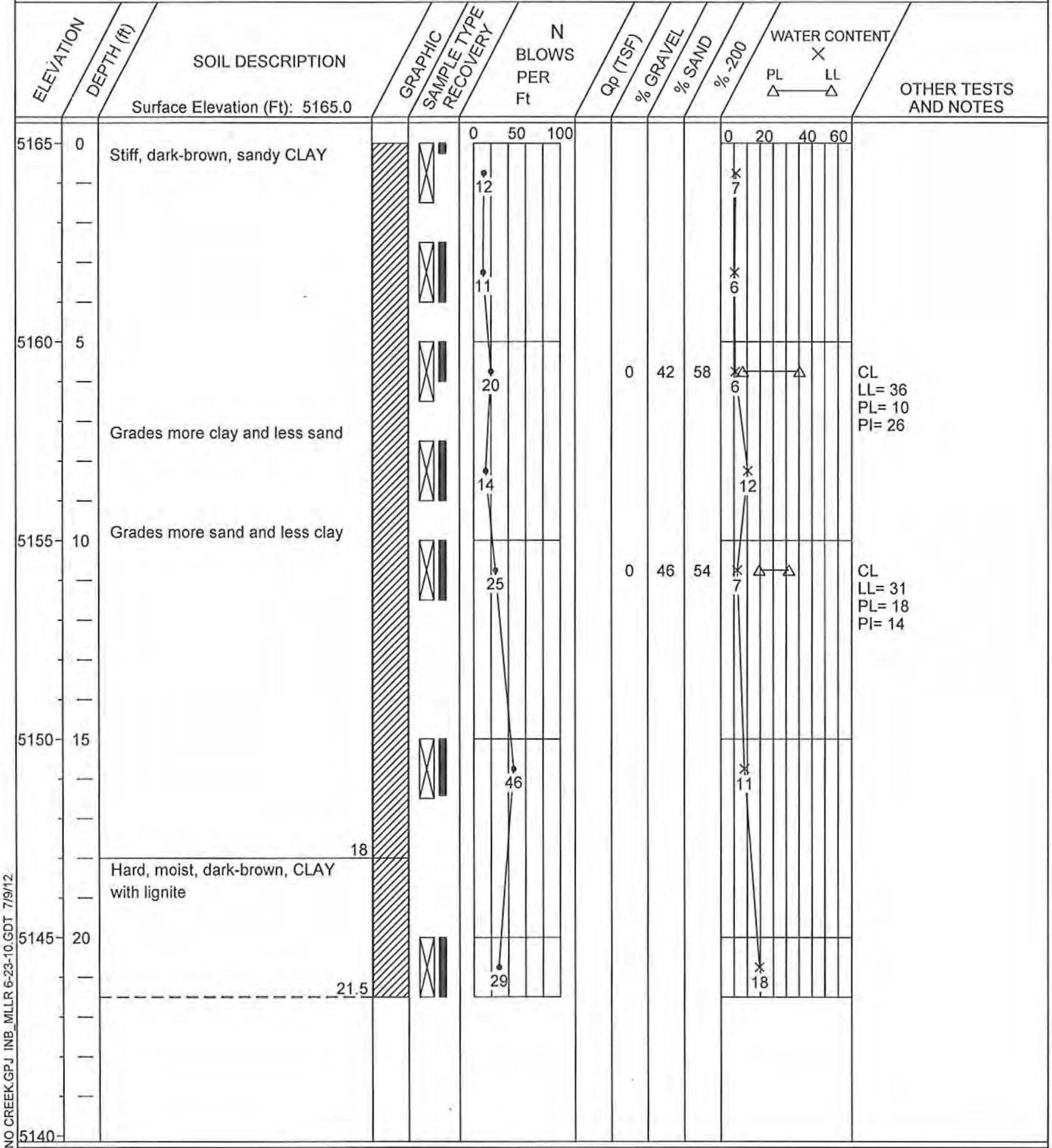
TEST BORING B12

Page 1 of 1

Project: Reno Creek
Location: WY State Plane 1145948, 517669

Job No.: 16216-CX
Client: AUC LLC

Surface Elevation (Ft): 5165.0



ELEVATION	DEPTH (ft)	SOIL DESCRIPTION	N BLOWS PER Ft	Qp (TSF)	% GRAVEL	% SAND	% -200	WATER CONTENT	OTHER TESTS AND NOTES
5165	0	Stiff, dark-brown, sandy CLAY	12					7	
			11					6	
5160	5		20		0	42	58	6	CL LL= 36 PL= 10 PI= 26
		Grades more clay and less sand	14					12	
5155	10	Grades more sand and less clay	25		0	46	54	7	CL LL= 31 PL= 18 PI= 14
5150	15		46					11	
	18	Hard, moist, dark-brown, CLAY with lignite							
5145	20		29					18	
	21.5								
5140									

Remarks:

Date Begun:	6/14/12
Date Completed:	6/14/12
Termination Depth (ft):	21.5
Crew:	BH,BWH,JLH
Rig:	CME-85
Method:	Solid-Stem Auger
Benchmark/Datum (Ft):	

SAMPLE TYPES

☒ Standard Penetration Test

WATER LEVEL OBSERVATIONS

⊻ While Drilling (ft)	None
⊻ End of Drilling(ft)	None

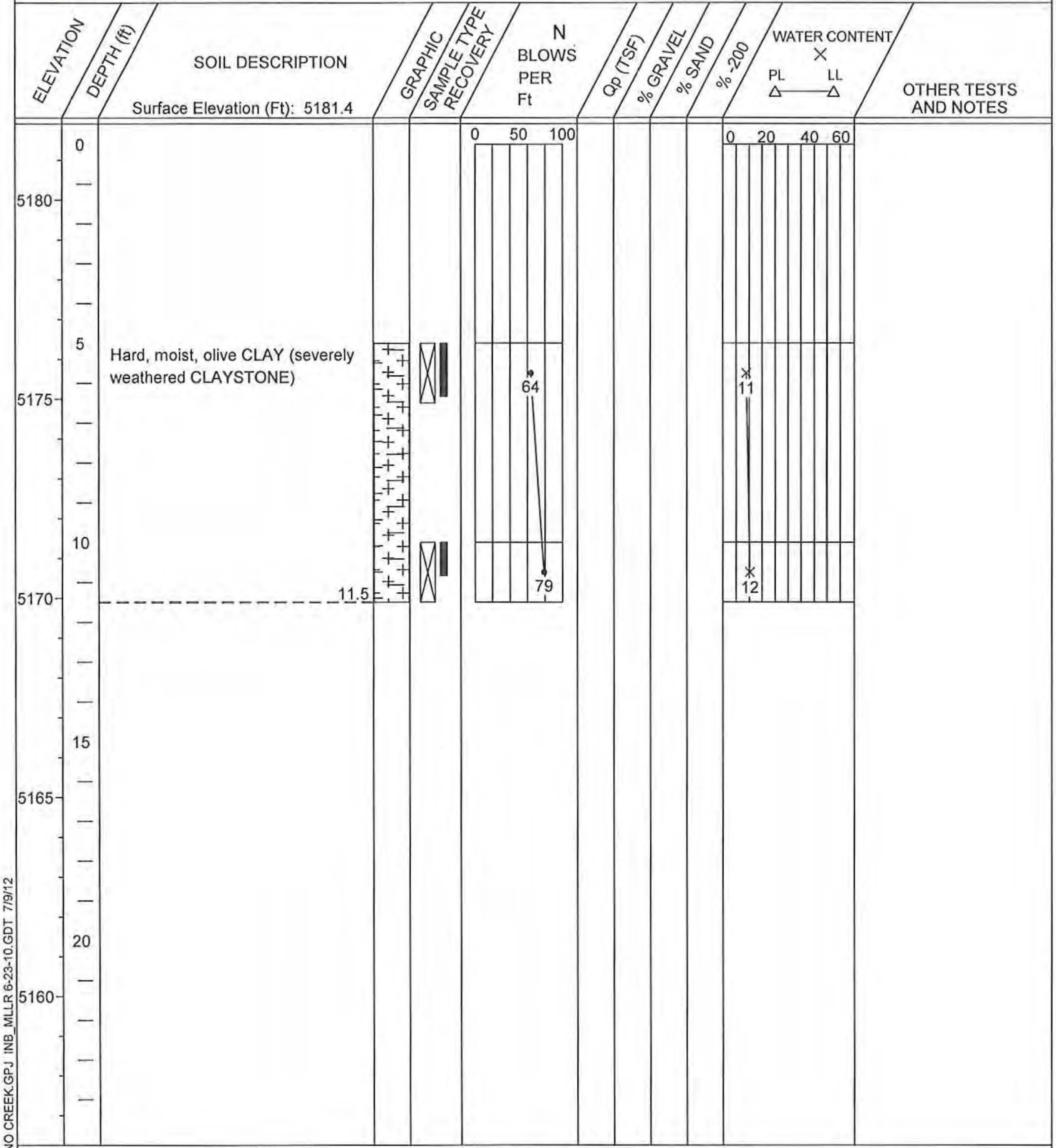
Depth to Cave In (Ft): 21.5

INBERG-MILLER ENGINEERS
QUALITY SOLUTIONS THROUGH TEAMWORK

TEST BORING B13

Page 1 of 1

Project: Reno Creek
Location: WY State Plane 1145983, 518301
Job No.: 16216-CX
Client: AUC LLC



Hard, moist, olive CLAY (severely weathered CLAYSTONE)

Remarks:

Date Begun:	6/14/12
Date Completed:	6/14/12
Termination Depth (ft):	11.5
Crew:	BH,BWH,JLH
Rig:	CME-85
Method:	Solid-Stem Auger
Benchmark/Datum (Ft):	

SAMPLE TYPES

☒ Standard Penetration Test

WATER LEVEL OBSERVATIONS

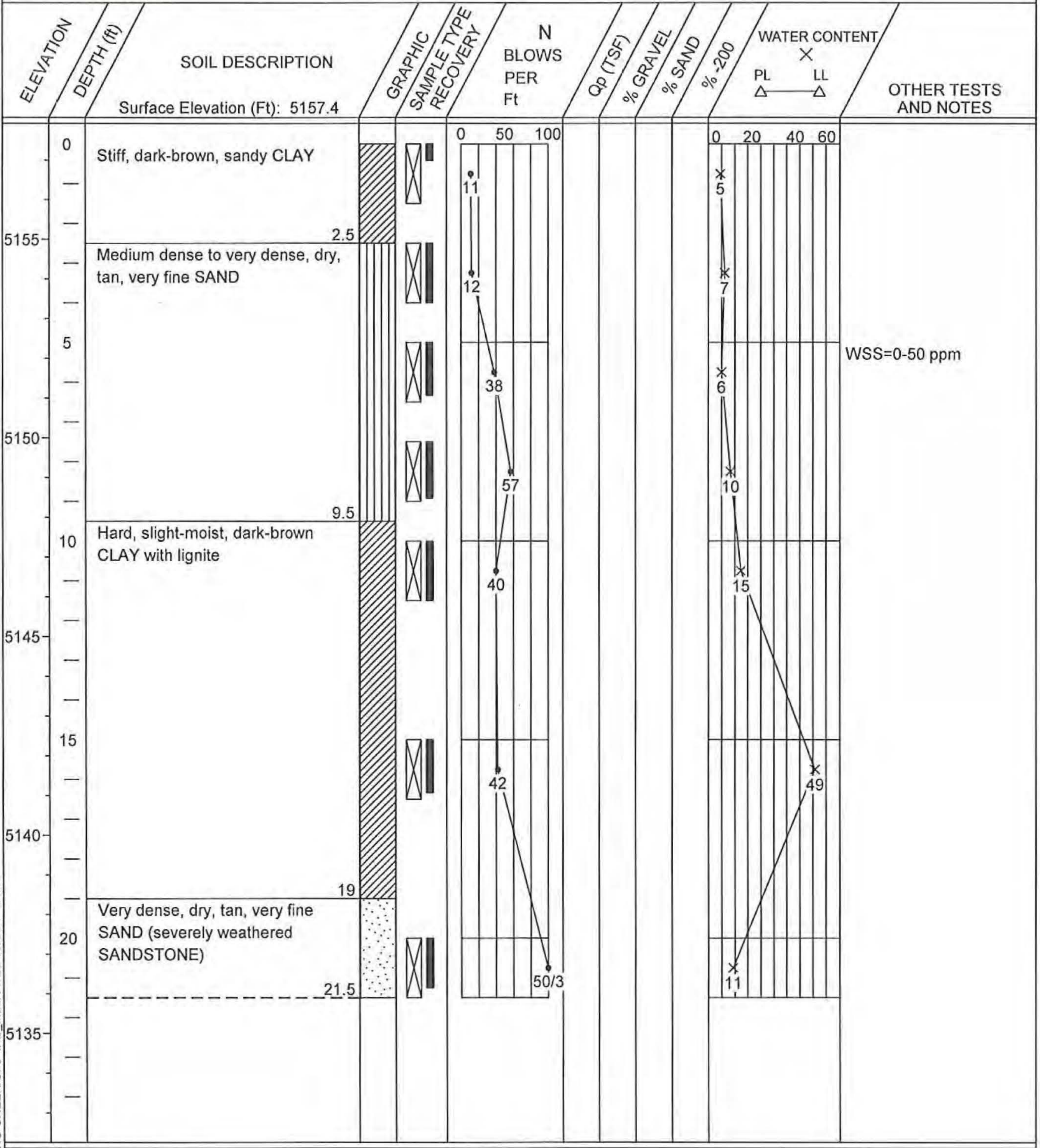
▽ While Drilling (ft)	None
▼ End of Drilling(ft)	None

Depth to Cave In (Ft): 11.5

TEST BORING B14

Project: Reno Creek
Location: WY State Plane 1146077,
518426

Job No.: 16216-CX
Client: AUC LLC



Remarks:

Date Begun: 6/14/12
Date Completed: 6/14/12
Termination Depth (ft): 21.5
Crew: BH,BWH,JLH
Rig: CME-85
Method: Solid-Stem Auger
Benchmark/Datum (Ft):

SAMPLE TYPES

☒ Standard Penetration Test

WATER LEVEL OBSERVATIONS

▽ While Drilling (ft)	None
▼ End of Drilling(ft)	None

Depth to Cave In (Ft): 21

INBERG-MILLER ENGINEERS
QUALITY SOLUTIONS THROUGH TEAMWORK

TEST BORING B15

Page 1 of 1

Project: Reno Creek
Location: WY State Plane 1146066, 518704
Job No.: 16216-CX
Client: AUC LLC

Surface Elevation (Ft): 5133.6

ELEVATION	DEPTH (ft)	SOIL DESCRIPTION	GRAPHIC	SAMPLE TYPE RECOVERY	N BLOWS PER Ft	Qp (TSF)	% GRAVEL	% SAND	% -200	WATER CONTENT	OTHER TESTS AND NOTES
5133.6	0	Stiff, moist, tan, sandy CLAY	▨	☒	5					5	
			▨	☒	21		0	19	81	9	CL LL= 42 PL= 18 PI= 24
			▨	☒	18					11	
	14	Medium dense, moist, brown, clayey SAND	▨	☒	20					9	
	16.5										

Remarks:

Date Begun:	6/14/12
Date Completed:	6/14/12
Termination Depth (ft):	16.5
Crew:	BH,BWH,JLH
Rig:	CME-85
Method:	Solid-Stem Auger
Benchmark/Datum (Ft):	

SAMPLE TYPES

☒ Standard Penetration Test

WATER LEVEL OBSERVATIONS

▽ While Drilling (ft)	None
▼ End of Drilling(ft)	None
	None
Depth to Cave In (Ft):	16

GENERAL NOTES - LOG OF TEST BORING/TEST PIT

DESCRIPTIVE SOIL CLASSIFICATION

Grain Size Terminology

Soil Fraction		Particle Size	U.S. Standard Sieve Size
Boulders		Larger than 12"	Larger than 12"
Cobbles		3" to 12"	3" to 12"
Gravel:	Coarse	3/4" to 3"	3/4" to 3"
	Fine	4.76mm to ¾"	#4 to ¾"
Sand:	Coarse	2.00mm to 4.76mm	#10 to #4
	Medium	0.42mm to 2.00mm	#40 to #10
	Fine	0.074mm to 0.42mm	#200 to #40
Silt		0.005mm to 0.074mm	Smaller than #200
Clay		Smaller than 0.005mm	Smaller than #200

Plasticity characteristics differentiate between silt and clay

Relative Density

Term	"N" Value*
Very Loose	0-4
Loose	4-10
Medium Dense	10-30
Dense	30-50
Very Dense	Over 50

Consistency

Term	q_u-tons/sq. ft.
Very Soft	0.0 to 0.25
Soft	0.25 to 0.5
Firm	0.5 to 1.0
Stiff	1.0 to 2.0
Very Stiff	2.0 to 4.0
Hard	Over 4.0

*Note: The penetration number, N, is the summation of blows required to effect two successive 6" penetrations of the 2" split-barrel sampler. The sampler is driven with a 140-pound weight falling 30", and is seated to a depth of 6" before commencing the standard penetration test.

DESCRIPTIVE ROCK CLASSIFICATION

Engineering Hardness Description of Rock

(not to be confused with MOH's scale for minerals)

Very Soft	Can be carved with a knife. Can be excavated readily with point of pick. Pieces one inch or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.
Soft	Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.
Medium Soft	Can be grooved or gouged 1/16-inch deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1-inch-maximum size by hard blows of the point of a geologist's pick.
Medium Hard	Can be scratched with knife or pick. Gouges or grooves to ¼-inch deep. Can be excavated by hard blow of a geologist's pick. Hand specimens can be detached by moderate blow.
Hard	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.
Very Hard	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist's pick.

NOMENCLATURE

Drilling and Sampling

SS -- Split Barrel (spoon) Sampler

N -- Standard Penetration Test Number, blows/foot*

ST -- Thin-walled Tube (Shelby Tube) Sampler

DC -- Thick-wall, ring lined, drive sampler

C -- Coring

DP -- Direct Push Sampler

CS -- Continuous Sampler (used in conjunction with hollow stem auger drilling)

D -- Disturbed Sample (auger cuttings, air/wash rotary cuttings, backhoe, shovel, etc.)

Laboratory Tests

USCS -- Unified Soil Classification System (soil type)

W -- Water Content (%)

LL -- Liquid Limit (%)

PL -- Plastic Limit (%)

PI -- Plasticity Index (LL-PL) (%)

q_u -- Unconfined Strength, TSF

q_p -- Penetrometer Reading (estimate of unconfined strength), TSF

γ_m -- Moist Unit Weight, PCF

γ_d -- Dry Unit Weight, PCF

WSS -- Water Soluble Sulfate (%)

Φ -- Angle of Internal Friction (degrees)

c -- Soil Cohesion, TSF

SG -- Specific gravity of soil solids

S -- Degree of Saturation (%)

e -- Void Ratio

n -- Porosity

k -- Permeability (cm/sec)

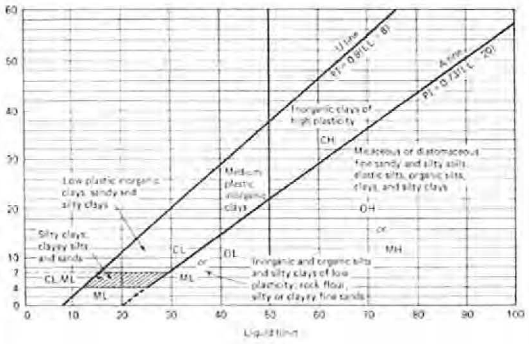
Water Level Measurement

▼ -- Water Level at Time Shown

Note: Water level measurements shown on the boring logs represent conditions at the time indicated, and may not reflect static levels, especially in cohesive soils. The available water level information is given at the bottom of each log.

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

ASTM Designation: D2487-69 and D2488-69
(Unified Soil Classification System)

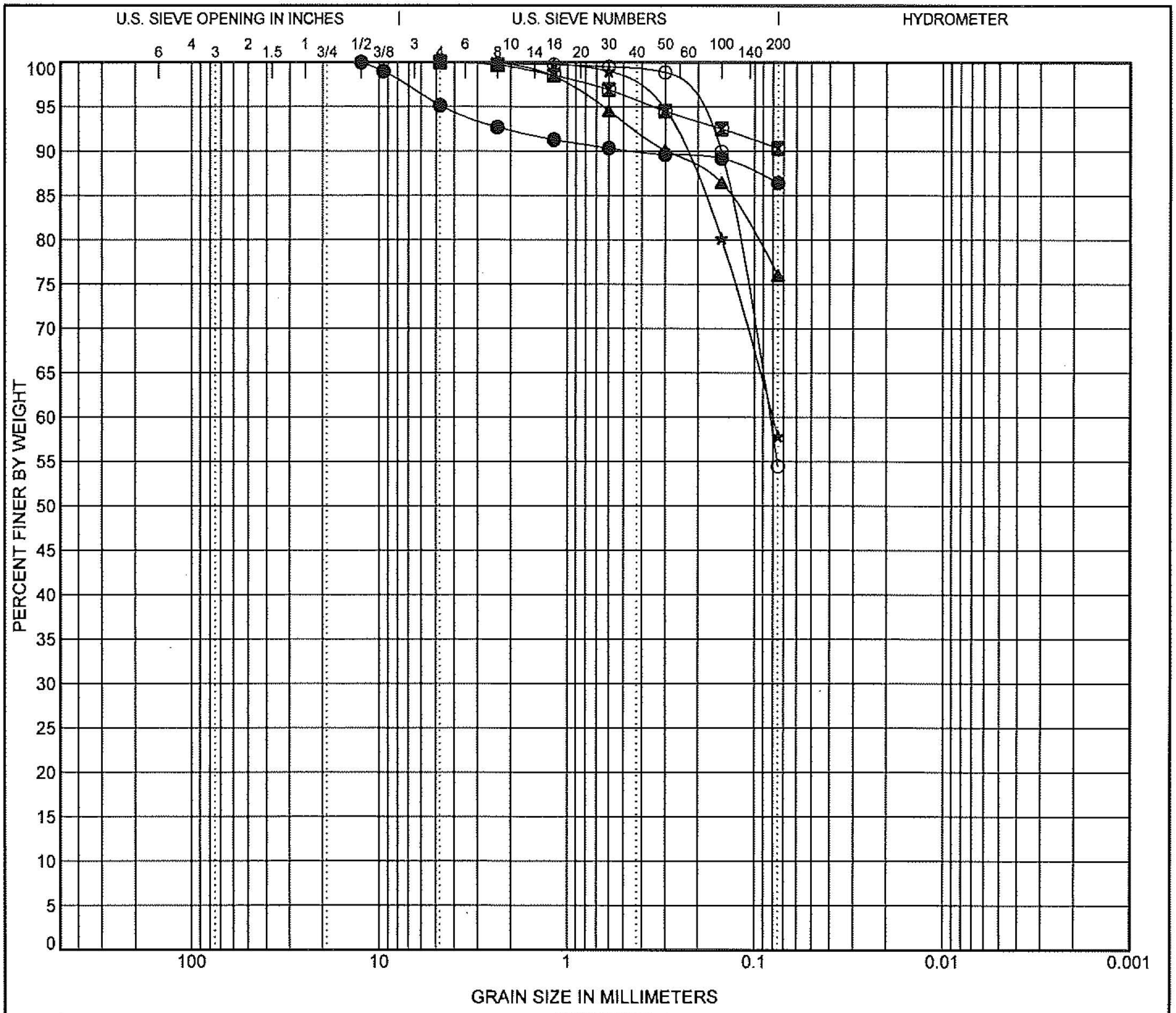
Major Divisions			Group Symbols		Typical Names	Laboratory Classification Criteria			
Coarse-Grained Soils (More than half of material is larger than No. 200 sieve size)	**Gravels** (More than half of coarse fraction is larger than No. 4 sieve size)	**Clean Gravels** (Little or no fines)	GW		Well graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:	Less than 5 % GW,GP, SW, SP More than 12% GM, GC, SM, SC	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} x D_{60}}$ between 1 & 3	
			GP		Poorly Graded gravels, gravel-sand mixtures, little or no fines			Not meeting all gradation requirements for GW	
		Gravels w/ Fines (Appreciable amount of fines)	GM^a	d	Silty gravels, gravel-sand-silt mixtures			Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
				u					
			GC		Clayey gravels, gravel-sand-clay mixtures			Atterberg limits below "A" line or P.I. greater than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	**Clean Sands** (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines			$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} x D_{60}}$ between 1 & 3	
			SP		Poorly graded sands, gravelly sands, little or no fines			Not meeting all gradation requirements for SW	
		Sands w/ Fines (Appreciable mount of fines)	SM^a	d	Silty sands, sand-silt mixtures			Atterberg limits above "A" line or P.I. less than 4	Limits plotting in hatched zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
				u					
			SC		Clayey sands, sand-clay mixtures			Atterberg limits above "A" line or P.I. greater than 7	
Fine-Grained Soils (More than half material is smaller than No. 200 sieve size)	**Silts and Clays** (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity	**Plasticity Chart** 			
			CL		Inorganic clays of low to medium plasticity, gravelly, clays, sandy clays, silty clays, lean clays				
			OL		Organic silts and organic silty clays of low plasticity				
	Silts and Clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts				
			CH		Inorganic clays of high plasticity, fat clays				
			OH		Organic clays of medium to high plasticity, organic silts				
	Highly Organic Soils		P_t		Peat and other highly organic soils				

---

[a] Division of GM and SM groups into subdivision of d and u are for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when L.L. is 28 or less and the P.I. is 6 or less; the suffix u used when L.L. is greater than 28.

[b] Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC, well-graded gravel-sand mixture with clay binder.

APPENDIX C



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	B1	2.5	LEAN CLAY(CL)	44	18	26		
☒	B10	7.5	FAT CLAY(CH)	68	25	43		
▲	B11	2.5	LEAN CLAY with SAND(CL)	49	18	31		
★	B12	5.0	SANDY LEAN CLAY(CL)	36	10	26		
⊙	B12	10.0	SANDY LEAN CLAY(CL)	31	18	13		

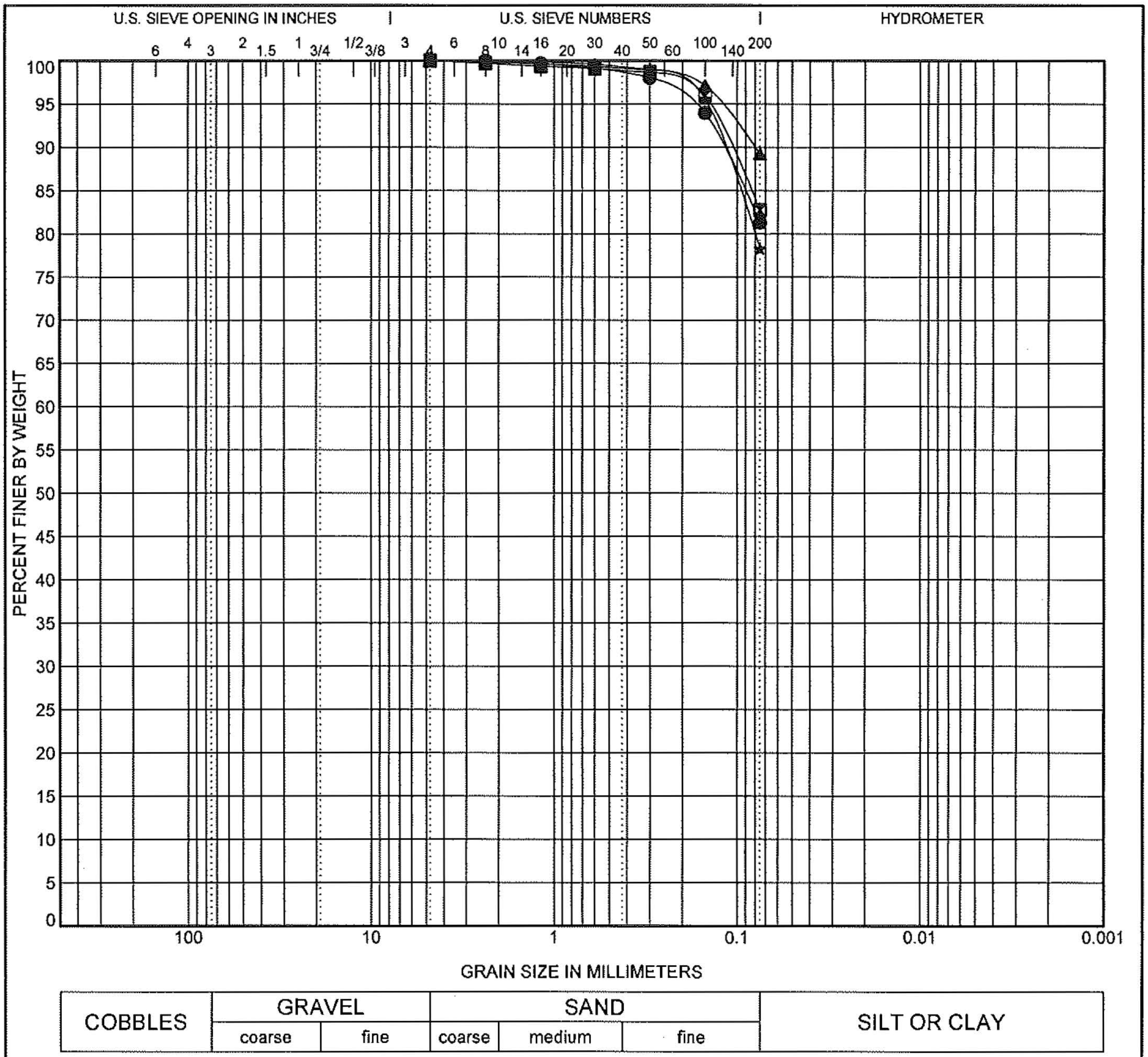
Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B1	2.5	12.5				4.8	8.7	86.5	
☒	B10	7.5	4.75				0.0	9.7	90.3	
▲	B11	2.5	4.75				0.0	24.0	76.0	
★	B12	5.0	4.75	0.08			0.0	42.1	57.9	
⊙	B12	10.0	4.75	0.084			0.0	45.5	54.5	

PROJECT: Reno Creek
JOB NO.: 16216-CX
CLIENT: AUC LLC
TEST METHOD: ASTM D422

PARTICLE SIZE ANALYSES

US_GRAIN_SIZE 16216-CX AUC RENO CREEK.GPJ US_LAB.GDT 7/9/12

INBERG-MILLER ENGINEERS



	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**B15**	**5.0**	**LEAN CLAY with SAND(CL)**	**42**	**18**	**24**		
☒	**B3**	**10.0**	**FAT CLAY with SAND(CH)**	**50**	**18**	**32**		
▲	**B7**	**20.0**	**LEAN CLAY(CL)**	**48**	**21**	**27**		
★	**B9**	**5.0**	**LEAN CLAY with SAND(CL)**	**39**	**21**	**18**		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B15**	**5.0**	**4.75**				**0.0**	**18.7**	**81.3**	
☒	**B3**	**10.0**	**4.75**				**0.0**	**17.2**	**82.8**	
▲	**B7**	**20.0**	**4.75**				**0.0**	**10.8**	**89.2**	
★	**B9**	**5.0**	**4.75**				**0.0**	**21.7**	**78.3**	

PROJECT: Reno Creek
JOB NO.: 16216-CX
CLIENT: AUC LLC
TEST METHOD: ASTM D422

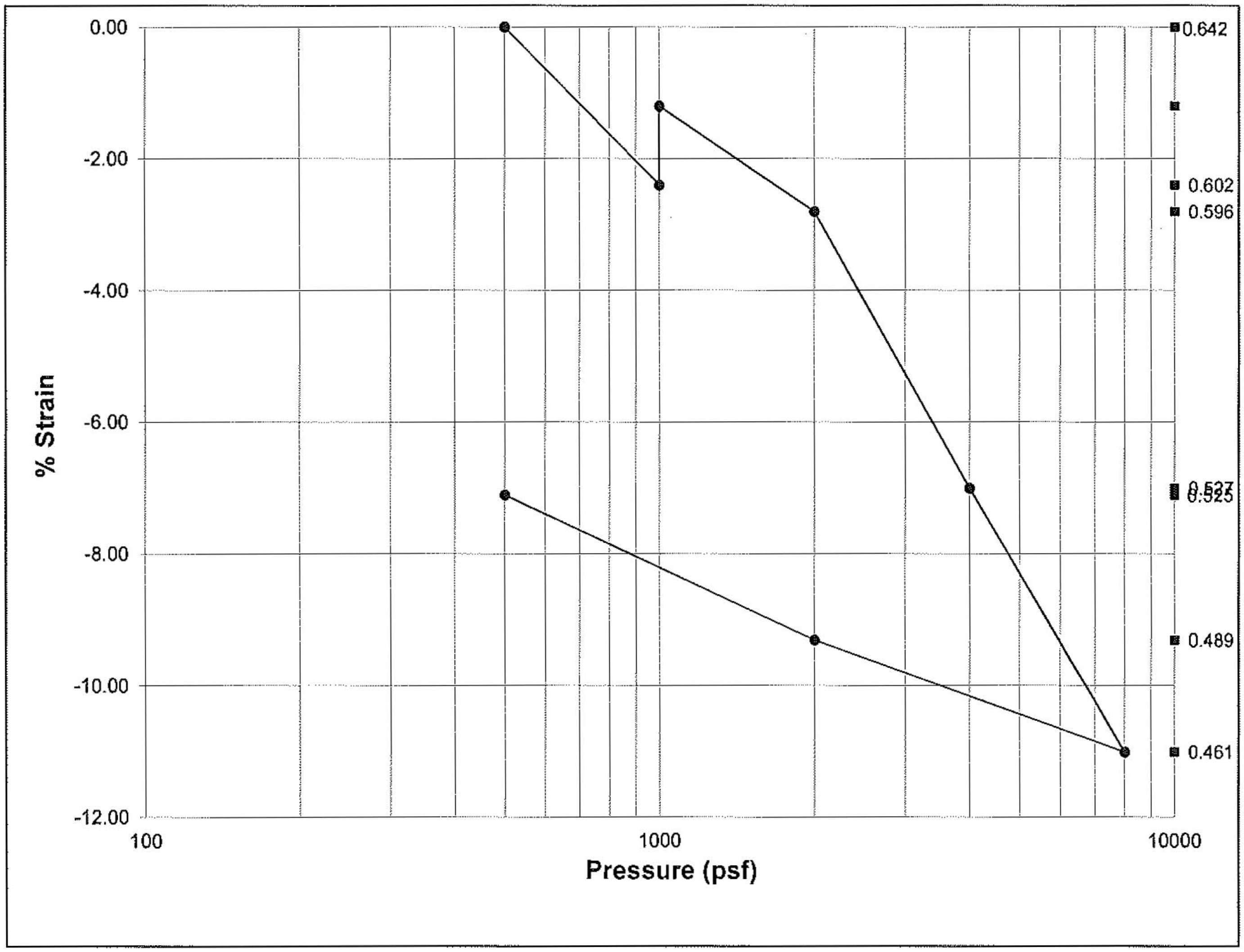
PARTICLE SIZE ANALYSES

INBERG-MILLER ENGINEERS

CONSOLIDATION-SWELL TEST

ASTM D2435

Project: Reno Creek Project
Client: AUC LLC
Job No: 16216-CX
Test Date: 6/1/12
Boring No: 1
Depth (ft): 7.5



Soil Description: Claystone

Specimen Diameter: 2.4125 in.
Specimen Height: 1.00 in.
Overburden Pressure (Po): 860 psf
Preconsolidation Pressure (Pp): 2700 psf
Overconsolidation Ratio: (OCR = pp/po) 3.1

Liquid Limit (%):
Plastic Limit (%):
Plasticity Index (%):

	Initial	Final
Moisture Content:	12.0%	22.0%
Saturation:	51%	108%
Wet Density (pcf):	114.9	132.5
Dry Density (pcf):	102.6	108.6

Comp. Index (Cc): 0.218
Consol. Index (Cr): 0.002

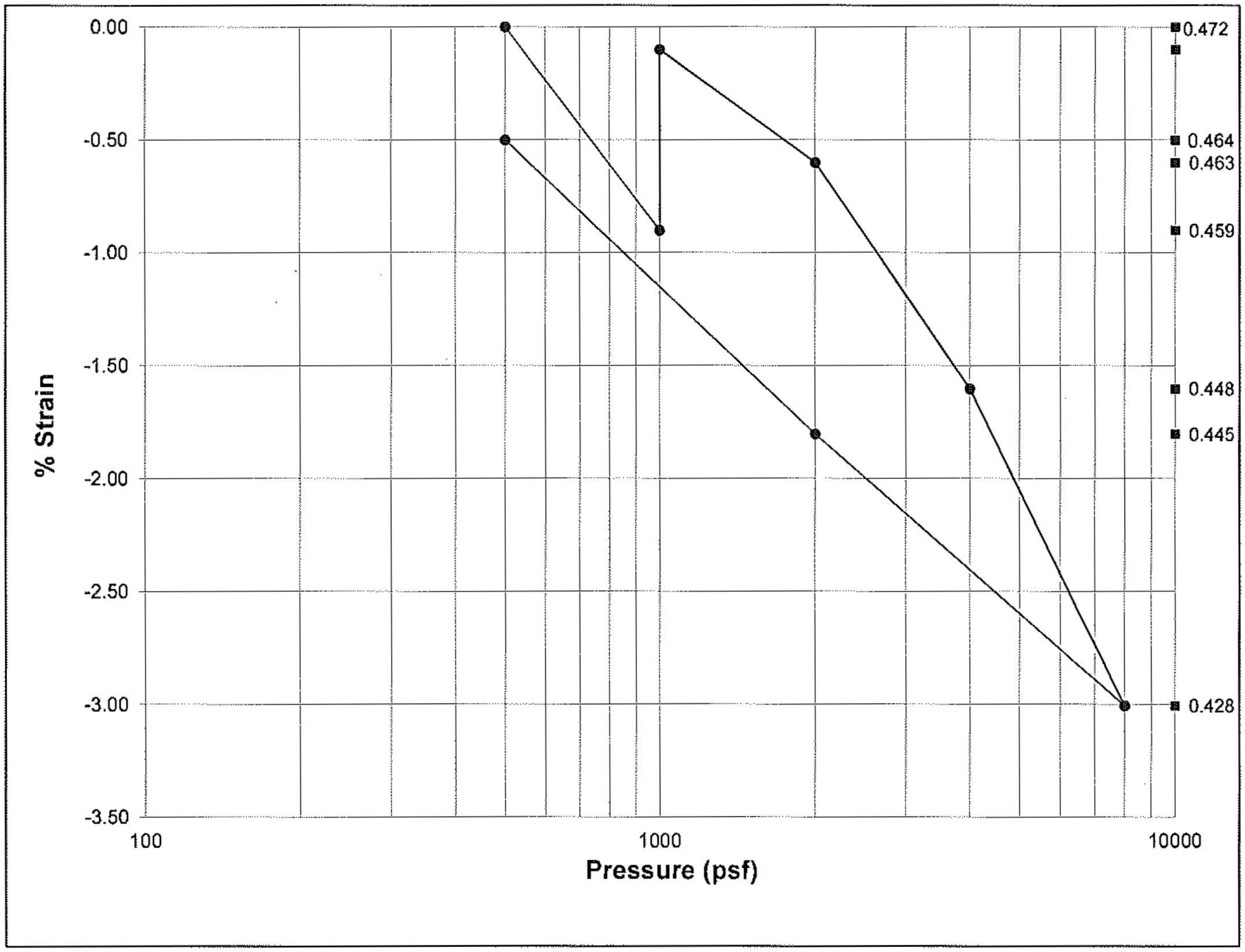
Swell Pressure: 1800 psf
Percent Swell or Collapse*: 1.23% (- indicates collapse) Pressure when wetted: 1000 psf

INBERG-MILLER ENGINEERS

CONSOLIDATION-SWELL TEST

ASTM D2435

Project:	Reno Creek Project	Client:	AUC LLC
Job No:	16216-CX	Test Date:	6/15/12
Boring No:	4	Depth (ft):	10



Soil Description: Claystone

Specimen Diameter: 2.4075 in.

Specimen Height: 1.00 in.

Liquid Limit (%):

Overburden Pressure (Po): 1265 psf

Plastic Limit (%):

Preconsolidation Pressure (Pp): 3300 psf

Plasticity Index (%):

Overconsolidation Ratio: (OCR = pp/po) 2.6

	Initial	Final
Moisture Content:	10.6%	16.5%
Saturation:	61%	100%
Wet Density (pcf):	126.6	135.5
Dry Density (pcf):	114.5	116.3

Comp. Index (Cc): 0.069

Consol. Index (Cr): 0.018

Swell Pressure: 2400 psf

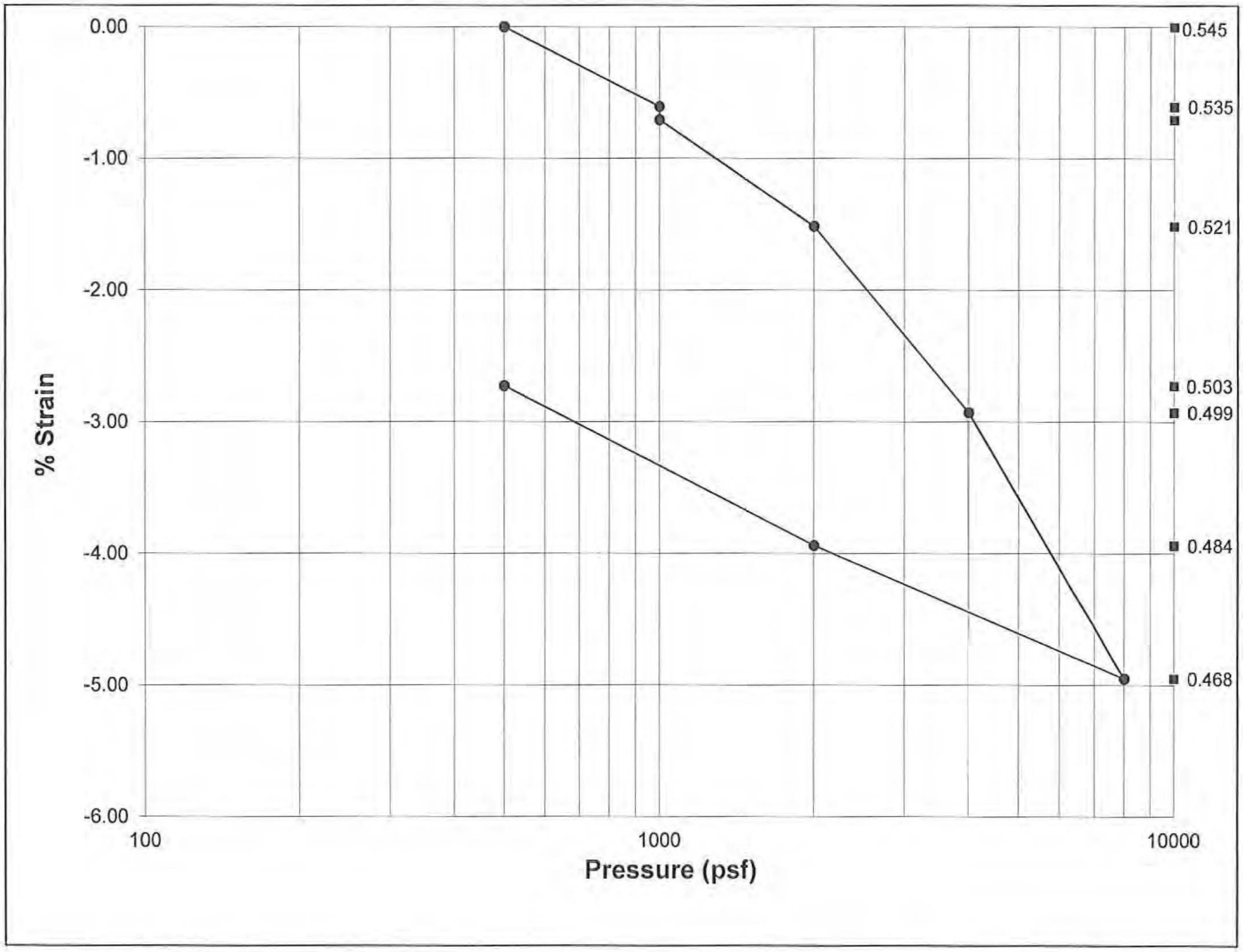
Percent Swell or Collapse*: 0.81% (- indicates collapse) Pressure when wetted: 1000 psf

INBERG-MILLER ENGINEERS

CONSOLIDATION-SWELL TEST

ASTM D2435

Project:	Reno Creek Project	Client:	AUC LLC
Job No:	16216-CX	Test Date:	6/15/12
Boring No:	6	Depth (ft):	5



Soil Description: Very Fine Sand

Specimen Diameter:	2.41	in.
Specimen Height:	0.99	in.
Overburden Pressure (Po):	550	psf
Preconsolidation Pressure (Pp):	3000	psf
Overconsolidation Ratio: (OCR = pp/po)	5.5	
Comp. Index (Cc):	0.104	
Consol. Index (Cr):	0.003	

Liquid Limit (%):

Plastic Limit (%):

Plasticity Index (%):

	Initial	Final
Moisture Content:	2.0%	22.2%
Saturation:	10%	97%
Wet Density (pcf):	110.4	126.6
Dry Density (pcf):	108.3	103.5

Swell Pressure: psf

Percent Swell or Collapse*: -0.10% (- indicates collapse) Pressure when wetted: 1000 psf

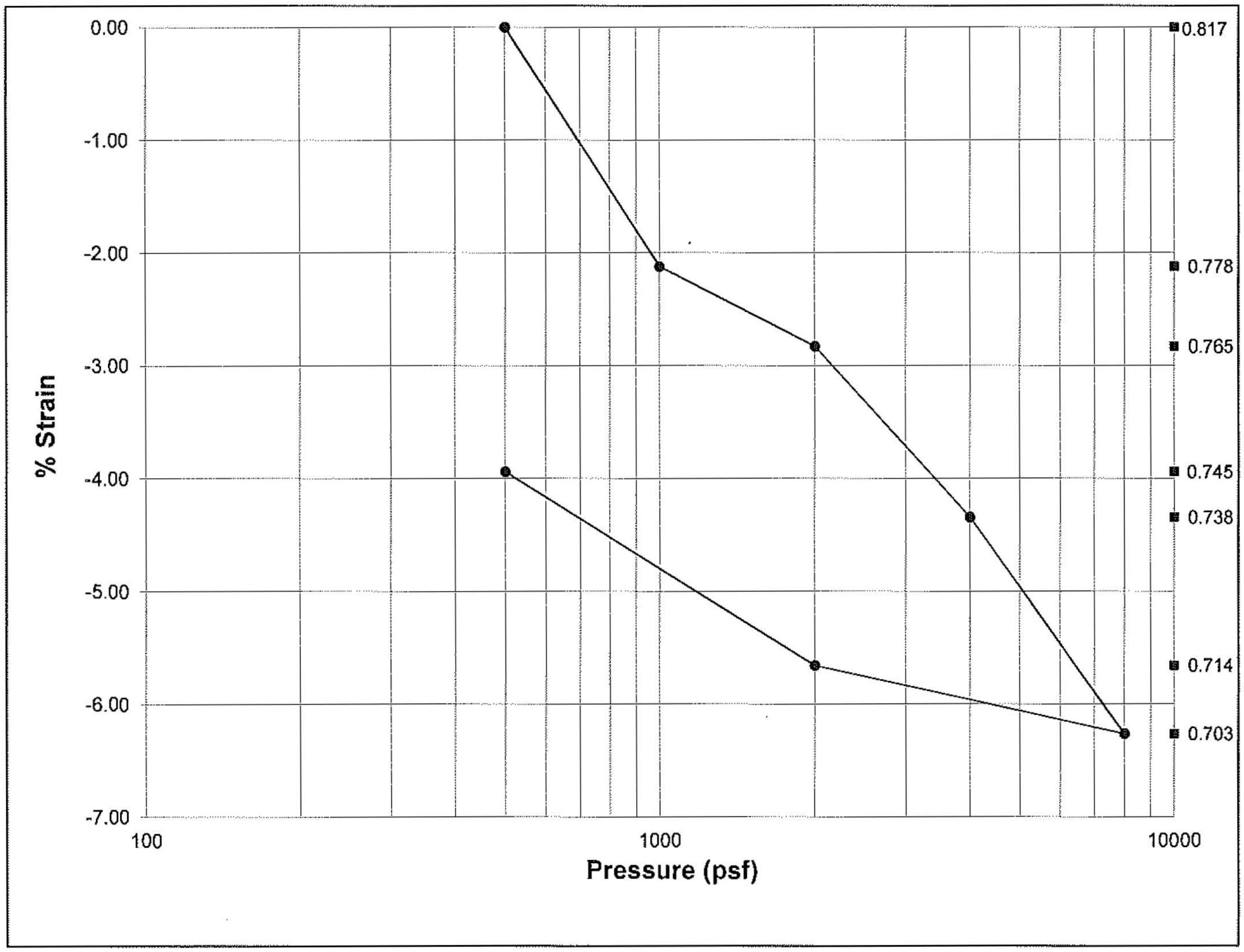
INBERG-MILLER ENGINEERS

CONSOLIDATION-SWELL TEST

ASTM D2435

Project: Reno Creek Project
Job No: 16216-CX
Boring No: 7

Client: AUC LLC
Test Date: 6/15/12
Depth (ft): 10



Soil Description: Claystone

Liquid Limit (%):
Plastic Limit (%):
Plasticity Index (%):

	Initial	Final
Moisture Content:	28.0%	66.9%
Saturation:	92%	150%
Wet Density (pcf):	117.8	127.3
Dry Density (pcf):	92.1	76.3

Specimen Diameter:	2.41	in.
Specimen Height:	0.99	in.
Overburden Pressure (Po):	1175	psf
Preconsolidation Pressure (Pp):	3300	psf
Overconsolidation Ratio: (OCR = pp/po)	2.8	
Comp. Index (Cc):	0.116	
Consol. Index (Cr):	0.008	

Swell Pressure: psf
Percent Swell or Collapse*: (- indicates collapse) Pressure when wetted: 1000 psf

INBERG-MILLER ENGINEERS

APPENDIX D

LIMITATIONS AND USE OF THIS REPORT

This report has been prepared by Inberg-Miller Engineers, hereinafter referred to as "IME", to evaluate this property for the intended use described herein. If any changes of the facility are planned with respect to the design vertical position or horizontal location as outlined herein, we recommend that the changes be reviewed, and the conclusions and recommendations of this report be modified in writing by IME.

The analyses and recommendations submitted in this report are our opinions based on the data obtained, and subsurface conditions noted from the field exploration. The locations of the exploration are illustrated on the accompanying map and diagram. Any variations that may occur between, beyond, or below the depths of test borings or test pits, are not presented in this report because these areas were not specifically explored. Excavations during the construction phases may reveal variations from subsurface conditions identified in our exploration. The nature and extent of such variations may not become evident until excavation and construction begins. If variations appear evident during construction, we advise a re-evaluation of the recommendations in this report. After performing additional on-site observations, we can provide an addendum to our recommendations noting the characteristics of any variations.

IME is responsible for the conclusions and opinions contained in this report based on the supplied data relative only to the specific project and location outlined in this report. If conclusions or recommendations are made by others, IME should be given an opportunity to review and comment on such conclusions or recommendations in writing, prior to the completion of the project design phase.

It is recommended that IME be provided the opportunity to review final designs, plans, and specifications using the conclusions of this report, in order to determine whether any change in concept may have any effect on the validity of the recommendations contained in this document. If IME is accorded the privilege of this review, IME can assist in avoiding misinterpretation or misapplication of these recommendations if changes have been made as compared with IME's understanding of either the project or design content. Review of the final design, plans, and specifications will be noted in writing by IME upon client's request, and will become a part of this report.

Standards are referenced by designated letters/numbers in several locations within this report. These standards were identified for the sole purpose of informing the reader what test methods were followed by IME during the execution of IME's scope of services. Anyone who reads, references, or relies on this report for any purpose whatsoever is hereby advised that IME has applied professional judgment in determining the extent to which IME complied with any given standard identified in this report or any other instrument of IME's professional service. Unless otherwise indicated, such compliance referred to as "general compliance," specifically excluded consideration of any standard listed as a reference in the text of those standards IME has cited. Questions about general compliance – i.e., which elements of a cited standard were followed and to what extent, should be directed to IME.

IME has performed exploration, laboratory, and engineering services sufficient to provide geotechnical information that is adequate for either the preliminary planning or the design phase of the project, as stated herein. IME's scope of services was developed and agreed to specifically for this purpose. Consequently, this report may be insufficient for other purposes. For example, this report may be insufficient for the contractor or his subcontractors to prepare an accurate bid for the construction phase of the project. The client, owner, potential contractors, and subcontractors are advised that it is specifically the contractor's and subcontractor's obligation and responsibility during the bidding process to collect whatever additional information they deem necessary to prepare an accurate bid. The contractor's and subcontractor's bid should include selection of personnel, equipment, bits, etc. that are necessary to complete the project according to the project specifications, on schedule, within budget, and without change orders resulting from unforeseen geologic conditions.

Variations in soil conditions may be encountered during construction. To permit correlation between soil data in this report and the actual soil conditions encountered during construction, we recommend that IME be retained to perform construction observations of the earthwork and foundation phases of the work. It is recommended that IME be retained to observe all areas where fills are to be placed, and test and approve each class of fill material to be used according to the recommendations for compacted fill presented in this report. IME can provide specific assistance in evaluating construction compliance with the design concepts, specifications, or recommendations if IME has been retained to perform continuous on-site observations and materials testing during construction.

The presence of IME's field representative, if such services are requested by the client, will be for the sole purpose of providing record observations and field materials testing. We recommend the contractor be solely responsible for supervision, management, or direction of the actual work of the contractor, his employees, or agents. The contractor for this project should be so advised. The contractor should also be informed that neither the presence of our field representative or the observation and testing by our firm shall excuse him in any way for defects discovered in his work. It is understood that IME will not be responsible for job or site safety on this project.

This report has been prepared in accordance with generally accepted geotechnical engineering practices, and makes no warranties, either expressed or implied. The services performed by IME in preparing this report have been conducted in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions. No other representation, express or implied, and no warranty or guarantee is included or intended in this report. The report has not been prepared for other uses or parties other than those specifically named, or for uses or applications other than those enumerated herein. The report may contain insufficient or inaccurate information for other purposes, applications, building sites, or other uses.

SAMPLE AND DATA COLLECTION INFORMATION

Field-sampling techniques were employed in this exploration to obtain the data presented in the Final Logs and Report generally in accordance with ASTM D420, D1452, D1586 (where applicable), and D1587 (where applicable).

The drilling method utilized in most test borings is a dry-process, machine rotary auger type that advances hollow steel pipe surrounded by attached steel auger flights in 5-foot lengths. This method creates a continuously cased test hole that prevents the boring from caving in above each level of substrata to be tested. Sampling tools were lowered inside the hollow shaft for testing in the undisturbed soils below the lead auger. In some test borings, as appropriate to advance to the desired depth, air or wash rotary drilling methods were utilized. Air or wash rotary drilling methods allow for the extraction of rock core samples.

Samples were brought to the surface, examined by an IME field representative, and sealed in containers (or sealed in the tubes) to prevent a significant loss of moisture. They were returned to our laboratory for final classification per ASTM D2487 methods. Some samples were subjected to field or laboratory tests as described in the text of this report.

Groundwater observations were made with cloth-tape measurements in the open drill holes by IME field personnel at the times and dates stated on the Final Logs. Recorded groundwater levels may not reflect equilibrium groundwater conditions due to relatively low permeability of some soils. It must also be noted that fluctuations may occur in the groundwater level due to variations in precipitation, temperature, nearby site improvements, nearby drainage features, underdrainage, wells, severity of winter frosts, overburden weights, and the permeability of the subsoil. Because variations may be expected, final designs and construction planning should allow for the need to temporarily or permanently dewater excavations or subsoil.

A Final Log of each test pit or boring was prepared by IME. Each Final Log contains IME's interpretation of field conditions or changes in substrata between recovered samples based on the field data received, along with the laboratory test data obtained following the field work or on subsequent site observations. The final logs were prepared by assembling and analyzing field and laboratory data. Therefore, the Final Logs contain both factual and interpretive information. IME's opinions are based on the Final Logs.

The Final Logs list boring methods, sampling methods, approximate depths sampled, amounts of recovery in sampling tools (where applicable), indications of the presence of subsoil types, and groundwater observations and measurements. Results of some laboratory tests are arrayed on the Final Logs at the appropriate depths below grade. The horizontal lines on the Final Logs designate the interface between successive layers (strata) and represent approximate boundaries. The transition between strata may be gradual.

We caution that the Final Logs alone do not constitute the report, and as such they should not be excerpted from the other appendix exhibits or from any of the written text. Without the written report, it is possible to misinterpret the meaning of the information reported on the Final Logs. If the report is reproduced for reference purposes, the entire numbered report and appendix exhibits should be bound together as a separate document, or as a section of a specification booklet, including all drawings, maps, etc.

Pocket penetration tests taken in the field, or on samples examined in the laboratory are listed on the Final Logs in a column marked "qp". These tests were performed only to approximate unconfined strength and consistency when making comparisons between successive layers of cohesive soil. It is not recommended that the listed values be used to determine allowable bearing capacities. Bearing capacities of soil is determined by IME using test methods as described in the text of the report.

Important Information About Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.

ASFE
The Best People on Earth

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@asfe.org www.asfe.org

INBERG-MILLER ENGINEERS

IME

QUALITY SOLUTIONS THROUGH TEAMWORK

www.inberg-miller.com

---

124 East Main Street
Riverton, WY 82501
307-856-8136
307-856-3851 (fax)
riverton@inberg-miller.com

1120 East "C" Street
Casper, WY 82601
307-577-0806
307-472-4402 (fax)
casper@inberg-miller.com

350 Parsley Boulevard
Cheyenne, WY 82007
307-635-6827
307-635-2713 (fax)
cheyenne@inberg-miller.com

428 Alan Road
Powell, WY 82435
307-754-7170
307-754-7088 (fax)
powell@inberg-miller.com

193 West Flaming Gorge Way
Green River, WY 82935
307-875-4394
307-875-4395 (fax)
greenriver@inberg-miller.com

APPENDIX C

NRC Document ML14066A397: Detector Equipment Clarification

(RAI-46)

Uranerz
ENERGY CORPORATION

February 18, 2014

Attn: Document Control Desk
Director, Office of Federal and State Materials and
Environmental Management Programs
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Attn: Document Control Desk
U.S. Nuclear Regulatory Commission
Deputy Director, Decommissioning and Uranium Recovery Licensing Directorate
Division of Waste Management and Environmental Protection
Office of Federal and State Materials and Environmental Management Protection
Mail Stop T-8F5
11545 Rockville Pike
Two White Flint North
Rockville, MD 20852-2738

RE: Uranerz Energy Corporation, Nichols Ranch Project, Source Materials License SUA-1597, Docket No. 040-09067, License Condition 12.11 Request for Additional Information Dated February 13, 2014.

Dear Director and Deputy Director,

Uranerz Energy Corporation (Uranerz) submitted information to the Nuclear Regulatory Commission (NRC) regarding Source Material and Byproduct License SUA-1597 pre operational License Condition 12.11 on October 3, 2013. The information submitted to the NRC was reviewed in two pre operational inspection conducted November 19 through 21, 2013 and January 28 through 30, 2014 by the NRC inspection team and found to be acceptable. However, the NRC staff, in a letter dated February 13, 2014, requested additional information (RAI) regarding pre-operational License Condition 12.11.

The RAI states:

U.S. Nuclear Regulatory Commission (NRC) staff evaluated the licensee's response to LC 12.11. NRC staff is seeking clarification on two instruments identified in Table 3 (Letter from Uranerz to NRC dated October 3, 2013). The instruments are the Ludlum 43-92 and Ludlum 43-93.

1) Provide a more detail explanation for the planned use of each instrument.

2) Provide lower limits of detection (i.e., MDA or MDC) for the above instruments under anticipated or typical ambient (background) levels during operations. Demonstrate that the above instrument can continue to detect and meet the regulatory limit for its planned use. More specifically, look at the locations where these instruments will be used in the field under anticipated ambient (background) levels during operations and demonstrate by calculations that the instruments can continue to detect and meet the regulatory limit.

FSME20

Uranerz has provided responses to the two RAIs in the attached document.

Upon review of the responses provided for the RAI for License Condition 12.11, Uranerz requests to amend Uranerz Energy Corporations NRC License SUA-1597 to remove License Condition 12.11.

If you should have any questions regarding this matter, please contact me by phone at 307-265-8900 or by e-mail at mthomas@uranerz.com.

Sincerely,

Mike Thomas
Vice President Regulatory and Public Affairs
Uranerz Energy Corporation

Attachment

cc: Ron Linton, Project Manager, NRC
Linda Gersey, Lead Inspector, NRC

Uranerz Energy Corporation Nichols Ranch ISR Project Responses to the NRC Request for Additional Information, Pre-operational License Condition 12.11, February 13, 2014.

U.S. Nuclear Regulatory Commission (NRC) staff evaluated the licensee's response to LC 12.11. NRC staff is seeking clarification on two instruments identified in Table 3 (Letter from Uranerz to NRC dated October 3, 2013). The instruments are the Ludlum 43-92 and Ludlum 43-93.

1) Provide a more detail explanation for the planned use of each instrument.

URZ Response:

The 43-93 probe will be used for the surveying of material for release from the plant and also for personnel monitoring stations. The 43-93, coupled with the 177-84 bench top ratemeter, will be used for personnel monitoring stations while the 43-93, coupled with the 2224-1 scaler/ratemeter, will be used for survey of equipment for release. These instruments will show that release limits are met as per regulatory requirements.

Uranerz does have a 43-92 probe coupled with a Ludlum Model 3 general purpose ratemeter. This instrument will not be used to meet any regulatory requirements. The purpose of the 43-92 is solely for use as an informational tool for the radiation safety staff.

2) Provide lower limits of detection (i.e., MDA or MDC) for the above instruments under anticipated or typical ambient (background) levels during operations. Demonstrate that the above instrument can continue to detect and meet the regulatory limit for its planned use. More specifically, look at the locations where these instruments will be used in the field under anticipated ambient (background) levels during operations and demonstrate by calculations that the instruments can continue to detect and meet the regulatory limit.

URZ Response:

In NUREG-1507, a MDA calculation is given by Strom and Stansbury for cases where the background and sample count times are different:

$$MDA = \frac{3 + 3.29\sqrt{R_b t_g(1 + \frac{tg}{tb})}}{t_g E}$$

Where

- Rb is the background counting rate
- Tg is the sample counting time
- Tb is the background counting time
- E is the efficiency

To illustrate that Uranerz can meet regulatory requirements for release of personnel and equipment in areas with gamma backgrounds, the following calculation shows worst case scenarios in which Uranerz can meet those objectives. For the 43-93 instruments that are on site, the average efficiency quoted from Ludlum is slightly higher than 25%. Ludlum quotes efficiency within a 20% uncertainty. Based on this uncertainty, a conservative use of 20% efficiency (E) is used in the calculation. The background count time (Tb) is set at 5 minutes and the sample count time (Tg) is set at 0.5 minutes, or 30 seconds. With a removable contamination release limit for betas of 1,000dpm/100cm^2 and a fixed contamination limit of 5,000 dpm/ 100cm^2, Uranerz assumes a conservative value of 900 dpm/100cm^2 in the equation. This value is used to demonstrate at what levels Uranerz can meet the removable contamination limit, with the understanding that Uranerz would still use swipes to better assess the amount of removable contamination on equipment. The calculation is as follows:

$$900\ dpm/100cm^2 = \frac{3 + 3.29\sqrt{R_b 0.5(1 + \frac{0.5}{5})}}{0.5(.20)}$$

$$R_b = 1{,}271\ cpm$$

From the calculation, in order to see at least 900 dpm/100cm^2, the background must be under 1,271 cpm on the instrument with these parameters. For release of equipment using the fixed contamination limit of 5,000 dpm/100 cm^2, the MDC is well below and is of little concern. To meet the removable limit of 1,000 dpm/100 cm^2, equipment being released may have to be moved to areas of lower background within the restricted area.

For personnel monitoring stations, health physic technicians (HPT) will need to verify background levels are below the above situation in order to ensure that the MDC are being met for beta. In discussion with other facilities, dose rates at their scanning stations were between 20 and 30 μR per hour. The manufacturer specifications state the sensitivity of the 43-93 instrument to gamma radiation is 15-20 cpm per μR/hr. Thus with 30 μR per hour one would expect to see an instrument reading of 600 cpm. This is well below the 1,271 cpm calculated above. In fact, to achieve the above scenario, a 60 μR/hr field would have to be present.

The above discussion demonstrates hypothetically that Uranerz can meet the required limits. Until operations begin, Uranerz will not know the specific dose rates at various scanning stations. However, Uranerz will verify backgrounds to ensure that acceptable MDCs are met. In situations where MDC are not being met because of high dose rates, items will be moved to lower background areas to perform the surveys. Also it is worthwhile to note it may be necessary to establish alpha to beta ratios to demonstrate compliance to limits. However, these ratios can only be established once operations begin.

APPENDIX D:

Table of Contents for the Anticipated Quality Assurance Program (QAP)

EXECUTIVE SUMMARY

1 INTRODUCTION, ORGANIZATIONAL STRUCTURE AND RESPONSIBILITIES OF MANAGERIAL AND OPERATIONAL PERSONNEL, AND APPLICABLE STANDARDS

1.1 Introduction

1.2 Corporate Management Commitment

1.3 Organizational Structure and Responsibilities

1.3.1 Corporate/Senior Management

1.3.2 Operational/Plant Management

1.3.2.1 Operational/Plant Manager

1.3.2.2 Operational/Plant Supervisors

1.3.3 Radiation Safety Officer, EH & S, and Quality Personnel

1.3.3.1 Radiation Safety Officer

1.3.3.2 Environmental Health & Safety Manager

1.3.3.3 Quality Assurance/Quality Control Manager

1.3.3.4 Safety and Environmental Review Panel (SERP)

1.3.4 Operational Personnel

1.3.4.1 Facility Workers

1.3.4.2 Outside Contractors

1.4 QA Policy

1.5 Applicable Standards

1.6 Summary of Major Elements of the QAP

2 PERSONNEL QUALIFICATIONS AND TRAINING

2.1 Introduction on Qualifications and Training

2.2 Corporate Management Qualifications and Training Facility Management Personnel Qualifications and Training

2.2.1 Plant Managers

2.2.2 Plant Supervisors

2.3 Radiation Safety Officer, EH & S, and QA/QC Personnel Qualifications and Training

2.3.1 Radiation Safety Officer

2.3.2 Environmental Health & Safety Manager

2.3.3 QA/QC Manager

2.4 Facility Personnel Qualifications and Training

2.4.1 General Staff

2.4.2 Radiation Workers

2.4.3 Health Physics Technicians

2.4.4 External Contractors

2.5 Initial on-the-job, and Continuing Training

2.5.1 Initial Training

2.5.2 On-the-job Training

2.5.3 Refresher Training

3 OPERATING PROCEDURES AND INSTRUCTIONS

3.1 Introduction to Standard Operating Procedures

3.2 Standard Operating Procedures Overview

4 RECORD KEEPING AND REPORTING REQUIREMENTS

4.1 Types of Documents, Records and Reports

4.2 Validations and Verification of Accuracy and Completeness

4.3 Preservation of Records and Record Retention

4.4 Access to Records

4.5 Electronic Media

4.6 Reporting Requirements

5 QUALITY ASSURANCE AND QUALITY CONTROL OF RADIOLOGICAL, ENVIRONMENTAL, AND EFFLUENT MONITORING DATA AND SAMPLES

5.1 Quality Objectives (General)

5.2 Regulatory Requirements and Limits

5.3 Radiological Monitoring QA/QC

5.3.1 Overall Objectives

5.3.2 Survey Methods for Radiological Exposure Monitoring

5.3.2.1 Surveys for Airborne Yellowcake

5.3.2.2 Surveys for Radon-222 and Progeny

5.3.2.3 Surveys for External Radiation

5.3.2.4 Surveys for Surface Contamination in Restricted Area Surveys for Contamination of Skin and Personal Clothing

5.3.2.5 Surveys of Equipment Prior to Release to Unrestricted Areas

5.3.2.6 Surveys of Packages Prepared for Shipment

5.3.2.7 Surveys for Contamination on Respirators

5.3.3 Frequency of Surveys for Radiological Exposure Monitoring

5.3.4 Quality Control of Radiological Exposure Monitoring Measurements

5.4 Environmental and Effluent Monitoring QA/QC

5.4.1 Overall Objectives

5.4.2 Methods of Environmental and Effluent Monitoring

5.4.3 Frequency and Locations of Environmental and Effluent Monitoring

5.4.4 Quality Control of Environmental and Effluent Monitoring Measurements

5.5 General Quality Control Considerations

5.6 Quality Control Samples

5.6.1 Types and Use of Field Duplicates

5.6.2 Methods for Field Duplicate Collection

5.6.3 Frequency of Field Duplicate Collection

5.7 Sample Handling, Custody, and Shipment

5.7.1 Sample Handling and Chain of Custody Requirements

5.7.2 Shipping Requirements

5.8 Application of Industry Standards

5.8.1 Application of Collection and Measurement Efficiencies to Determine Actual Sample Results

5.8.2 Uncertainty Limits for Volume and Mass Measurements

6 LABORATORY MANAGEMENT AND QUALITY CONTROL

6.1 Analytical Laboratory Quality Objectives

- ***6.1.1 Representativeness and Completeness***
- ***6.1.2 Comparability and Ability to Meet MDL, MDC, Etc.***
- ***6.1.3 Sensitivity and Specificity***
- ***6.1.4 Precision, Bias, and Accuracy***

6.2 Reference Standards and Calibration

- ***6.2.1 Calibration of Instruments and Equipment***
  - ***6.2.1.1 Methods***
  - ***6.2.1.2 Frequency of Calibrations and Quality Control Checks***
  - ***6.2.1.3 Tracking Calibration Results and Trends***
- ***6.2.2 Instruments, Measuring and Test Equipment Maintenance Monitoring for Contamination***
  - ***6.2.2.1 Background Measurement***
  - ***6.2.2.2 Blank Measurement***

6.3 Verification and Validation of Contract Laboratory QA/QC Programs

- ***6.3.1 Regulatory Requirements***
- ***6.3.2 Preparation and Analytical Methodology***
- ***6.3.3 Data Presentation and Reporting Results***

6.4 Quality Control Samples

- ***6.4.1 Quality Control Sample Types***
  - ***6.4.1.1 Blanks***
  - ***6.4.1.2 Matrix Spike***
  - ***6.4.1.3 Laboratory Control Sample***
  - ***6.4.1.4 Laboratory Duplicate Samples (Replicates and Splits)***
  - ***6.4.1.5 Computational and Reference Checks***
- ***6.4.2 Quality Control Sample Analysis Protocols and Frequency***
- ***6.4.3 Quality Control Acceptance Requirements***
- ***6.4.4 Quality Control Sample Results Tracking and Trending***

6.5 Inter-Laboratory Performance Evaluation Programs

6.5.1 Contract Laboratory Requirement to Participate in an External Performance Evaluation Program

6.5.2 Selection of Performance Evaluation Sample Supplier

6.5.3 Selection of Performance Evaluation Samples and Frequency

6.5.4 Acceptance Requirements for Performance Evaluation Sample Results

6.5.5 Performance Evaluation Sample Results Tracking and Trending

7 QUALITY CONTROL FOR MAINTENANCE AND CALIBRATION OF RADIOLOGICAL, ENVIRONMENTAL AND EFFLUENT MONITORING INSTRUMENTATION AND EQUIPMENT

7.1 Instruments and System Calibration and Maintenance Requirements

7.1.1 Radiological Process and Effluent Monitoring Instrumentation

7.1.1.1 Calibration Protocols and Frequency

7.1.1.2 Quality Control Acceptance Requirements

7.1.1.3 Quality Control Calibration Results Tacking and Trending

7.1.2 Flow Monitoring Instrumentation

7.1.2.1 Calibration Protocols and Frequency Quality Control Acceptance Requirements

7.1.2.2 Quality Control Calibration Results Tacking and Trending

7.2 Calibration Requirements of Sampling Equipment and Containers

7.3 Requirements for Calibrated Instruments and Equipment Used for Collection of Composite Samples

7.4 Frequencies and Procedures

7.5 Verification of Vendor Qualifications

7.6 Documentation

7.7 Identification of Non-Compliant Results and Corrective Actions

8 VERIFICATION AND VALIDATION

8.1 Organizational Assignments

8.1.1 Responsibilities

8.1.2 Authorities

8.2 Verification and Validation of Data

8.2.1 Requirements for Verification and Validation Plans Used to Assess Analytical Data and Validation of Analytical Data

8.2.2 Requirements and Development of Verification and Validation Plans for Software Controlled Analytical Equipment

8.3 Verification and Validation of Radiological Exposure Monitoring Results

8.3.1 Methods

8.3.2 Frequencies

8.4 Verification and Validation of Environmental and Effluent Monitoring Results

8.4.1 Methods

8.4.1.1 Selection of the Appropriate Measurement Quality Objectives for the Particular Samples

8.4.1.2 Assessment of Sampling Protocols

8.4.1.3 Impact of Sampling and Analytical Variability on the Analytical Results

8.4.2 Frequencies

8.5 Identification of Deficiencies and Corrective Actions

9 ASSESSMENTS, AUDITS, AND SURVEILLANCES

9.1 Organizational Assignments

9.1.1 Responsibilities

9.1.2 Authorities and Qualifications of Inspectors and Auditors

9.2 Assessments

9.2.1 Types of Assessments Training/Qualification Requirements for Assessors

9.2.2 Assessment Plans

9.2.3 Assessment Frequency

9.2.4 Key Performance Indicator Assessment and Trending

9.3 Audits

9.3.1 Types of Audits

9.3.2 Training/Qualification Requirements for Auditors

9.3.3 Audit Plans

9.3.4 Audit Frequency

9.3.5 Key Performance Indicator Assessment and Trending

9.4 Annual Audits

9.4.1 Verification and Validation of License Compliance and ALARA

9.5 Surveillances

9.5.1 Types of Surveillances

9.5.2 Training/Qualification Requirements for Auditors

9.5.3 Surveillance Plans

9.5.4 Surveillance Frequency

9.5.5 Key Performance Indicator Assessment and Trending

9.6 Daily and Weekly Operational Inspections

9.7 Monthly Inspections by the RSO

9.8 Safety and Environmental Review Panel (SERP)

9.9 Assessment, Audit, and Surveillance Reports

9.10 Documentation and Record Retention Requirements

10 PREVENTIVE AND CORRECTIVE ACTIONS

10.1 Introduction

10.2 Continuous Improvement Program

10.2.1 Using the Continuous Improvement Process to Evaluate Program Performance Levels and Deficiencies

10.2.2 Requirements to use the Continuous Improvement Process in all Process or Analytical Measurements

10.3 Corrective Actions

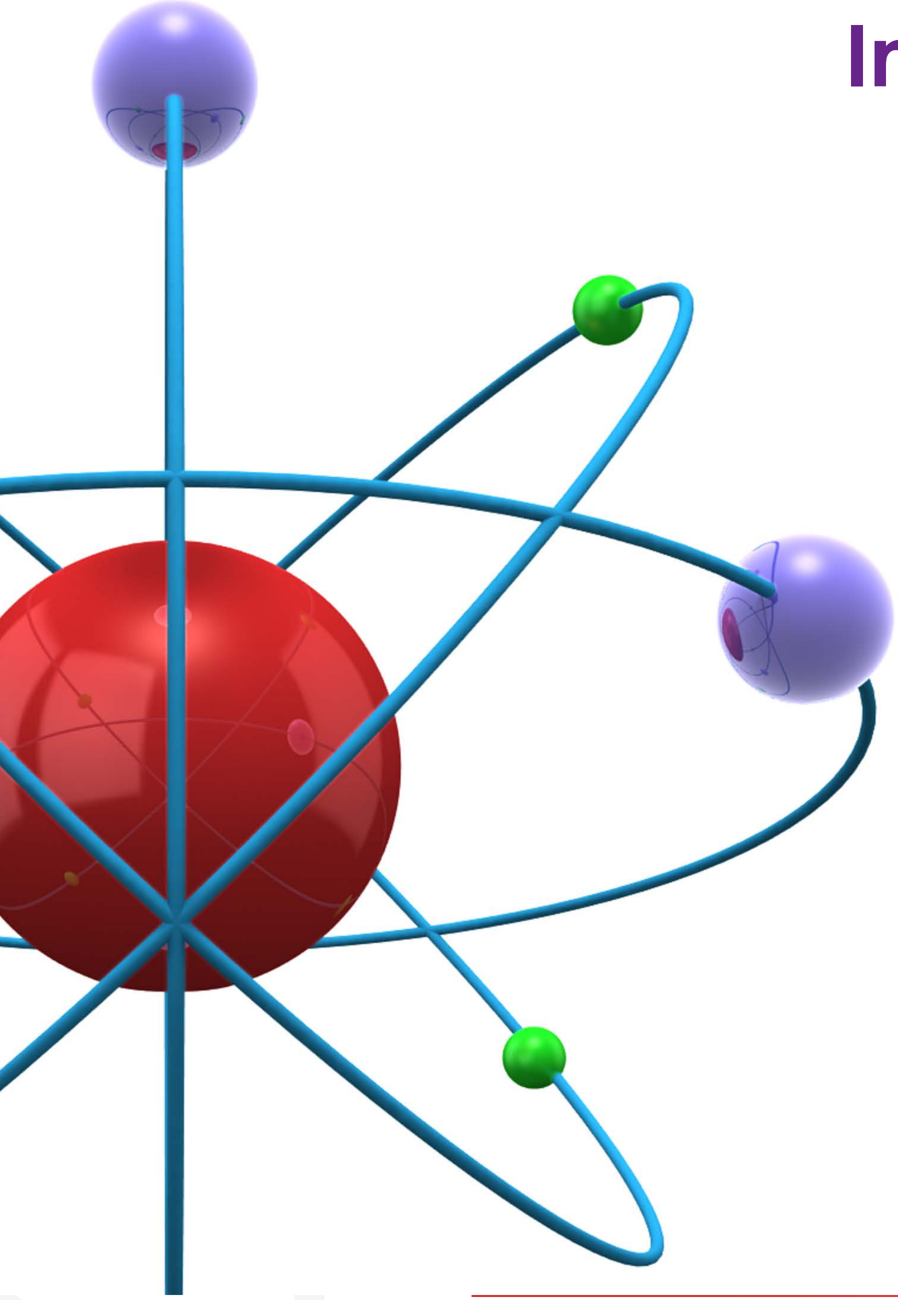
10.3.1 Requirements of a Corrective Action Program

10.3.2 Documenting, Tracking, and Reporting Requirements for Corrective Actions

APPENDIX E

Improving Radon Public Dose Estimates

(RAI-74)



Improving Radon Public Dose Estimates

Dr. C.A.Little, Two Lines Inc.
Dr. H.R.Meyer, Keystone Scientific
J.Viellenave, AUC LLC
L.Huffman, AUC LLC
P.Cavendor, AUC LLC

30 September 2013

Goal: Develop an NRC-Acceptable Method to Determine Rn Dose for ISR U Mill License Compliance

Radon dose is a function of:

- Measured radon concentration in air, and
- Equilibrium fraction (relative concentration of radon decay products)

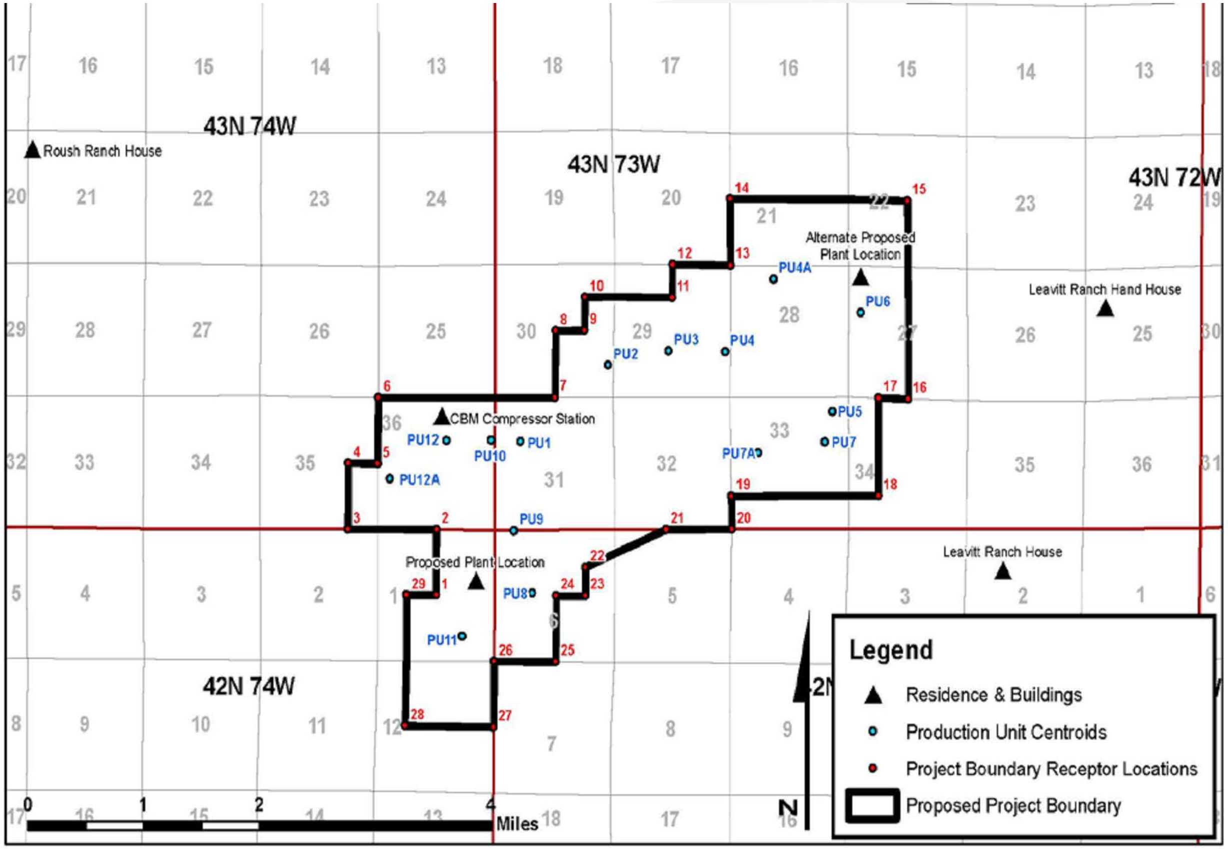
Both are quite difficult to measure at low levels

Radon Dosimetry: It's Complicated

- Radon (Rn) dose is not directly from the radon gas
    - Dose is from radon decay products (RDP)
    - RDP are alpha-particle-emitters
    - When inhaled, they may attach to the lung surface, then decay
- Radon released from a uranium recovery operation contains few RDP initially
- The decay products grow in as a result of radioactive decay, as the radon-containing air mass ages, concentrations increase

What Do We Do At the Moment?

We simply monitor for Rn at a few locations selected per Reg. Guide 4.14



Impetus for Change:

From USNRC 2011draft guidance FSME-ISG-01: "There appears to have been confusion in the past about accounting for exposure and dose from radon progeny (the short-lived progeny). The radon progeny will be the principal contributor to radiation dose in most practical radon exposure situations. Therefore, the NRC staff concludes that determinations of radon-222 doses to the public must include the dose from radon progeny."

Bottom Line: Dose should no longer be calculated for radon with decay progeny removed.

Key Documents

- "Demonstrating compliance with 10CFR20 exposure limits for Rn & progeny", D. Schmidt, USNRC, 1/2011
- Evaluations of Uranium Recovery Facilities Surveys of Rn and Rn Progeny in Air and Demonstrations of Compliance with 10CFR20.1301, 9/2011Draft Guidance
- "An update on radon guidance", D. Schmidt, 5/2012

These are NRC discussions of "..issues related to methods being used to demonstrate compliance with public dose limit for radon emissions."

One acceptable survey method is to perform environmental measurements of radon in outdoor air at appropriate locations, and use an equilibrium fraction based on generally acceptable values.

Issues

- Key NRC issues:
  - Must account for radon progeny
  - Can use either dose assessment or comparison to effluent concentration values
  - Must use 10 CFR 20 App B T2 value for radon with daughters present
  - May apply equilibrium fraction
  - Must address most highly exposed person, which may include public exposed onsite
  - May subtract background Rn, "..but determination of background may be complex."

Problems with Rn Dose Calcs

- Difficult to demonstrate compliance using measurements
  - Part 20 “limit” of 0.1 pCi/l. This is low, relative to:
    - Sensitivity/Uncertainty for typical detectors
    - Variability in background
- Very difficult to measure site-specific equilibrium fraction. Even if feasible, not correct.
- Adequacy of radon measurement programs
- Selection of points of compliance
- Appropriate default equilibrium fractions

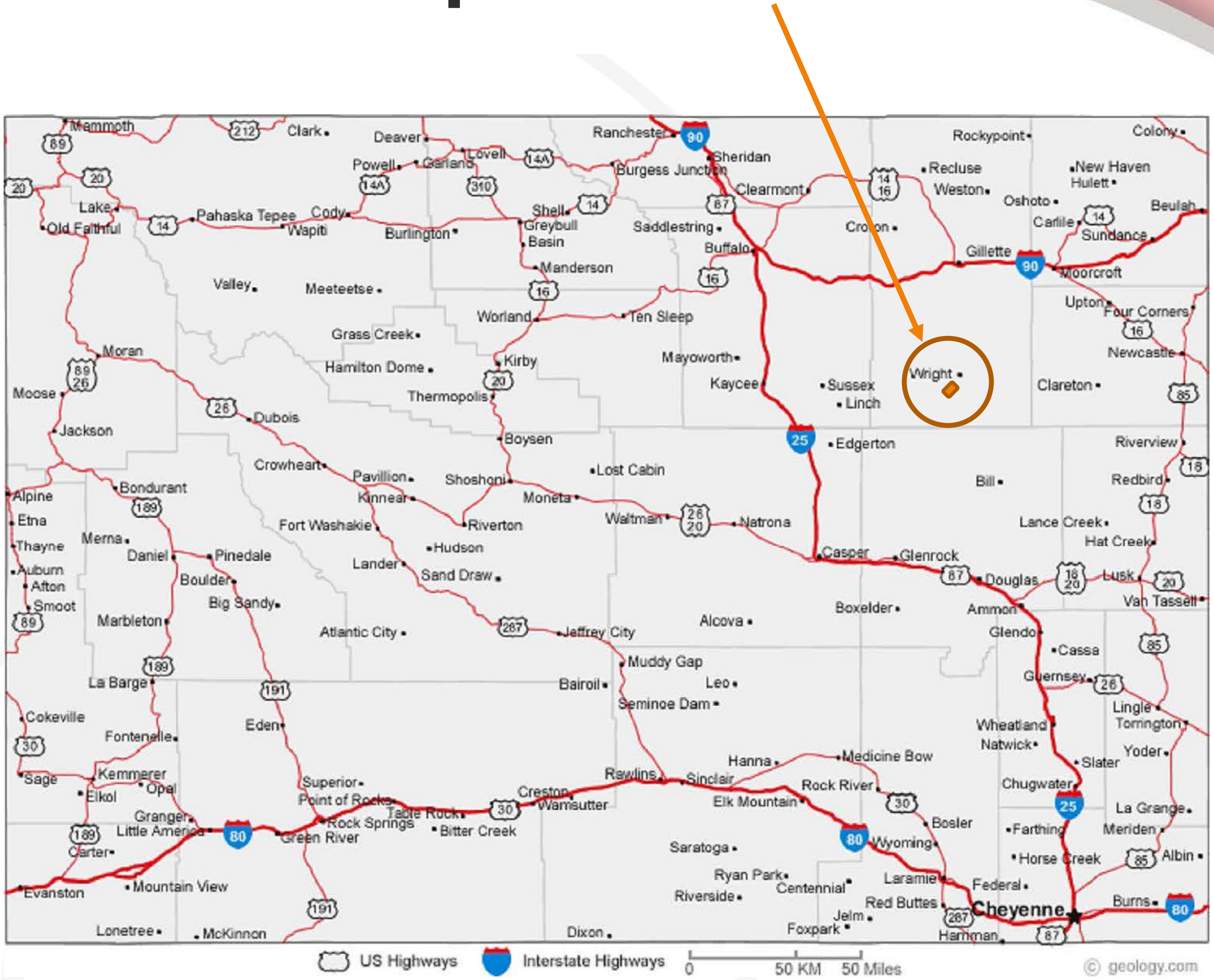
We suggest:

1) Improvement of site Rn measurements

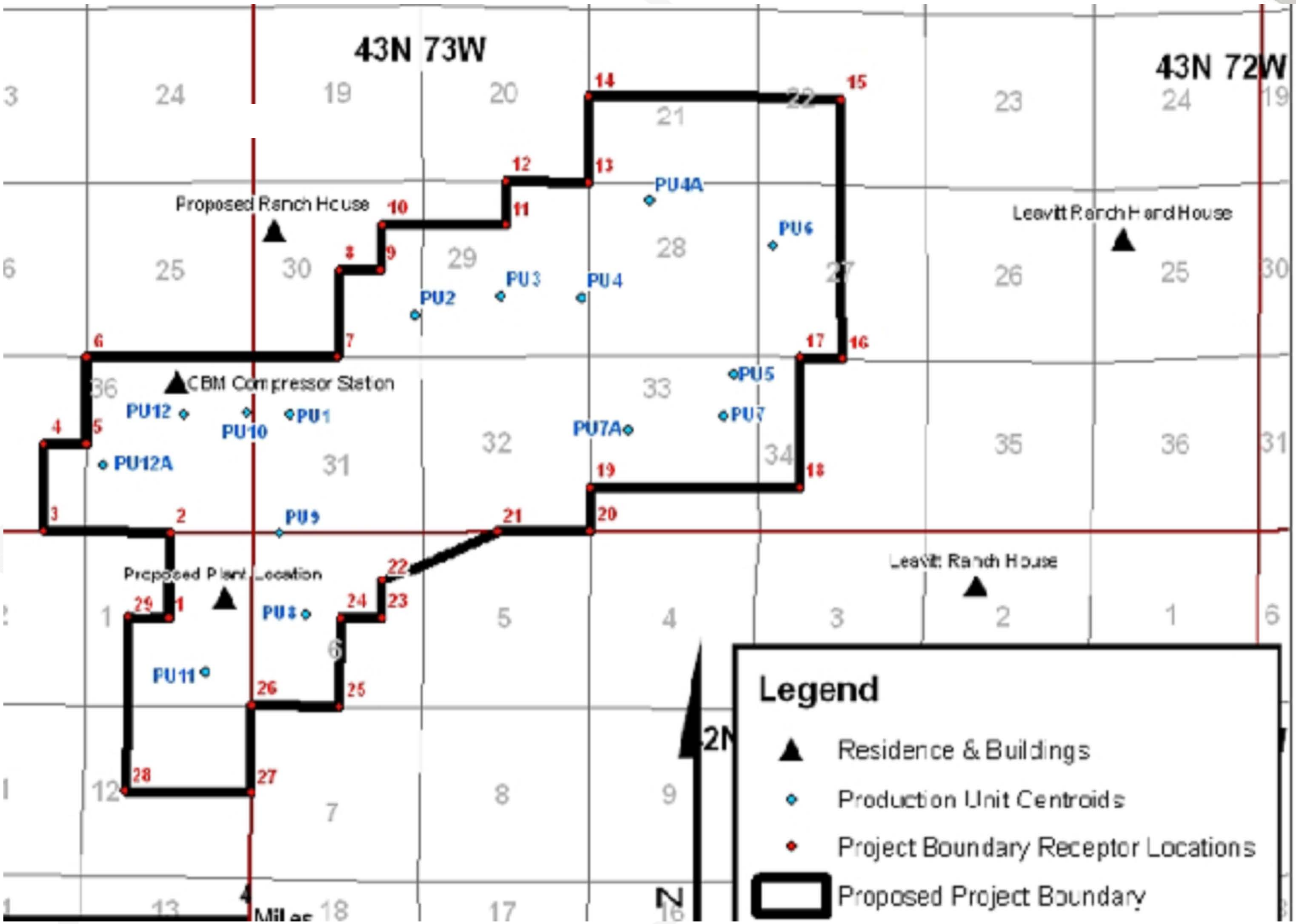
2) Using site-specific met data and MILDOS to calculate equilibrium fractions at various locations

Let’s consider a specific site.

Reno Creek Proposed ISR Site



Reno Creek Site - Closeup



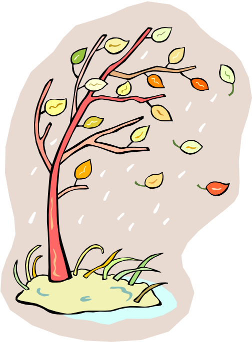
Regulations Set The Uranium ISR's Dose Limit for A Member of the Public

The USNRC's10 CFR 20.1301 specifies that it is

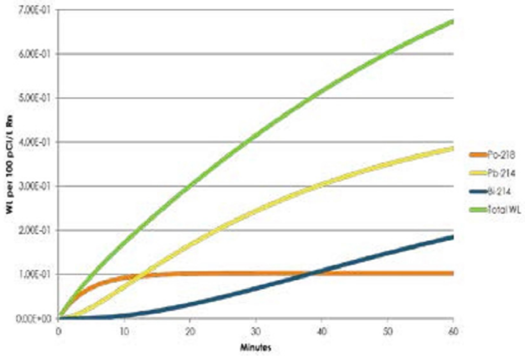
- "Necessary to show that dose from radon and its daughters, when added to dose calculated for 40 CFR 190 compliance, does not exceed 0.1 rem." (100 mrem)
- Effluent limits in the NRC's 10 CFR 20 Appendix B, Table 2 reflect a Rn dose of 50 mrem/yr.
- A 0.1 pCi/l increase in radon conc. represents a dose of 50 mrem/yr.
- A uranium ISR facility must meet the dose limits, but variability in the measurements may cause apparent violations.

Measured radon-222 concentration may be used to estimate working level and dose

Basic factors complicate a radon dose calculation:

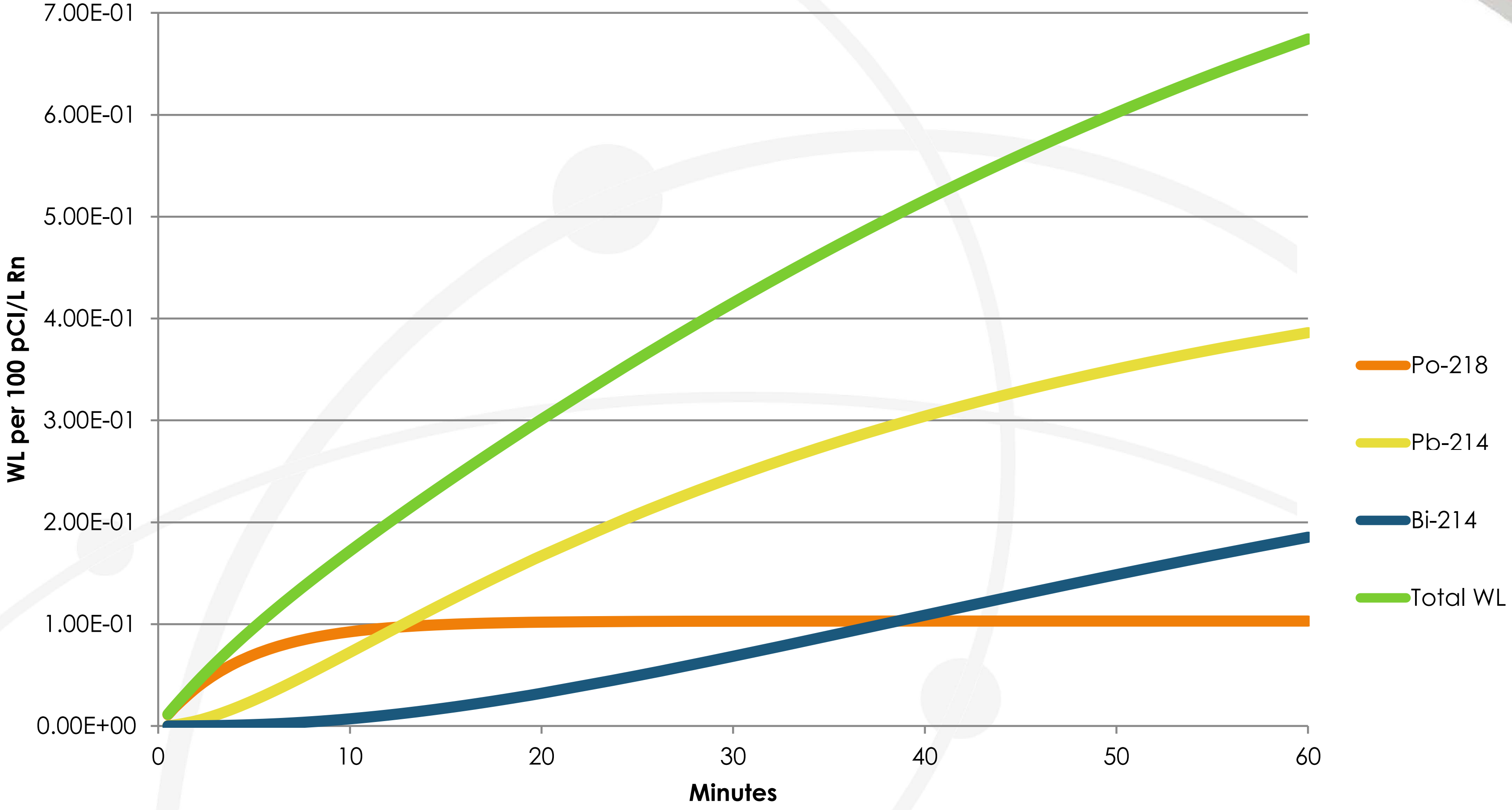


- Rn-222 concentration in air
  - Decreases (radon disperses) as the gas moves away from a source
- Equilibrium fraction (EF)
  - Level of RDP ingrowth
  - Increases with time as radon decays to RDP
  - The rate of increase is complex
  - 1 WL = 100 pCi/L @ 100% EF



Ingrowth of RDP

(From Evans, 1980)



Rn Concentration Measurements

- Usually performed with Landauer high-sensitivity RadTrak monitors; 3-month placement
- Reno Creek proposed ISR site background ranges from 0.05 – 1 pCi/L)
- Landauer reports detector MDCs from 0.06 to 0.1 pCi/l for the same data set

Therefore, we are often working at the extreme limits of the Landauer device sensitivity/accuracy.

Question (1): Can track etch measurements be improved?

Equilibrium Fraction (EF)

- Radon dose calculation is directly related to EF.
  - Dose at an EF of 0.1 is 1/10 that at a default EF of 1.
- If EF of 1 assumed, maximizes the radon dose for an operating uranium ISR facility.
  - Result: Dose limit may appear to be exceeded.
- Background measurements before ISR start-up merely reflect RDC ingrowth from offsite sources.
  - The EF for distant sources can approach equilibrium.
- Actual EF for ISR-released radon may be much less.
  - But, it can't be accurately measured: Difficult, and dominated by radon from distant sources regardless.
- Question (2): Is there an acceptable way to determine radon EF, to avoid assuming EF=1?

(1) Develop better Rn-222 air concentration data:

- Better measurements:
  - Landauer can reduce track-etch film physical background variability, if requested.
    - Minimizes detector Bg variations
  - Request increase in film area scanned
- More measurements:
  - Greater number at each location
    - Reduces variation at location
  - Greater number of measurement locations
    - Data for onsite receptors, low-lying areas
- Longer measurements
  - Increase effective detector sensitivity
- More years
  - Better establish range of existing Rn concentrations

(2) **Use MILDOS to estimate EFs using site-specific meteorological data, weighted by source**

- MILDOS: Accepted for pre-op public dose estimation
- Calculates 10CFR20 and 40CFR190 doses
    - from up to 10 sources per run
    - for up to 48 receptor locations per run
- Provides data to calculate location-specific equilibrium fractions:
    - Rn-222 concentrations
    - Concentrations of radon decay products
    - Working level values

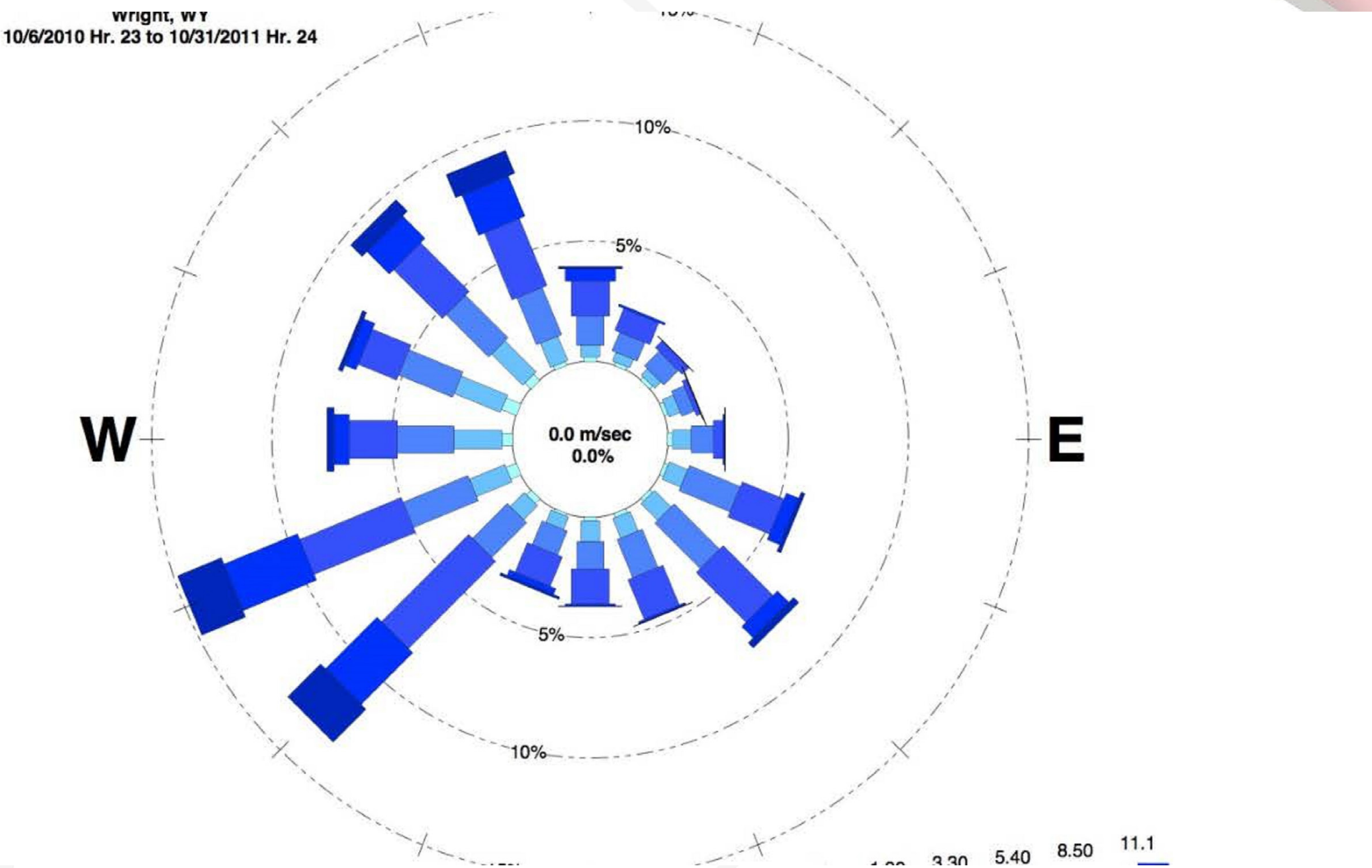
  EF is easily derived from the output

Example: Calculate a Source-Weighted EF Using MILDOS-AREA

For each public receptor location, EF may be calculated using MILDOS for each U ISR radon release source:

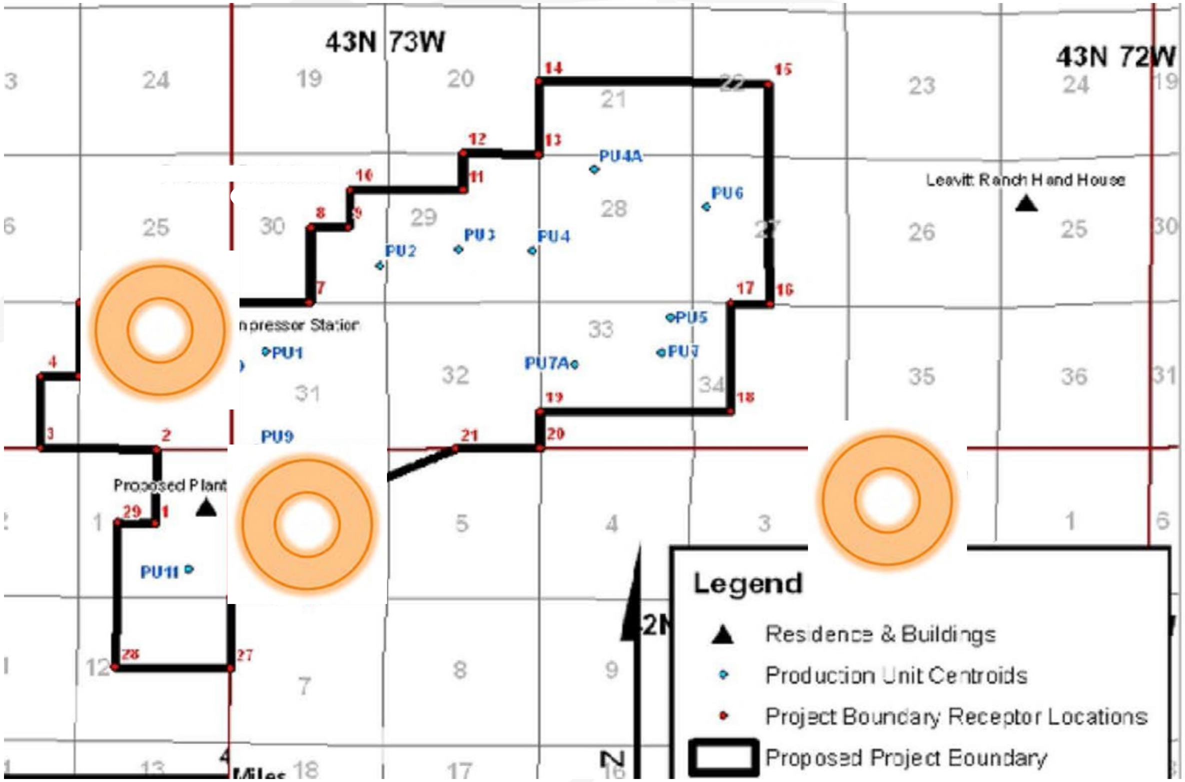
1. MILDOS calculates WLs and Rn-222 concentrations by source
2. For each source, EF = 100 pCi/L x 1000 L/m^3 x WL / Rn-222 pCi/m^3
3. Calculate a weighted EF at each receptor location by weighting for the local Rn-222 concentration associated with each source

Use the Reno Creek Wind Rose



Example Reno Creek Locations

Receptor	X, km	Y, km
Perimeter location #24	1.13	-0.18
CBM compressor station	-0.47	2.02
Leavitt ranch house	7.33	0.12



Calculate Weighted EF

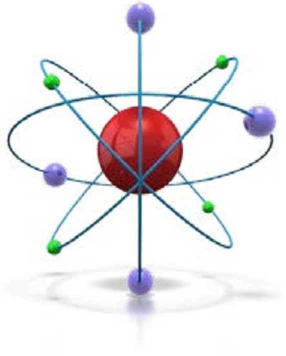
Source Type	Rn-222 at a Receptor (pCi/m^3)	Working Level	Equilibrium Fraction
CPP	2.47E+00	4.19E-06	1.70E-01
New Wells	1.35E-03	2.40E-09	1.78E-01
Production Venting	2.81E+01	1.69E-05	6.03E-02
Restoration Purge	1.93E-01	9.70E-07	5.04E-01
Restoration Venting	5.31E-02	2.65E-07	4.99E-01
Average EF:			*2.82E-01*
Weighted Avg. EF:			7.6E-02

Weighted EF Dose Results

3 selected receptor points in max dose year

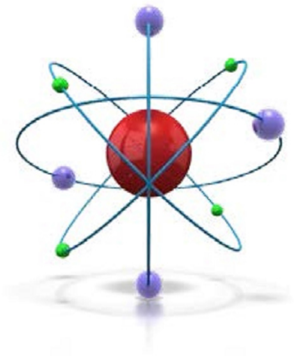
Receptor	Rn-222 pCi/m^3	Weighted EF	TEDE mrem/yr
Perimeter location #24	3.76E+00	2.99E-01	2.89E-01
CBM compressor station	4.39E+01	5.63E-02	3.71E+00
Leavitt ranch house	1.7E+00	3.04E-01	2.63E-01

Weighted EF is greatest at receptor points that are farthest away from the sources, and out of the dominant wind pattern



Impact of Using EF=1, Instead

Location	Weighted EF	MILDOS-calculated TEDE mrem	TEDE assuming 100% EF mrem
Perimeter location #24	2.99E-01	2.89E-01	9.7E-01
CBM compressor station	5.63E-02	3.71E-00	6.6E+01
Leavitt ranch house	3.04E-01	2.63E-01	8.7E-01



Worst Case: Assuming EF = 1 increases dose from the CBM compressor station by 18X.

Conclusions

Improving estimates of radon dose to the public

1) Radtrak field measurements of radon can be significantly improved.

2) Assuming 100% equilibrium when reporting on compliance will overestimate the dose, Instead:

Calculate EFs weighted by individual source Rn values, using site met data and MILDOS

Then: Determine Rn dose using site-measured concentrations and the weighted EF.

References

- Argonne National Laboratory (ANL), 1998. MILDOS-AREA User's Guide (Draft). Env. Assessment Division.
- Evans, R.D., 1980. Engineers' Guide to the Elementary Behavior of Radon Daughters.
- AUC LLC, 2012. Reno Creek Technical Report, in Reno Creek In Situ Leach Uranium Recovery Project Application for Combined Source and 11e.(2) Byproduct Materials License.
- Schmidt, D., 2011. Demonstrating Compliance with 10 CFR 20 Exposure Limits for Radon-222 and Progeny. Presentation at NMA/NRC Uranium Recovery Workshop, January 11, Denver.
- Evaluations of Uranium Recovery Facility Surveys of Radon and Radon Progeny in Air and Demonstrations of Compliance with 10CFR20.1301. USNRC Draft, Sept. 2011

rmeyer7@mindspring.com