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December 4, 2009

Attn: Document Control Desk
Doug Mandeville, Project Manager
Uranium Recovery Licensing Branch
Division of Waste Management
and Environmental Protection,
Office of Federal and State Materials
and Environmental Management Programs,
US Nuclear Regulatory Commission
Two White Flint North, MS T8F5
11545 Rockville Pike
Rockville, MD 20852

RE: ADDITIONAL INFORMATION REQUESTED FOR THE MOORE RANCH IN SITU URANIUM RECOVERY PROJECT LICENSE APPLICATION (TAC JU011), SAFETY EVALUATION REPORT OPEN ISSUES.

Dear Mr. Mandeville:

By letter dated May 26, 2009, the U.S. Nuclear Regulatory Commission (NRC) staff provided questions on open issues identified as part of the development of the Safety Evaluation Report (SER) for the License Application for the Moore Ranch In Situ Uranium Recovery Project.

By this letter, Uranium One is submitting responses to open issues (OI's) identified in the May 26, 2009 SER Open Issues conference call summary report. The response includes:

- A detailed written response is provided to each SER open issue. If revisions to the Technical Report are necessary as a result of these responses, then the specific section of the Technical Report is presented in a redline strike-out format with the proposed revisions.

- A revised Technical Report will be submitted at a later date, incorporating the responses presented in this submittal.

NMSS01

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Significant SER Open Issues addressed in these responses include, but are not limited to, updated geological information; updated hydrological information including groundwater modeling addressing operations and restoration in unconfined aquifer conditions; restoration criteria; additional information on facility instrumentation; coal-bed methane impacts on shallow aquifers, health physics issues and additional information on accident prevention, and mitigation.

If you should have any questions on these responses, please contact me by phone at (307) 234-8235 ext. 331 or by email at jon.winter@uranium1.com.

Sincerely,

Jon Winter

Manager, Wyoming Environmental and Regulatory Affairs

Enclosures: Safety Evaluation Report Open Issues responses

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MOORE RANCH URANIUM PROJECT

RESPONSES TO:

NRC

MAY 11, 2009

SAFETY EVALUATION REPORT

OPEN ISSUES

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MOORE RANCH

NRC SER OPEN ITEMS

APRIL 2009

April 11, 2009
Non-Hydrology
1-16

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1-5

Non-Hydrology Open Issue No.1
Consistency in Identification of Wellfields
May 11 2009 Teleconference

Open Issue discussion:

Chapter 1 of the Technical Report (TR) discusses 3 wellfields, with other chapters showing 3 wellfields in some figures. In other places in the TR only two wellfields are identified, with wellfield 3 designated as part of wellfield 2. The application must be consistent.

Answer:

The original application was based on three wellfields. Additional delineation drilling conduced since the original submittal has resulting in combining Wellfields 2 and 3 into a single wellfield. Therefore, the correct number of wellfields is two.

Revised TR and ER will reflect this change.

Proposed Revisions to License Application

All narrative and figures in the Technical and Environmental Reports will be corrected to reflect two wellfields.

Non-Hydrology Open Issue No. 2
Update Schedule of Activities
May 11 2009 Teleconference

Open Issue discussion:

The schedule of activities shown in figure 1.8-1 of the TR indicates construction is to begin in early 2009 with production starting in mid 2009. This should be updated and consistent in the TR.

Answer:

Figures 1.8-1, 3.1-6 and 6.1-1 have been revised to reflect the current schedule of activities and will be inserted in the revised Technical Report.

Text in Section 1.8.1 Moore Ranch Construction, Operation, and Restoration Schedule will be revised to reflect new schedule of activities.

Figure 1.8-2 revised to reflect 2 wellfields as shown in Figure 1.8-1 Moore Ranch Production, Restoration and Decommissioning Schedule.

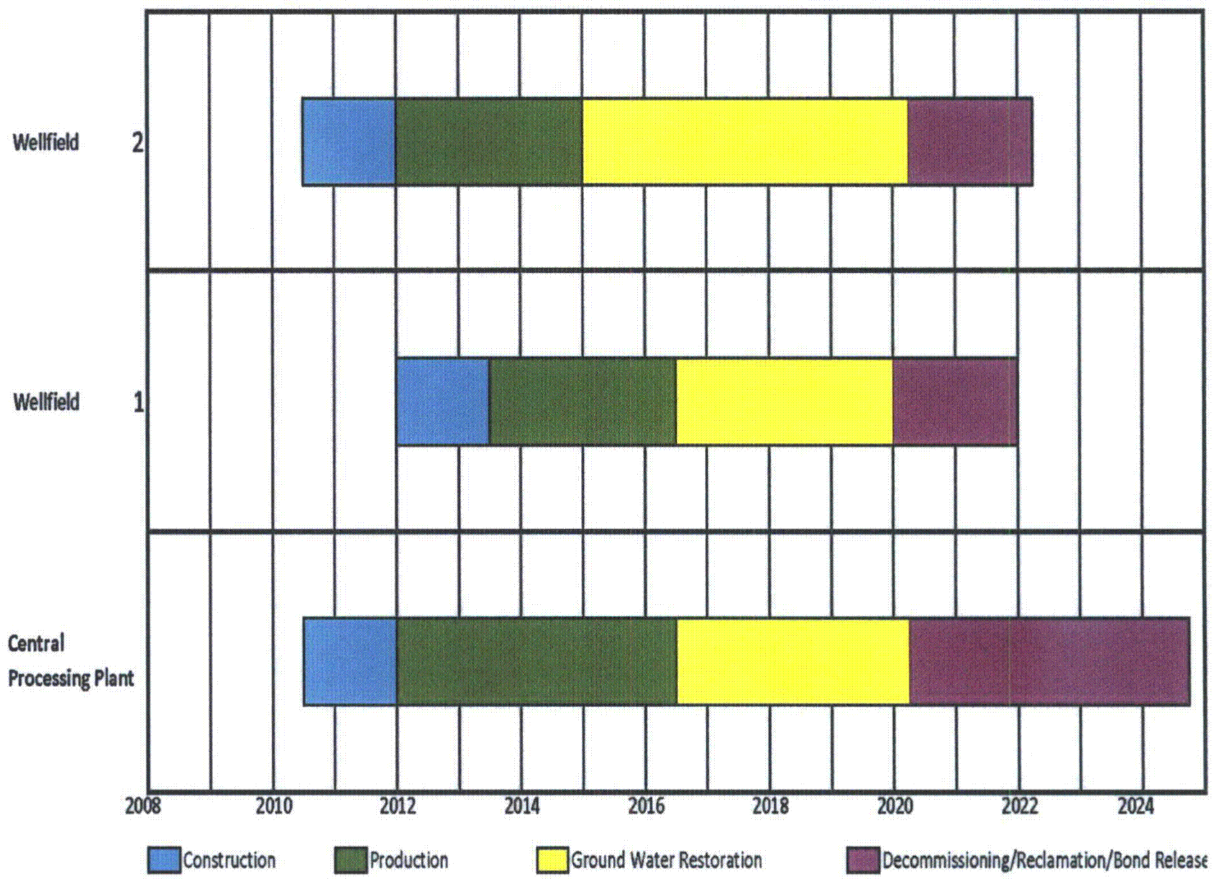
Proposed Revisions to License Application

Section 1.8.1 Moore Ranch Construction, Operation, and Restorations

Following approval of the NRC Source Material License, construction of Wellfield ~~1,~~ 2 the central plant, and ancillary facilities is planned to begin in ~~February of 2009.~~ 3rd Quarter of 2010. Completion of the central plant and ancillary facilities, deep disposal wells, and all or a portion of Wellfield ~~1~~ 2 is expected to be completed in ~~November 2009~~ the 4th Quarter of 2013 and startup of operations will commence. Construction of Wellfields ~~2~~ ~~and 3~~ ~~will follow within two years respectively.~~ 1 is anticipated to be completed at the end of the 2nd Quarter 2013. Projected production and restoration schedules for the Proposed Moore Ranch Project are shown in Figure 1.8-1.

Additional wellfield plans are developed approximately one year prior to the planned commencement of new mining operations. The layout of the planned wellfields is shown in Figure 1.8-2. It is currently anticipated that ISR operations and wellfield restoration will continue for approximately ~~10~~ 5.5 years. At this point, decommissioning of wellfields including well abandonment, piping and equipment removal, wellfield building removal, surface scanning and reclamation will commence. It is anticipated that the central plant ~~will continue operations past 10 years after decommissioning of Moore Ranch wellfields to accommodate processing of other potential satellite projects in the Powder River Basin area.~~ will undergo decommissioning and reclamation, and a bond release by the 3rd Quarter of 2024.

FIGURE 1.8-1 Moore Ranch Project Production, Restoration and Decommissioning Schedule



Non-Hydrology Open Issue No. 3
Correct Longitude and Latitude of the Site
May 11 2009 Teleconference

Open Issue discussion:

The latitude (72° 55' 28.5739") and longitude (-72° 32' 14.4097") provided in section 2.1 of the TR are incorrect; those coordinates are a location in Baffin Bay off the coast of Canada. The correct coordinates should be provided.

Answer:

The correct Latitude and Longitude for the Moore Ranch Site is as follows: 43°34'12.83" and -105°50' 49.72".

These changes will be incorporated into the revised Technical Report.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

2.1 SITE LOCATION AND LAYOUT

The location of the proposed Moore Ranch Uranium Project is in Township 42 North, Range 75 West, Sections 26, 27, 33, 34, 35, 36 and Township 41 North, Range 75 West, Sections 1, 2, 3, and 4, and Township 42 North, Range 74 West, Section 31. Coordinates for the Central Plant are Latitude 43°34'12.83" ~~72° 55' 28.5739"~~ and Longitude -105°50'49.72" ~~72° 32' 14.4097"~~. Figure 2.1-1 shows the general location of the site in the Powder River Basin area in relation to surrounding population centers, interstates and highways, and County boundaries. Population centers around the Moore Ranch Project area include Casper (approximately 57 miles south-southwest), Gillette (approximately 54 miles north-northeast), Wright (approximately 25 miles northeast), and Midwest/Edgerton (approximately 24 miles southwest). Section 2.3 provides more information on surrounding population and Figure 2.3-1 shows population and distances to population centers within a 50-mile (80 km) radius.

Non-Hydrology Open Issue No. 4
Explanation of proposed distant site boundaries
May 11 2009 Teleconference

Open Issue discussion:

The total area within the proposed site boundary is 7110 acres (11.1 square miles), while the restricted area around the central plant is approximately 1 acre. The proposed site boundary is, in many locations, more than a mile away from the central plant and the wellfields, as shown in figure 2.1-2. EMC has not provided explanation for the proposed distant site boundaries.

Answer:

The proposed license boundary is based upon the boundaries of the mineral leases held by EMC. EMC has indications that mineralization occurs in other areas of the proposed license area beyond the proposed two wellfields. Additional exploration, delineation, and characterization will be necessary to determine whether these areas can be developed for production. These activities will be performed by EMC concurrent with mining activities in Wellfields 1 and 2. This process is recognized by NRC in Section 2.3.1.1 of NUREG-1910, where NRC notes that wellfields are developed in sequence and that the Crow Butte Mine has constructed 10 wellfields since 1991. NRC notes that "*…at any one-time; different well fields are likely to be in different stages of construction, operation, aquifer restoration, and decommissioning/reclamation (Crow Butte Resources, Inc., 2007). Construction and testing for each well field may require up to a year and a half before production begins (NRC, 2006). The locations and boundaries for each well field are adjusted as more detailed data on the subsurface stratigraphy and uranium mineralization distribution are collected during well field construction.*"

Proposed Revisions to License Application

No changes are proposed to the license application in response to this Open Issue.

Non-Hydrology Open Issue No. 5
Figure 5.7-1 is missing
May 11 2009 Teleconference

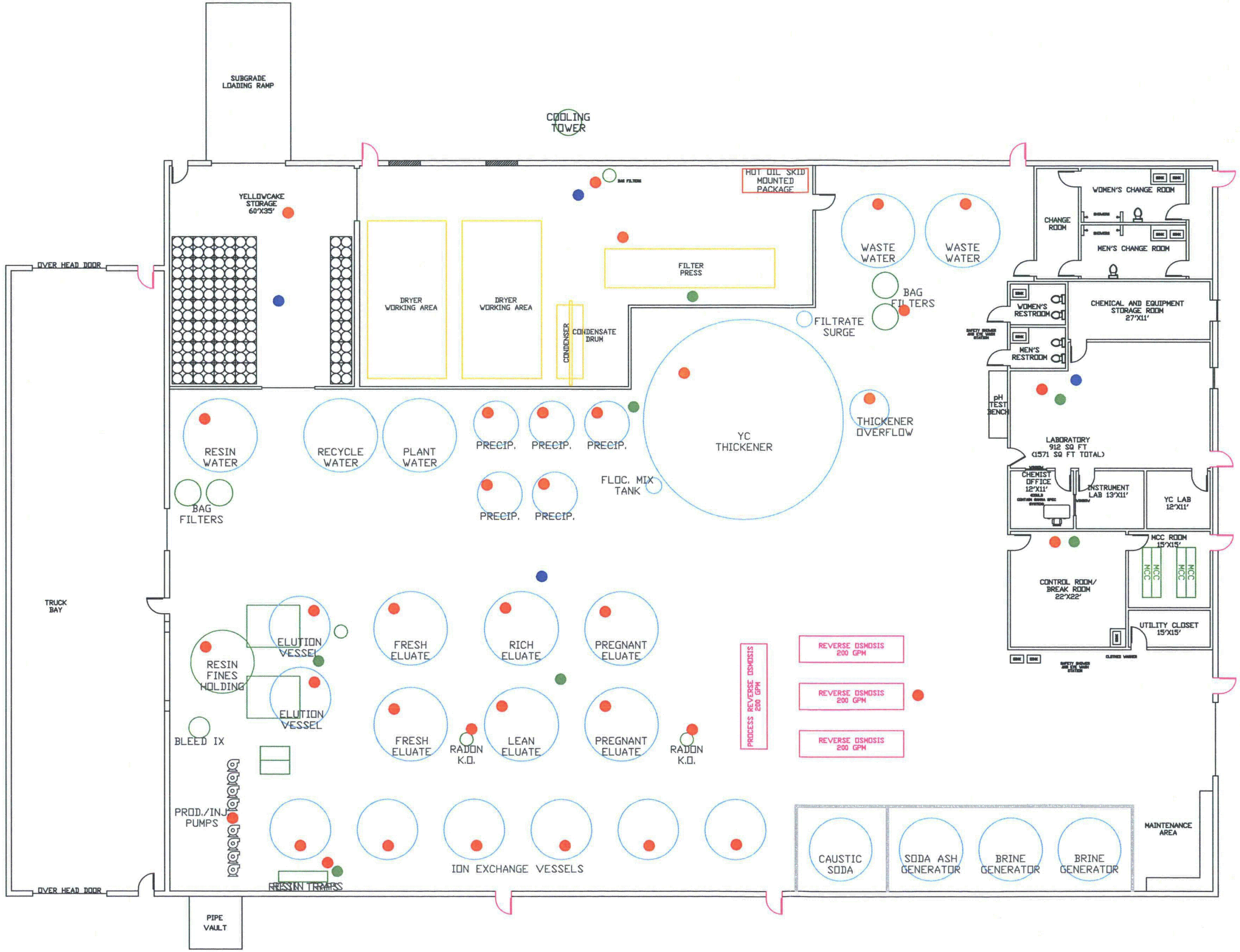
Open Issue discussion:

EMC indicated in Section 3.2.3.2 of the TR that a description of the areas in the proposed plant facility where radiological gases or air particulates could be generated is provided in Section 5.7 and shown on Figure 5.7-1 as monitoring locations. Note that Figure 5.7-1, intended to show monitoring locations for potential radiological gases or air particulates, is missing.

Answer:
Revised Figure 5.7-1 has been provided.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.



LEGEND

- RADON TESTING LOCATIONS
- GAMMA SURVEY LOCATIONS
- AIR PARTICULATE MONITORING LOCATIONS

N

10' 0 20'

VERIFY SCALE

SCALE 1": 20'

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Moore Ranch ISR Project
Radiological Survey Locations

Date:	By:	Checked:	
Rev. No.	Description	Date	By
1	Initial Draft	9/08/09	CM

TREC, Inc.
Engineering & Environmental Management
951 Werner Ct. Suite 395 Casper, WY 82601
Phone (307)265-0696 Fax (307)265-2498
www.trecorp.com

Figure Number: 5.7-1

Non-Hydrology Open Issue No. 6
Liquid waste disposal plans are contingent on approval by Wyoming
May 11 2009 Teleconference

Open Issue discussion:

EMC submitted an application on May 12, 2008, to the State of Wyoming (WDEQ-WQD) for a UIC Permit. Since liquid waste disposal plans are contingent upon the approval of the State for deep well disposal, EMC must provide either the completed permit information or information on the latest status of this permit request which would then lead to a license condition requiring the completed permit information prior to operation.

In addition, EMC indicated in the TR that it plans to install three deep disposal wells at the Moore Ranch facility for liquid waste disposal. Subsequently, it stated that the third well may be constructed as back up during restoration. Definitive clarification is needed on the waste volumes, well capacities, and resulting number of disposal wells.

Answer:

Uranium One has recently resubmitted its application for Class I UIC permits for deep disposal wells. The initial Class V UIC Permit Application was received by WDEQ on May 14, 2008. Per direction from WDEQ in an April 27, 2009 letter, the Moore Ranch Class V UIC application has been changed to a Class I UIC application. In response to WDEQ's request, Uranium One has included a plan to drill and test the Teckla, Teapot, and Parkman (TTP) interval as a potential injection zone. Hence, the revised submittal includes two Volumes as follows:

Class I UIC Application: Lance Formation and Fox Hills Sandstone – Volume 1
Class I UIC Application: Teckla, Teapot and Parkman Formations – Volume 2

The revised application was submitted to the Wyoming Department of Environmental Quality – Water Quality Division on August 17, 2009.

The Teapot-Teckla-Parkman interval is at depths of 7,916 ft to 9,610 ft (based on logs from the Sun Oil No. 1 Ross API No. 522824 located in T41N R75W, Section 3, NE ¼). Based on available data, the hydrologic properties of this interval would allow injection rates on the order of 30 gpm per well. Based on projected maximum production rates during ISR operations, four injection wells may be required to provide sufficient capacity during maximum periods of injection. Water quality within the TTP interval is anticipated to exceed 3,000 mg/L TDS.

The second volume is a permit application for the Lance Formation at depths of 3,700 to 7,500. The Lance interval has much greater injection capacity than the Teapot-Teckla-Parkman interval, based on regional information. However, water quality may be an issue as the Lance Formation is likely to be less than 3,000 mg/l TDS. If this interval provides a suitable injection interval for permitting, only two wells would be necessary to meet the capacities for the project. Both the Lance or Teapot-Teckla-Parkman injection targets are located at depths that make any environmental impacts negligible. As part of the permitting process, the potential for environmental impacts is thoroughly evaluated by WDEQ.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this Open Issue. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

4.2.2 Liquid Waste Disposal

EMC expects that the liquid waste stream generated at the Moore Ranch Facility will be chemically and radiologically similar to the waste disposed in the current disposal wells in operation at existing ISR sites in the Powder River Basin. EMC has submitted an application to the WDEQ for the Class I UIC Permits necessary to construct and operate the disposal wells. In response to a request by the WDEQ, EMC has included a plan to drill and test the Teckla, Teapot, and Parkman (TTP) interval as a potential injection zone. Hence, the revised application includes two Volumes as follows:

Class I UIC Application: Lance Formation and Fox Hills Sandstone – Volume 1
Class I UIC Application: Teckla, Teapot and Parkman Formations – Volume 2

The Teapot-Teckla-Parkman interval is at depths of 7,916 ft to 9,610 ft (based on logs from the Sun Oil No. 1 Ross API No. 522824 located in T41N R75W, Section 3, NE ¼). Based on available data, the hydrologic properties of this interval would allow injection rates on the order of 30 gpm per well. Based on projected maximum production rates during ISR operations, four injection wells may be required to provide sufficient capacity during maximum periods of injection.

The Lance Formation is at depths of 3,700 to 7,500. The Lance interval has much greater injection capacity than the Teapot-Teckla-Parkman interval, based on regional information. Lance wells are expected to allow injection rates of 125 gpm. If this interval provides a suitable injection interval for permitting, only two wells would be necessary to meet the capacities for the project.

~~Three disposal wells are planned for the Moore Ranch Project.~~ The proposed location of the ~~the~~four~~se~~ Tekla, Teapot, and Parkman wells and the two Lance wells is shown on Figure 3.1-4A and Figure 3.1-4B. ~~These proposed wells will be permitted for a capacity of 125 gpm per well, giving a total of 375 gpm of disposal capacity. The estimated depth of the disposal wells and target zone is~~

~~approximately 6,400 feet.~~ . As shown in Figures 3.1-4A and 3.1-4B, anticipated disposal during operations is approximately 50.4 gpm and during restoration could be as high as 90 gpm. ~~A minimum of two disposal wells will be constructed for the first several years of operation (40 gpm) which will provide capacity of 125 gpm each. One well will handle all disposal flow from operations during this period. If a well becomes inoperable for a short time during maintenance or integrity testing, then the additional well will provide adequate disposal capacity. A third disposal well may be constructed to provide a backup well once restoration disposal flows commence.~~

EMC believes that permanent deep disposal is preferable to evaporation in evaporation ponds or land application methods for the following reasons: (1) Liquid waste disposed of through deep wells is secluded from human contact eliminating risk to human health; (2) large evaporation ponds have the potential for leaks and impacts to the environment and much larger volume of 11.e(2) byproduct is created through use of evaporation ponds; (3) land application methods have the potential to impact surface media from prolonged discharge and would require extensive treatment to meet land application standards. All compatible liquid wastes at the Moore Ranch Facility will be disposed in the planned deep wells. The application for the proposed deep disposal wells at Moore Ranch was submitted to the WDEQ-WQD on May 12, 2008. A revised application based on WDEQ direction was submitted on August 17, 2009 and is currently under review.

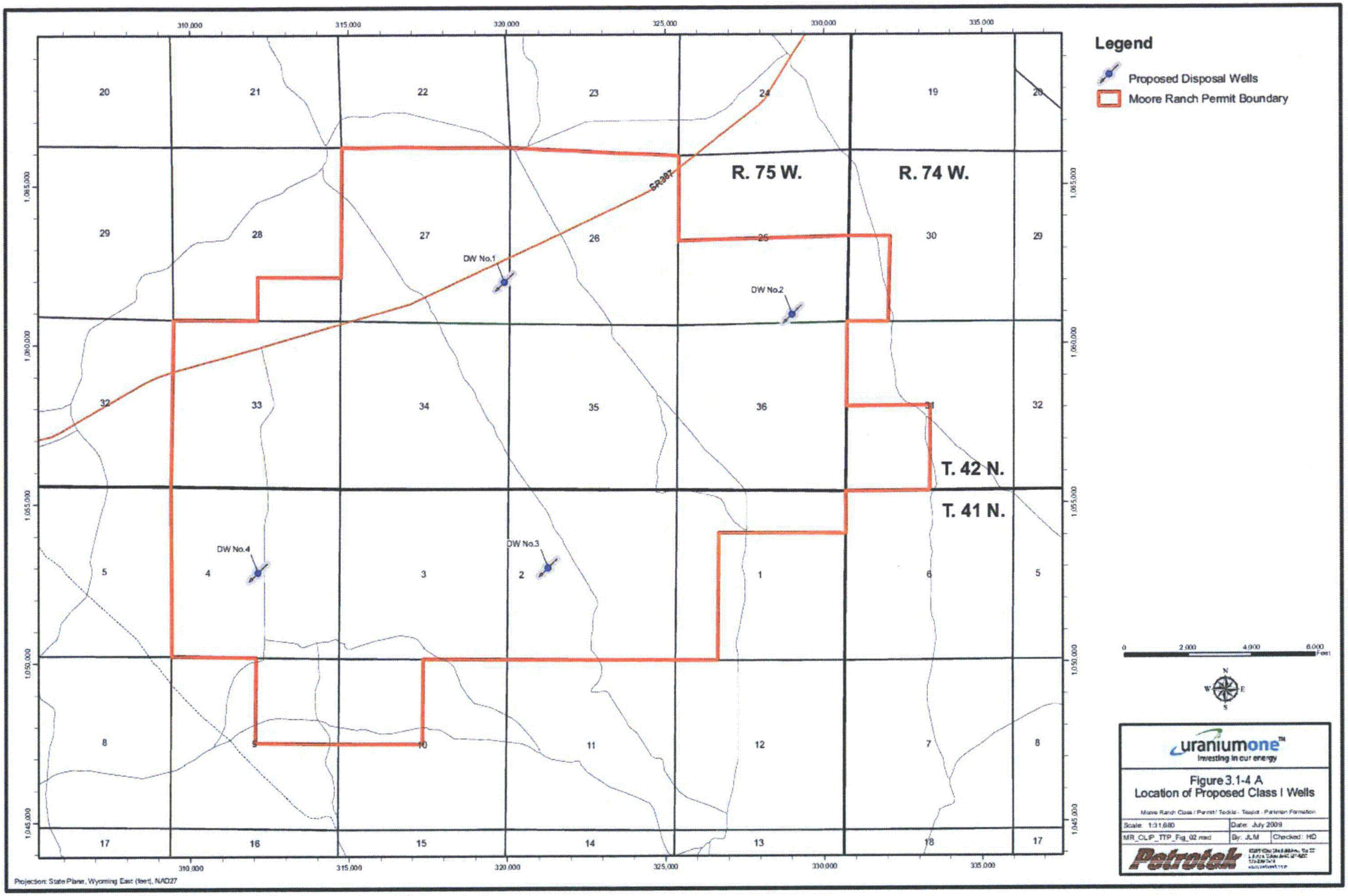

Figure 3.1-4 A
Location of Proposed Class I Wells

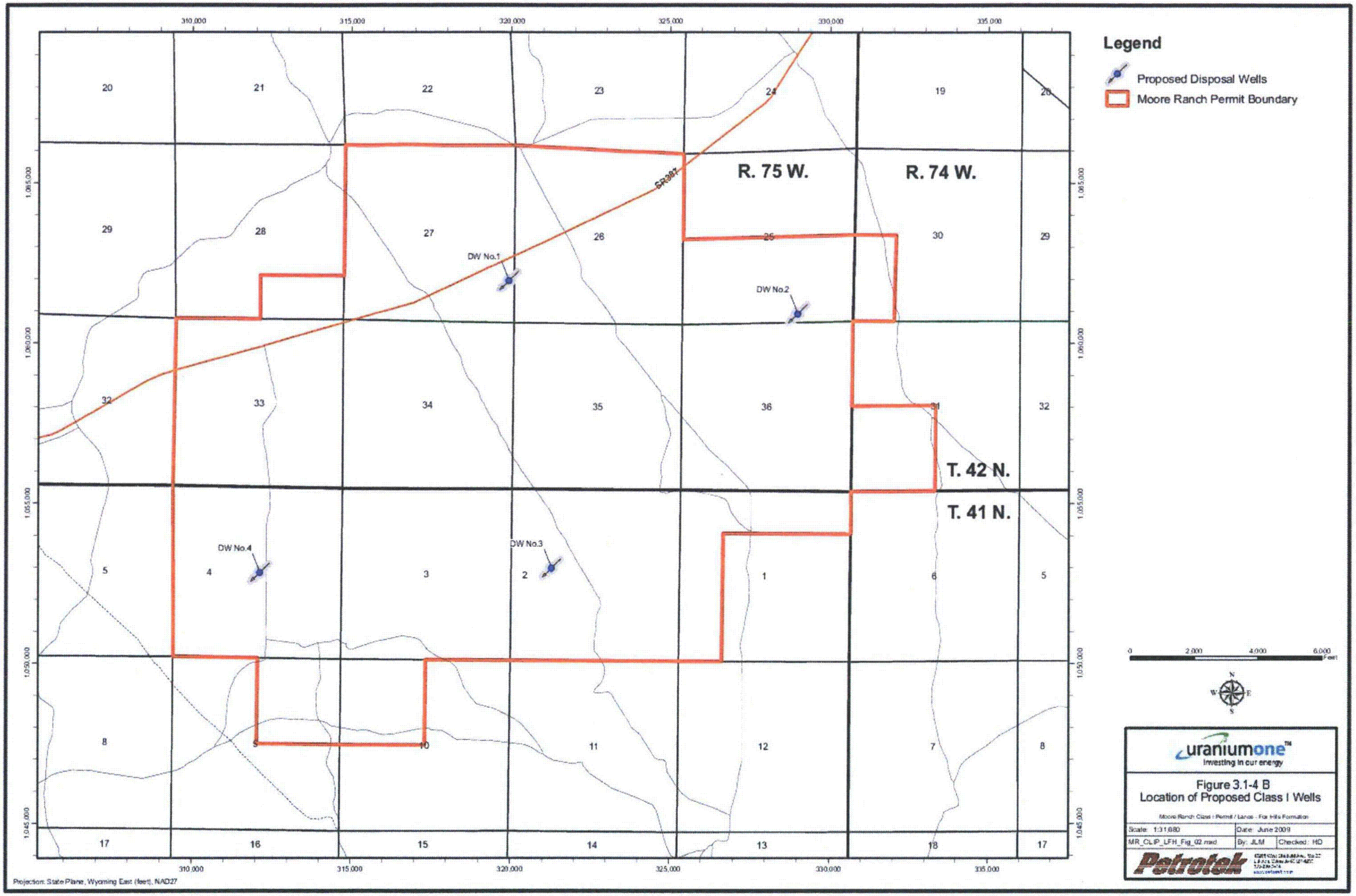

Figure 3.1-4 B
Location of Proposed Class I Wells

Non-Hydrology Open Issue No. 7
Incorrect references
May 11 2009 Teleconference

Open Issue discussion:

There are two minor issues related to the plans for liquid waste disposal: 1) TR page 4-6, section 4.2.2 incorrectly references Figure 3.1-5A when it should reference Figure 3.1-4A, and 2) page 4-8 has 2 paragraphs at the top that are duplicates of paragraphs on the previous page.

Answer:

The figure references will be corrected and the duplicate text removed as shown below.

Proposed Revisions to License Application

Corrections to Section 4.2.2 are shown in the response to Non-Hydrology Open Issue #6.

<u>Section 4.2.2.1, Page 4-8 removed duplicated text:</u>

~~It is understood that WDEQ recently has been requesting an EPA 624 Analysis for the waste stream. If this standard should be required by the WDEQ, Uranium One will comply.~~

~~Monitoring records will be submitted to WDEQ quarterly (within 30 days after the end of the quarter) and will include:~~

~~1) Date, location and time of sampling~~
~~2) Name(s) of sampling personnel~~
~~3) Date(s) of analysis~~
~~4) Analytical laboratory and name(s) of analytical technician(s)~~
~~5) Analytical procedures or methods used~~

Non-Hydrology Open Issue No. 8
Multiple tank failures are not addressed
May 11 2009 Teleconference

Open Issue discussion:

EMC indicated that a concrete curb would be built around the entire process building, and would be designed to contain the entire contents of the largest tank within the building in the event of a rupture. Any spill of plant fluids would be contained by this curb, drained to the sump system, and pumped to the waste disposal system. The applicant also needs to address the likelihood of and measures for preventing a multiple tank failure such as might occur if one failed tank fell into an adjacent tank or as recently occurred during an accident at PRI.

Non-Hydrology Open Issue No. 15
Multiple tank failure accidents are not discussed
May 11 2009 Teleconference

Open Issue discussion:

The discussions in TR section 7.5 did not consider the possibility of multiple tank failures caused by a single event.

Answer:

The response to Non-Hydrology Open Issue 8 and 15 has been combined since they both address the same accident scenario.

The largest volume liquid-containing vessel in the central processing plant is the yellowcake thickener with a maximum capacity of 9,263 cubic feet (69,300 gallons). The next largest liquid-containing vessel in the central plant is the pregnant eluant tank with a maximum capacity of 3,079 cubic feet (23,031 gallons). Although the yellowcake thickener and the pregnant eluant tank are not adjacent to each other and would therefore not be subject to the scenario postulated by NRC staff of one tank falling into another, the "worst-case" scenario of these two liquids-containing vessels failing at the same time would cause a maximum spill volume of 12,342 cubic feet. The plant retention volume is 12,200 cubic feet within the 6 inch curbing area. Therefore, the maximum volume spilled in this unlikely scenario would slightly exceed the plant curb capacity. However, it should be noted that the cited tank capacities are based on the maximum volume and not the operating volume.

Measures taken to minimize the potential of multiple tank failures include plant design of tanks and vessels that meet applicable ASME and or ASTM code for construction design.

It is our understanding that the accident referenced at PRI was not a result of multiple tank failures but failure of a valve followed by overflowing of the tank utilized to receive solutions transferred from the floor sump. We understand that human factors played a role in this event. As discussed above, the curbing area of the Moore Ranch facility will have enough capacity to hold the contents of the two largest vessels which would give adequate time to ensure sump solutions can be adequately managed and contained. Standard operating procedures and employee training will be in place for emergency situations including spills in the process plant.

EMC will add a discussion of the potential for multiple tank failures to the application. Although NRC Staff referenced Section 4.2.3.2 of the Moore Ranch Technical Report, EMC believes that this discussion belongs in Section 7.5.2.1, Tank Failure. This conforms to guidance given by NRC at the Licensing Workshop held in Denver, Colorado on November 17 and 18, 2009.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this Open Issue. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

The following new text will be inserted following the fourth paragraph in Section 7.5.2.1 of the Technical Report:

As discussed in Section 4.2.3.2, a concrete curb will be built around the entire central process plant building to contain spilled liquids. The curb is designed to hold 12,200 cubic feet (91,256) gallons. The largest liquid-containing vessel in the plant is the yellowcake thickener with a maximum capacity of 9,263 cubic feet (69,300 gallons). Therefore, the building curb capacity will be adequate to contain the contents of the largest tank in the plant.

NRC staff requested that EMC address the likelihood of and measures for preventing a multiple tank failure such as might occur if one failed tank fell into an adjacent tank. The next largest liquid-containing vessel in the central plant is the pregnant eluant tank with a maximum capacity of 3,079 cubic feet (23,031 gallons). Although the yellowcake thickener and the pregnant eluant tank are not adjacent to each other and would therefore not be subject to the scenario postulated by NRC staff of one tank falling into another, the "worst-case" scenario of these two liquids-containing vessels failing at the same time would cause a maximum spill volume of 12,342 cubic feet. The plant retention volume is 12,200 cubic feet within the 6 inch curbing area. Therefore, the maximum volume spilled in this unlikely scenario would slightly exceed the plant curb capacity. However, it should be noted that the cited tank capacities are based on the maximum volume and not the operating volume.

Construction of tanks and vessels will be in accordance with ASME and ASTM codes, providing sufficient liquid containment for potential releases. In addition, standard operating procedures for central processing plant operations will be used by EMC to minimize the potential of releases escaping the central processing plant primary containment systems.

There are a number of unlikely scenarios that could cause the failure of multiple tanks other than one tank falling into another tank. These primarily relate to natural disasters. For instance, an earthquake or a direct strike by a tornado could cause failures that would lead to leaks from multiple tanks. The likelihood of these events is discussed in Sections 2.6.6 and 2.5, respectively. The radiological impacts from these scenarios are discussed in Section 7.5.8 and address the primary radiological hazard, which would be the release of yellowcake. It is possible that in the unlikely event of multiple tank failures due to a natural disaster, the plant curb may not be able to contain all of the liquid released in the plant. However, the radiological risk of such an event is minimal and is bounded by the analysis in Section 7.5.8. Spilled liquids containing radioactive material released outside the plant containment would quickly absorb into the surrounding soil and would not present a radiological risk to workers or the public beyond that discussed in section 7.5.8. Any released radioactive material would be cleaned up using reclamation procedures as discussed in Section 6.2. The following sections discuss accident prevention and mitigation/accident response measures.

Non-Hydrology Open Issue No. 9
An agreement for disposal of 11e.(2) is needed
May 11 2009 Teleconference

Open Issue discussion:

EMC has committed to disposing of byproduct material (expected to average about 100 cubic yards per year) at a licensed site, and has indicated that a disposal agreement will be in place prior to the start of operations. Unless an agreement is provided before it is issued, the initial license will have a condition requiring verification of the solid waste disposal agreement prior to the start of operations.

Answer:

The preferred destination for radioactive waste produced from the Moore Ranch project is the Pathfinder Mines Shirley Basin site, which is licensed to receive 11(e).2 byproduct materials. However, an agreement for disposal has not been executed at this time. EMC would expect that the NRC License for Moore Ranch would contain the standard License Condition that requires an agreement for disposal of byproduct material at a licensed facility during operations.

Proposed Revisions to License Application

No changes are proposed to the license application in response to this open issue.

Non-Hydrology Open Issue No. 10
Interim storage of 11e.(2) is not discussed
May 11 2009 Teleconference

Open Issue discussion:

EMC estimates that the proposed project will produce approximately 100 cubic yards of 11e.(2) byproduct material per year, and that this material will be stored on site until such time as a full shipment can be made. The location of, and plans for, interim storage of 11e.(2) material prior to disposal must be included in the application's discussion of waste.

Answer:

EMC will store a minimal amount of 11e.(2) byproduct material at the Moore Ranch project. Section 4.4.2 of the TR estimates that approximately 100 cubic yards of byproduct material will be produced each year and notes that the byproduct material will be stored inside the restricted area until such time that a full shipment can be made to a licensed disposal facility. Byproduct material will be collected and stored within the Central Processing Plant (CPP) in appropriate containers (e.g., 55-gallon drums with drum liners). When these containers are full, they will be closed and stored within the CPP or will be moved to a byproduct storage area and stored in a strong tight container as defined by DOT regulations. The strong tight containers will be capable of preventing the spread of contamination and contact with precipitation. EMC plans to use covered roll-off containers with an approximate capacity of 20 cubic yards. Larger items such as contaminated equipment that cannot be stored in a roll-off container will be stored in the CPP or covered/sealed in manner that will prevent the spread of contamination in the byproduct storage area.

EMC has estimated approximately five shipments per year based on the planned use of 20 cubic yard roll-off containers. These roll-off containers will be used to provide storage of byproduct material as it is generated. Once a roll-off container is full, arrangements will be made for shipment of the byproduct material for disposal. The proposed disposal site is Pathfinder Mines Shirley Basin facility, located approximately 132 miles from Moore Ranch. Due to winter weather conditions in this part of Wyoming, EMC estimates that up to three 20 cubic yard roll-off containers will be necessary for storage of byproduct material awaiting disposal.

10 CFR §20.1301(a)(2) requires that a licensee conduct operations so that the dose in any unrestricted area from external sources does not exceed 2 millirem in any one hour. It is likely that the byproduct roll-off containers may occasionally contain material that could exceed this surface dose rate limit. In addition, source materials licenses typically contain a License Condition that requires that the licensee maintain an area within the restricted area boundary for storage of contaminated materials prior to disposal. In order to meet these requirements, EMC will construct a fenced restricted area with adequate storage space for three 20 cubic yard roll-off containers. The area will be locked and will be

posted as a restricted area. EMC is currently completing final site layout designs for the Moore Ranch Central Processing Plant and support facilities and has not determined the final location for a byproduct storage facility. However, the final location will be based on the following considerations:

- Close proximity to the Central Processing Plant to allow observation of the byproduct storage facility by operating personnel;
- Convenience for moving byproduct material from the generation point(s) to the byproduct storage location; and
- Ready access for transport equipment to pick up loaded containers and position empty containers.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this Open Issue. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

: Proposed new Section 3.3.6 to Technical Report

3.3.6 Byproduct Material Disposal

Byproduct material will be collected and stored within the Central Processing Plant (CPP) in appropriate containers (e.g., 55-gallon drums with drum liners). When these containers are full, they will be closed and stored within the CPP or will be moved to the byproduct storage area and stored in a strong tight container as defined by DOT regulations. The strong tight containers will be capable of preventing the spread of contamination and contact with precipitation. EMC plans to use covered roll-off containers with an approximate capacity of 20 cubic yards. Byproduct material will be collected and stored in roll off containers with an approximate capacity of 20 cubic yards. Once full, these containers will be shipped for disposal to a licensed disposal facility. During storage, the containers will be located within a restricted area. Access to the byproduct storage facility will be controlled through the use of security fencing, locked gates, and proper posting as a restricted area.

Larger items such as contaminated equipment that cannot be stored in a roll-off container will be stored in the CPP or covered/sealed in manner that will prevent the spread of contamination in the byproduct storage area.

Non-Hydrology Open Issue No. 11
Section 5.2 does not include a focused discussion of reporting requirements
May 11 2009 Teleconference

Open Issue discussion:

Although Section 5.2 of the TR acceptably discusses recordkeeping, it does not include a focused discussion of reporting requirements – see SRP 5.2.3 (13) and relevant regulations in Parts 20 and 40.

Answer:

EMC will provide a new section 5.2.6 in the Technical Report that will provide a focused discussion of reporting requirements.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this Open Issue. New section 5.2.6 will be added to the Technical Report.

5.2.6 Reporting

Reporting will be consistent with the requirements of 10 CFR 20 Subpart M and 10 CFR §40.64 and §40.65. The following specific reporting requirements will be implemented:

- *Reports of theft or loss of licensed material (10 CFR §20.2201);*
- *Notification of incidents (10 CFR §20.2202);*
- *Reports of exposures, radiation levels, and concentrations of radioactive material exceeding the constraints or limits (10 CFR §20.2203);*
- *Reports of planned special exposures (10 CFR §20.2204);*
- *Reports to individuals of exceeding dose limits (10 CFR §20.2205);*
- *Reports (10 CFR §40.64);*
- *Effluent monitoring reporting requirements (10 CFR §40.65); and*
- *Requirements for advance notice of export shipments of natural uranium (10 CFR §40.66).*

An annual report will be prepared and submitted to NRC based on the guidance contained in NUREG-1569. The annual report will contain the following information:

- *The as low as is reasonably achievable (ALARA) audit report;*
- *The land use survey;*
- *A summary of monitoring data;*
- *The corrective action program report;*

- *The semiannual effluent and environmental monitoring report required by 10 CFR §40.65; and*
- *The Safety and Environmental Review Panel information.*

Non-Hydrology Open Issue No. 12
Offsite waste disposal
May 11 2009 Teleconference

Open Issue discussion:

The TR sections on reclamation and decommissioning are also lacking information on an approved waste disposal agreement for 11e.(2) byproduct material. Also note that on TR page 6-22, top paragraph, there is a reference to "NRC-licensed disposal facility," when in fact the disposal facility does not have to be licensed by NRC.

Answer:

Please see the response to Non Hydrology Open Issue #6 concerning the agreement for disposal of byproduct material.

EMC agrees that disposal of byproduct material could be at an Agreement State-Licensed facility. Section 6 will be revised to reflect this.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this Open Issue. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

6.3.2 Removal of Process Buildings and Equipment

The majority of the process equipment in the process building will be reusable, as well as the building itself. Alternatives for the disposition of the building and equipment are discussed in this section.

All process or potentially contaminated equipment and materials at the process facility including tanks, filters, pumps, piping, etc., will be inventoried, listed and designated for one of the following removal alternatives:

- Removal to a new location for future use;
- Removal to another licensed facility for either use or permanent disposal; or
- Decontamination to meet unrestricted use criteria for release, sale or other unrestricted use by others.

EMC believes that process buildings will be decontaminated, dismantled and released for use at another location. If decontamination efforts are unsuccessful, the material will be sent to a permanent licensed disposal facility. Cement foundation pads and footings will be broken up and trucked to a solid waste disposal site or to a ~~NRC~~ licensed 11e.(2) byproduct material disposal facility if contaminated.

All waste that could pose a threat to human health and the environment will disposed of offsite~~, EMC~~. -This will effectively control, minimize, or eliminate post-closure escape of nonradiological hazardous constituents, leachate, contaminated rainwater or waste composition products to the ground or surface waters, or to the atmosphere.

Non-Hydrology Open Issue No. 13
Flare factor used for surety estimate is not justified and is inconsistent in application
May 11 2009 Teleconference

Open Issue discussion:

The flare factor and pore volume assumptions must first be resolved in the hydrology review and then applied to the surety estimates. TR page 6-33 indicates that a flare factor of 1.5 is used, while the cost estimates in Appendix D use 1.4. The pore volume is an open issue in the hydrology review.

Answer: Horizontal flare factor determined from numerical modeling was 1.18. It is assumed that vertical factor is approximately the same. The product of horizontal and vertical flare is then 1.18 x 1.18 = 1.3924 or ~1.4. However, on the conservative side, Uranium One proposes a flare factor of 1.44 be used for surety calculations. The text in the license application will be revised to clearly state 1.44 is the value used for flare factor/surety calculations. Surety calculations for the first year of operations will be submitted for approval to the Wyoming Department of Environmental Quality and the NRC prior to Permit or License issuance.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

Under Section 6.6 second paragraph:

Groundwater restoration costs are based on ~~treatment of 1 pore volume for groundwater sweep and 5~~ 6 pore volumes for reverse osmosis and reductant/bioremediation. Wellfield pore volumes are determined using the following equation:

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

~~Flare factor has been determined for PRI's Smith Ranch wellfields to be approximately 1.5 to 1.7. This~~ Fflare factor was estimated for the Moore Ranch project using a three dimensional groundwater flow model (MODFLOW) in conjunction with an advective particle tracking technique (MODPATH). ~~Horizontal and vertical flare factors of 1.5 and 1.3, respectively, have been approved by the US Nuclear Regulatory Commission for the Hydro Resources, Inc. Churchrock licensing action in New Mexico. COGEMA Mining, Inc., at the Irigaray/Christensen Ranch sites, uses an overall flare factor of 1.44.~~ The numerical modeling results (contained in Appendix B4) indicate a horizontal flare factor of approximately 1.2 and it is assumed that the vertical flare will be similar, resulting in a total wellfield flare factor of 1.4~~ to 1.5~~44.

Similar flare factors have been used for other licensed ISR facilities. Horizontal and vertical flare factors of 1.5 and 1.3, respectively, have been approved by the US Nuclear Regulatory Commission for the Hydro Resources, Inc. Churchrock licensing action in New Mexico. COGEMA Mining, Inc., at the Irigaray/Christensen Ranch sites, uses an overall flare factor of 1.44.

-Accordingly, EMC is using a flare factor of 1.5 44 for the surety estimate attached in Appendix D. Using the equation provided above with a porosity of 0.26 and an average thickness of 29.7 feet, the calculated pore volume for Wellfields 1 and 2 would be approximately 95,368,700 and 132,864,000 gallons, respectively.
Using the equation provided above with a porosity of 0.2, the wellfield pore volume for Wellfields 1 and 2 would be approximately 65,511,727 gallons and 94,151,490 gallons respectively.

Non-Hydrology Open Issue No. 14
Compliance with 10 CFR 20.2202 and 20.2203 after radiological release accident is not discussed
May 11 2009 Teleconference

Open Issue discussion:

The discussion in TR section 7.5.2, discussing radiological release accidents, did not address how EMC would meet the requirements in 10 CFR 20.2202 regarding notification of incidents and 20.2203 regarding reports of exposures, radiation levels, and concentrations exceeding limits.

Answer:

EMC will provide a new section 7.5.2.3 in the Technical Report that will provide a discussion of reporting requirements related to radiological release accidents.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this Open Issue. New section 7.5.2.3 will be added to the Technical Report.

> ***7.5.2.3 Radiological Release Reporting***
>
> *Reporting of releases of source or byproduct material will be consistent with the requirements of 10 CFR 20 Subpart M. These reporting requirements are discussed in detail in Section 5.2.6 of this Technical Report.*

Non-Hydrology Open Issue No. 15
Multiple tank failure accidents are not discussed
May 11 2009 Teleconference

Open Issue discussion:

The discussions in TR section 7.5 did not consider the possibility of multiple tank failures caused by a single event.

Answer: *See response to Non-Hydrology Open Issue #8*

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this Open Issue. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

See Non-Hydrology Open Issue #8

Non-Hydrology Open Issue No. 16
Vacuum dryer accidents are not discussed
May 11 2009 Teleconference

Open Issue discussion:

The discussion in TR section 7.5.2, discussing radiological release accidents did not address accidents involving the vacuum dryer or other plant equipment handling radioactive material.

Answer:

New section 7.5.2.3 has been prepared to address potential accidents involving the vacuum dryer. Accidents involving other plant equipment handling radioactive material would be covered in section 7.5.2.1, which addresses a thickener tank failure, and would be bounded by the analysis provided for the yellowcake dryer provided with this response.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this Open Issue. New section 7.5.2.3 has been prepared.

7.5.2.2 Yellowcake Dryer Accident

NUREG/CR-6733 analyzed the potential effects of accidents involving yellowcake dryers by examining the scenarios analyzed in NUREG-0706. The impact analysis for the four scenarios in NUREG-0706 (i.e., fire and explosion in the yellowcake drying area, discharge valve at bottom of dryer fails open, failure of offgas treatment system on one dryer, and tornado strikes to the dryer room) were based on two yellowcake dryers, each having a capacity of 4,300 lb of yellowcake, and two yellowcake dryer feed hoppers, each with a 155 ft^3 volume. NUREG-0706 also reports an upper-limit failure rate of 5×10^{-3} per plant year. NUREG/CR-6733 notes that this frequency appears to be for a gas-fired multiple hearth dryer based on failure rates for piping used in the transmission of natural gas. NUREG/CR-6733 concludes that the failure rate for the rotary vacuum dryer is likely to be less since it is not a gas-fired unit and uses hot oil as the heating medium for drying the yellowcake. However, the analysis did not quantify the expected failure rate for a hot oil-heated vacuum dryer. A gas explosion for the Moore Ranch yellowcake dryer is not a credible scenario since the dryer is heated with hot oil, eliminating the potential for an gas explosion at the dryer.

Of the four scenarios, NUREG/CR-6733 noted that the fire and explosion scenario bounded the analysis for discharge valve failure and tornado strike. The remaining scenario, failure of the offgas treatment system, is specific to gas-fired multiple hearth dryers. For the purposes of the Moore Ranch design, use of the *fire and explosion scenario will provide a bounding analysis for an accident involving a large quantity of dried radioactive material.*

The Moore Ranch design includes one rotary vacuum dryer with a maximum capacity of 7,353 pounds of yellowcake. This capacity is based on an optimal dryer loading of 60 percent of the dryer capacity and 35 percent solids and 65 percent liquid by weight slurry from the filter press. The yellowcake hopper from the filter press to the dryer has a maximum capacity of 366 cubic feet of wet yellowcake. Assuming a specific gravity of wet yellowcake of 1.346, the weight of the yellowcake contained in the hopper would be 30,740 pounds. Using the 35 weight percent slurry from the filter press, the weight of yellowcake powder in the hopper would be 10,759 pounds. This results in a total of 18,112 pounds of dry yellowcake available in the hopper and dryer for dispersion in the event of a fire or explosion.

NUREG/CR-6733 assumed that approximately 50 percent of the maximum yellowcake capacity available in two dryers and two hoppers would not be converted into aerosol size particles by the fire or explosion. Assuming this same factor for the Moore Ranch scenario, 9,056 pounds of yellowcake could become airborne. The volume of the Moore Ranch dryer room is approximately 7.37×10^4 ft^3.

NUREG/CR-6733 cites studies that indicate that the maximum sustainable airborne yellowcake concentration in air is 100 mg/m^3 (6.2×10^{-6} lb/ft^3), with heavier materials dropping out within a few minutes. Under the NUREG/CR-6733 scenario of 9,500 pounds of yellowcake dispersed in a dryer room with a volume of 1.2×10^5 ft^3, the average airborne yellowcake concentration for the first ten minutes was estimated at 3.8×10^{-2} lb/ft^3. This concentration resulted in a potential dose to a worker wearing respiratory protection (protection factor = 1,000) of 8.8 rem for the first ten minutes and 1.4 mrem for the second ten minutes after the heavier material had settled. This dose was based on Y class U_3O_8.

The average concentration of airborne uranium in the dryer room for the first ten minutes under the Moore Ranch scenario would be 6.16×10^{-2} lb/ft^3. Although this average concentration would result in a higher dose during the first ten minutes than that postulated under the NUREG/CR-6733 scenario, the uranium produced at Moore Ranch is expected to be D Class materials. This is particularly true of the 10,759 pounds contained in the hopper. For the sake of conservatism until samples of the actual Moore Ranch product can be analyzed for solubility, W Class uranium has been assumed in this application. W Class uranium would result in a dose lower than Y Class by a factor of 25. Although some of the dispersed material could be converted to Y Class depending on the temperature produced by the fire or explosion and the period of time that the material is exposed to that heat, it is clear that the dose under the Moore Ranch scenario would be less than that determined in NUREG/CR-6733.

NUREG/CR-6733 made the following recommendations due to the potentially severe consequences of a yellowcake dryer explosion:

- *The checking and logging requirements contained in 10 CFR Part 40, Appendix A, Criterion 8 should be retained;*
- *Operators should train crews for response to an accident of this type;*
- *Dryer manufacturer maintenance and operations recommendations should be followed; and*
- *Respirators should be used in the area of the dryer when it is operating.*

Uranium One will implement all of these recommendations at Moore Ranch.

Hydrology Open Issue No.1
Characterization of 60 sand is incomplete
May 11 2009 Teleconference

Open Issue discussion:

EMC reported that an approximately 80-foot shale separates the "68 sand" from the next aquifer known as the "60 sand." The "60 sand" aquifer is about 100 feet thick and continuous across the proposed license area. Where the 68 and 70 sands coalesce in Wellfield 2, EMC stated that it considers the "60 sand" as the underlying aquifer to the ore zone. EMC reported that no wells are currently in the "60 sand," so no information on the potentiometric surface or groundwater flow system is available. EMC stated that it is in the process of characterizing the "60 sand" by additional borings, so a technical evaluation of its behavior as the proposed underlying aquifer in these areas is not possible at this time.

Answer: The 60 Sand is generally the first sand unit underlying the 68 Sand. In areas where the 70 and 68 Sand coalesce, the 60 Sand may be considered the underlying aquifer to the Production Zone aquifer. The 60 Sand is approximately 100 feet thick and is continuous throughout the area. It is separated from the underlying 58 Sand by 5 to 70 feet of shale or mudstone with some interspersed sandstone lenses.

Three additional monitor wells have been drilled and completed in the 60 Sand within the project area. The locations of the wells are shown on revised Figure 2.7.2-3 (attached).

A potentiometric surface map was developed from water level data collected on August 11 2009. The potentiometric surface map shown on Figure 2.7.2-8 (attached), indicates groundwater flow within the 60 sand is generally toward the north.

Two of the three 60 Sand Monitor Wells were pump tested in August 2009. Results of the testing indicate transmissivity in the range of 1.4 to 2.4 ft^2/d significantly lower than the values determined for the 70 Sand.

Initial water quality samples were collected from the three 60 Sand Monitor Wells in May 2009. A total of four quarterly rounds of water quality samples will be collected to evaluate water quality for the 60 Sand representative of the Moore Ranch License Area. One of the wells (UMW-10) is located within proposed Wellfield 2 in the area where the 72 and 68 Sands coalesce. Results of the initial sampling of the 60 Sand are summarized in the following table.

Figure 2.7.2-1a Water Quality Results from 60 Sand Monitoring Wells

		UMW-7			UMW-10		UMW-11	
		5/12/2009	5/21/2009	7/22/2009	5/18/2009	8/17/2009	5/20/2009	8/20/2009
Major Cations and Anions								
Na	(mg/l)	62	68	59	64	63	86	90
K	(mg/l)	6	7	6	11	9	11	8
Ca	(mg/l)	48	49	50	44	53	70	68
Mg	(mg/l)	6	6	6	5	5	8	7
Cl	(mg/l)	<1	<1	2	1	2	5	3
HCO3	(mg/l)	280	241	274	236	267	148	135
CO3	(mg/l)	<1	<1	<5	12	<1	8	3
SO4	(mg/l)	67	93	51	67	64	284	273
F	(mg/l)	0.2	0.2	0.2	0.2	0.2	0.2	0.2
General Chemistry								
TDS	(mg/l) @180F	337	359	374	354	359	573	545
Conductivity	(umhos/cm)	522	594	550	528	551	807	795
pH	(s.u.)	7.87	7.97	7.81	8.77	8.34	8.77	8.51
Trace Metals								
As	(mg/l)	0.002	<0.001	0.001	0.001	0.001	0.001	0.002
Mn	(mg/l)	0.03	0.02	<0.01	<0.01	<.01	<.01	0.01
Se	(mg/l)	0.076	0.075	0.087	0.102	0.1	0.074	0.072
Radionuclides								
G Alpha	(pCi/l)	64.5	50.6	79.1	93.9	81.7	70.6	83
G Beta	(pCi/l)	14.8	13.9	16.8	27.5	2.05	21.5	18.5
Pb-210	dissolved (pCi/L)	<2.0	<0.5	0	<3.0	<2.0	<0.4	0.3
Po-210	dissolved (pCi/L)	0.1	2.8	0	0.2	3.6	0.3	0.06
Ra-226	dissolved (pCi/L)	0.35	0.4	0.56	1.1	0.72	0.99	0.87
Ra-228	dissolved (pCi/L)	1.4	0.4	1.3	1.5	1.3	0.9	2.5
Th-230	dissolved (pCi/L)	<0.04	0	0.08	0.1	0.01	0.05	<0.04
U	(mg/l)	0.0524	0.0484	0.0581	0.0645	0.0775	0.0360	0.0355

All 60 Sand samples were < detection for NH4 as N, Ba, B, Cd, Cr, Cu, Fe, Pb, Hg, Mo, Ni, V and Zn

Of note is that the selenium levels in all three wells exceed the Wyoming Class I Standard of 0.05 mg/l and the uranium levels in all three wells exceed the US EPA MCL of 0.03 mg/l. Sulfate and TDS exceed the Wyoming Class I Standard in UMW-11.

In the area of Wellfield 2 where the 70 and 68 sands coalesce, the 60 sand will be considered the underlying aquifer. Monitor wells will be placed in the underlying 60 sand in the areas where the 70 and 68 sand coalesce at a spacing of 1 well per 4 acres. The number and location of these underlying wells will be determined during final wellfield planning.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

Under Section 2.7.2.2

60 Sand

The 60 Sand is generally the first sand unit underlying the 68 Sand. In areas where the 70 and 68 Sand coalesce, the 60 Sand may be considered the underlying aquifer to the production zone aquifer. The 60 Sand is approximately 100 feet thick and is continuous throughout the area. It is separated from the underlying 58 Sand by 5 to 70 feet of shale or mudstone with some interspersed sandstone lenses. Three additional monitor wells have been drilled and completed in the 60 Sand within the project area. The location of the wells are shown on Figure 2.7.2-3.

Deeper Wasatch Sands

Several deeper sands that are included in the Wasatch Formation are present beneath the Permit Area. The Geologic cross sections described and included in Section 2.7 indicate, in descending order, the 58, 50, 40, 30, 20 and 10 Sands. Beneath the 10 Sand is the Roland Coal that is considered the top of the Fort Union Formation. Data from these deeper Wasatch Formation Sands are limited because these hydrostratigraphic units are not anticipated to be impacted by ISR activities at Moore Ranch and therefore have not been extensively characterized as part of this License application. The 40 and 50 Sands were considered by Conoco (1982) to be locally significant aquifers. However these hydrostratigraphic units are separated from the Production Zone aquifer by over 250 feet of section which includes the 68 Sand, the 60 Sand and the 58 Sand. The 68 Sand is the underlying aquifer across most of the site with the exception of areas where the 68 and 70 Sands coalesce. In those areas, the 60 Sand is considered the underlying aquifer. The 58 Sand is present between the 60 Sand and the 50 Sand. It is not anticipated that ISR activities will impact the 40 or 50 Sand within the License Area or areas downgradient.

Monitor wells have been completed within the 58, 50 and 40 Sands along the southern portion of the License Area.

Potentiometric Surface, Groundwater Flow Direction and Hydraulic Gradient

The EMC hydrologic evaluation of the Moore Ranch Project included measurement of water levels in monitor wells completed in the 70 Sand (production zone), the overlying aquifer (72 Sand) and the underlying aquifer (68 Sand) to assess the potentiometric surface, groundwater flow direction and hydraulic gradient of those units. Additional historic water level data were available from the Conoco hydrologic evaluation of the site (1982). Water levels have also been measured in monitor wells completed in the 80, 60, 58, 50 and 40 Sands. Table 2.7.2-2 lists water level data recorded for the site monitor wells.

The potentiometric surface for the 70 Sand production zone is shown on Figures 2.7.2-5a through 2.7.2-5e. The figures show a consistent hydraulic gradient toward the north throughout the period of measurement (February 2007 through March 2008) with the exception of the July 2007 potentiometric surface map. The potentiometric surface in July 2007 (Figure 2.7.2-5c), indicates a depression at baseline monitor well MW8. Hydrographs have also been prepared for all of the baseline monitor wells completed within the 70 Sand that illustrate water level fluctuations since the wells were installed in 2006 The 70 Sand monitor wells on the west side of the License Area are shown on Figure 2.7.2-5f and on the east side on Figure 2.7.2-5g. Water level fluctuations are generally less than a few feet with the exception of monitor well MW8. MW8 showed a decrease of almost 20 feet in two measurements in July 2007 and then rebounded to previous levels. No direct cause has been identified for the decrease although it is suspected that the low water level is the result of slow recovery after purging the well prior to a sampling event. A potentiometric map was also constructed for the July 2007 data without including the MW8 measurement (Figure 2.7.2-5h). The results of the mapping indicate that the depression around MW8 is localized and does not impact the other baseline monitor wells. Water level data used to develop the potentiometric surface maps and the hydrographs are included in Table 2.7.2-2. Based on those data, the direction of groundwater flow within the 70 Sand is predominantly to the north, generally consistent with the regional flow system. The horizontal hydraulic gradient calculated from this data is approximately 0.0040 ft/ft (21.1 ft/mile).

Deleted: (Figures 2.7.2-5f and 2.7.2-5g).

Potentiometric maps of the 72 Sand were developed (Figures 2.7.2-6a through 2.7.2-6e). The figures illustrate that the potentiometric surface is relatively stable throughout the period of measurement (February 2007 through March 2008). Water levels collected from the overlying aquifer (72 Sand) indicate a similar northerly groundwater flow direction as for the 70 Sand aquifer. The horizontal hydraulic gradient calculated from the data for the 72 Sand aquifer is approximately 0.0039 ft/ft (20.4 ft/mile). Hydrographs of the 72 Sand baseline monitor wells indicate minimal change in the water level elevations within that hydrostratigraphic unit since the wells were installed in 2006 (Figure 2.7.2-6f). Water level data used to develop the hydrographs are included in Table 2.7.2-2. Saturated thickness of the 72 Sand ranges from 10 feet at OMW2 to over 50 feet at OMW1.

Potentiometric surface maps for the 68 Sand were also prepared (Figures 2.7.2-7a through 2.7.2-7e). The maps show that the horizontal hydraulic gradient is consistently toward the northwest, however the magnitude of the gradient varies. Changes in the horizontal hydraulic gradient are predominately caused by large fluctuations in water levels that occur in 68 Sand monitor well UMW3. Additional monitoring of that well was performed by EMC and is described in detail later in this section. Although the general direction of groundwater flow is also to the north, the horizontal hydraulic gradient calculated for the 68 Sand (0.0005 ft/ft [2.6 ft/mi]), is much flatter than for the 70 and 72 Sands. Hydrographs have been prepared for the 68 Sand baseline monitor wells showing water level changes over time for each well [Figure 2.7.2-7f]. With the exception of well UMW3, water levels remain relatively stable during the period of measurement (February 2007 through March 2008). Water level data used to develop the potentiometric surface maps and the hydrographs are included in Table 2.7.2-2.

Three monitor wells were installed in the 60 Sand during the spring of 2008. A potentiometric surface map of the 60 Sand is presented in Figure 2.7.2-8.

Vertical hydraulic gradients were determined by measuring water levels in closely grouped wells completed in different hydrostratigraphic units. Figure 2.7.2-9a shows the location of the well groups used for the assessment of vertical hydraulic gradients. Table 2.7.2-3 summarizes the calculated vertical gradients between the 72, 70, 68 and 60 Sand aquifers. The potentiometric surface of the 70 Sand ranges from 50 to 60 feet lower than the potentiometric surface of the overlying 72 Sand at the grouped wells, suggesting that the overlying aquifer and the production zone aquifer are not in hydraulic communication. Vertical hydraulic gradients range from approximately 0.6 to 0.9 ft/ft between the 72 and 70 Sand aquifers and consistently indicate decreasing hydraulic head with depth (downward potential). A downward potential is indicative of an area of recharge, as opposed to an upward potential that is normally indicative of an area of groundwater discharge.

Hydrographs were constructed illustrating the hydraulic relationship between the 70 and 72 Sands at each of the four monitor well clusters (Figures 2.7.2-9b through 2.7.2-9e). Water level data used to develop the hydrographs are included in Table 2.7.2-2. The large difference in heads between the hydrostratigraphic units demonstrates a lack of hydraulic communication between them. Available data indicate the 72 Sand is a perched aquifer system in the southern portion of the License Area. The uppermost portion of the 70 Sand is unsaturated across the southern portion of the site. This unsaturated zone between the 70 Sand and the 72 Sand hydrostratigraphic units provides a buffer that will prevent hydraulic communication between the sands during production and restoration activities. Furthermore, the production and restoration phases of the project will be operated under a net bleed (overpumpage), resulting in declining water levels within the 70 Sand that will further separate the 72 and 70 Sands hydraulically.

Deleted: Hydrographs of the 72 Sand baseline monitor wells indicate minimal change in the water level elevations within that hydrostratigraphic unit since the wells were installed in 2006 (Figure 2.7.2-6a). Water level data used to develop the hydrographs are included in Table 2.7.2-2. Saturated thickness of the 72 Sand ranges from 10 feet at OMW2 to over 50 feet at OMW1. Additional potentiometric maps of the 72 Sand have been prepared and are attached (Figure 2.7.2-6b through 2.7.2-6f). The figures illustrate that the potentiometric surface is relatively stable throughout the period of measurement (February 2007 through March 2008). Water levels collected from the overlying aquifer (72 Sand) in indicate a similar northerly groundwater flow direction as for the 70 Sand aquifer. The horizontal hydraulic gradient calculated from the data for the 72 Sand aquifer is approximately 0.0039 ft/ft (20.4 ft/mile).

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Hydrographs illustrating the hydraulic relationship between the 68 and 70 Sands at each of the four well clusters were also developed and are shown on Figures 2.7.2-10a through 2.7.2-10d. Water levels between the MW1/UMW1 and MW2/UMW2 well clusters are very similar and no clear vertical hydraulic gradient predominates. The data are consistent with isopach maps that indicate the absence of the underlying shale between the 70 and 68 Sands in the central portion of Wellfield 2 and therefore possible hydraulic communication between those units. At the MW4/UMW4 well group there is a distinct downward hydraulic gradient between the 70 and 68 Sands with water levels in the 70 Sand monitor wells consistently 8 to 10 feet greater than in the 68 Sand monitor wells. In the area of the MW4 well group, the shale unit between the 70 and 68 Sand is 25 to 40 feet thick. The thickness of the shale unit, coupled with the large head difference indicates that the 68 and 70 Sand aquifers are not in direct hydraulic communication at this location. The hydraulic relationship between the 70 and 68 Sands at the MW3/UMW3 well pair is not clear because of the large fluctuations in water levels at UMW3. Figure-2.7.2-10e shows additional water level monitoring that has been conducted at monitor well UMW3. Water level data used to develop the potentiometric surface maps and the hydrographs are included in 2.7.2-2.

The cause for the large fluctuation in water levels in the 68 Sand at well UMW3 is unknown. Well UMW-3 experienced steady drawdown from February of 2007 through July 2007. Approximately 25 feet of water level decline was observed during that period. None of the other underlying 68 Sand wells in the project area showed this declining trend and only showed fluctuations of a few feet. From July 2007 until October 2007, water levels showed a gradual recovery in UMW3 only to drop off sharply again. The decrease in water levels in October 2007 was in response to a sampling event in which the well was purged prior to sampling. Almost two months following the sampling event, water levels in the well were still almost 18 ft lower than the pre-sample level (Figure 2.7.2-10e). This slow recovery indicates that the 68 Sand in the vicinity of UMW3 has a relatively low transmissivity or that there is significant skin damage in the well. The water level in UMW3 returned to static levels around February 2008. An August 2009 measurement at UMW3 indicates that the water level at that well is anomalously high.

The cause of the earlier declining trend in well UMW3 is unknown and was not replicated in other wells Additional investigation indicates that the drawdown observed in the water levels of UMW-3 from February through July of 2007 does not correspond with production from nearby CBNG wells. Production from the six closest wells was ongoing through both drawdown and subsequent recovery of the water levels in UMW-3. Water production from the CBNG wells in March 2008 was more than 5,780 bbls/day (WOGCC, 2008), while the water levels in UMW-3 stabilized in February 2008. The majority of produced water has come from the 34S-1 (NENE, Section 34, T42N, R75W) and 35S-4 wells (NWNW, Section 35, T42N, R75W). Impacts to the monitor well due to CBNG production seems highly unlikely given this scenario.

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Deleted: The vertical gradient between the 70 and 68 Sand aquifers is minimal at two of the well groups (MW1 and MW2). There may be hydraulic communication between the aquifers at these locations. This is consistent with earlier observations that the 68 and 70 Sands coalesce in places within the License Area. At the MW4 well group, there is a 5 to 10 foot head difference between the 70 and 68 Sand aquifers (decreasing with depth). In the area of the MW4 well group, the shale unit between the 70 and 68 Sand is 25 to 40 feet thick. The thickness of the shale unit, coupled with the large head difference indicates that the 68 and 70 Sand aquifers are not in direct hydraulic communication at this location. The vertical hydraulic gradient between the 68 and 70 Sand aquifers is variable at the MW3 well group location. Recent data, collected in June and July of 2007, indicate that the potentiometric heads are higher in the 70 Sand aquifer (at well MW3) by 10 to 20 feet. Data collected in February 2007 indicated the potentiometric heads in the 68 Sand aquifer (well UMW3) were higher than the heads in the 70 Sand aquifer by 7 to 10 feet

Water levels at two 60 sand monitor wells were compared to levels in overlying wells in August 2009. The water levels indicate a downward hydraulic gradient between the 60 and overlying 68 and 70 Sands (Table 2.7.2-3).

Aquifer Properties

Hydrologic properties for the Wasatch aquifers within the Moore Ranch Project area are estimated from historic and recent pumping tests. Dames & Moore conducted an initial investigation (1978) for Conoco of the hydrologic properties within three delineated ore bodies. The ore bodies were designated by Conoco as the 34 (located in Section 34 T42N, R75W) and 35N (located in the north portion of Section 35, T42N, R75W) and 35S (located in the south portion of Section 35, T42N, R75W). Conoco performed additional hydrologic evaluation in 1982 to determine the feasibility of in-situ and/or open pit production of those uranium ore bodies.

EMC conducted pump tests in 2007 and 2008 to evaluate hydrologic properties of the Production Zone aquifer (70 Sand). Results of the hydrologic testing are summarized below.

Additional hydrologic testing was performed in August 2009 to evaluate hydrologic properties of the other hydrostratigraphic units that could be potentially impacted by ISR operations including the shallowest occurrence of groundwater (80 Sand), the overlying aquifer (72 Sand), the underlying aquifer (68 Sand) and the unit underlying the area where the 70 and 68 Sands coalesce (60 Sand). Results of those tests will be provided in a supplemental hydrologic testing report.

SECTION 2.7.2.4 Groundwater Quality

EMC has installed a monitor well network to evaluate pre-mining baseline conditions within the License Area. The location of the monitor wells are shown on Figure 2.7.3-2. Four well groups or clusters were constructed, each including a completion in the Production Zone aquifer (70 sand), the overlying aquifer (72 Sand), and the underlying aquifer (68 Sand). In addition to the well groups, four wells completed in the 70 Sand are included in the baseline water quality monitoring network. Three monitor wells have also been installed in the 60 Sand which underlies the 68 Sand. One of those 60 Sand monitor wells is located in the area where the 68 and 70 Sands coalesce. A row of monitor wells completed in the 58, 50 and 40 Sands was installed in the southern portion of the License Area. Three wells were also installed in the 80 Sand that overlies the 72 Sand. Only one of those 80 Sand monitor wells contains sufficient water for sampling. Table 2.7.3-15 provides a summary of well construction information. The parameters included in the EMC Monitoring Program are listed in Table 2.7.3-16.

Three of the original Conoco wells, 8-3, 1808, and 885, and 4 private stock wells were also included in the monitoring program. These wells are not a part of the baseline monitoring program. Water quality from these wells are used only for comparison to

Deleted: The water levels in the 70 Sand aquifer remained relatively constant throughout the year but changed by as much as 25 feet in the 68 Sand aquifer at UMW3. The cause for the large fluctuation in water levels in the 68 Sand at well UMW3 is unknown. Well UMW-3 experienced steady drawdown since early February of 2007. Approximately 25 feet of water level decline was observed until mid-August, when the well began to show recovery trend with the water level rising approximately 10 feet. None of the other underlying 68 Sand wells in the project area showed this declining trend and only showed fluctuations of a few feet. Investigation has not revealed the cause of the declining water levels. The unexplained drawdown observed in the water levels of UMW-3 from February through July of 2007 does not correspond with production from nearby CBNG wells. Production from the six closest wells was ongoing through both drawdown and subsequent recovery of the water levels in UMW-3. Water production from the CBNG wells in March 2008 was more than 5,780 bbls/day (WOGCC, 2008), while the water levels in UMW-3 stabilized in February 2008. The majority of this has come from the 34S-1 (NENE, Section 34, T42N, R75W) and 35S-4 (NWNW, Section 35, T42N, R75W). Impacts to the monitor well due to CBNG production seems highly unlikely given this scenario. ¶

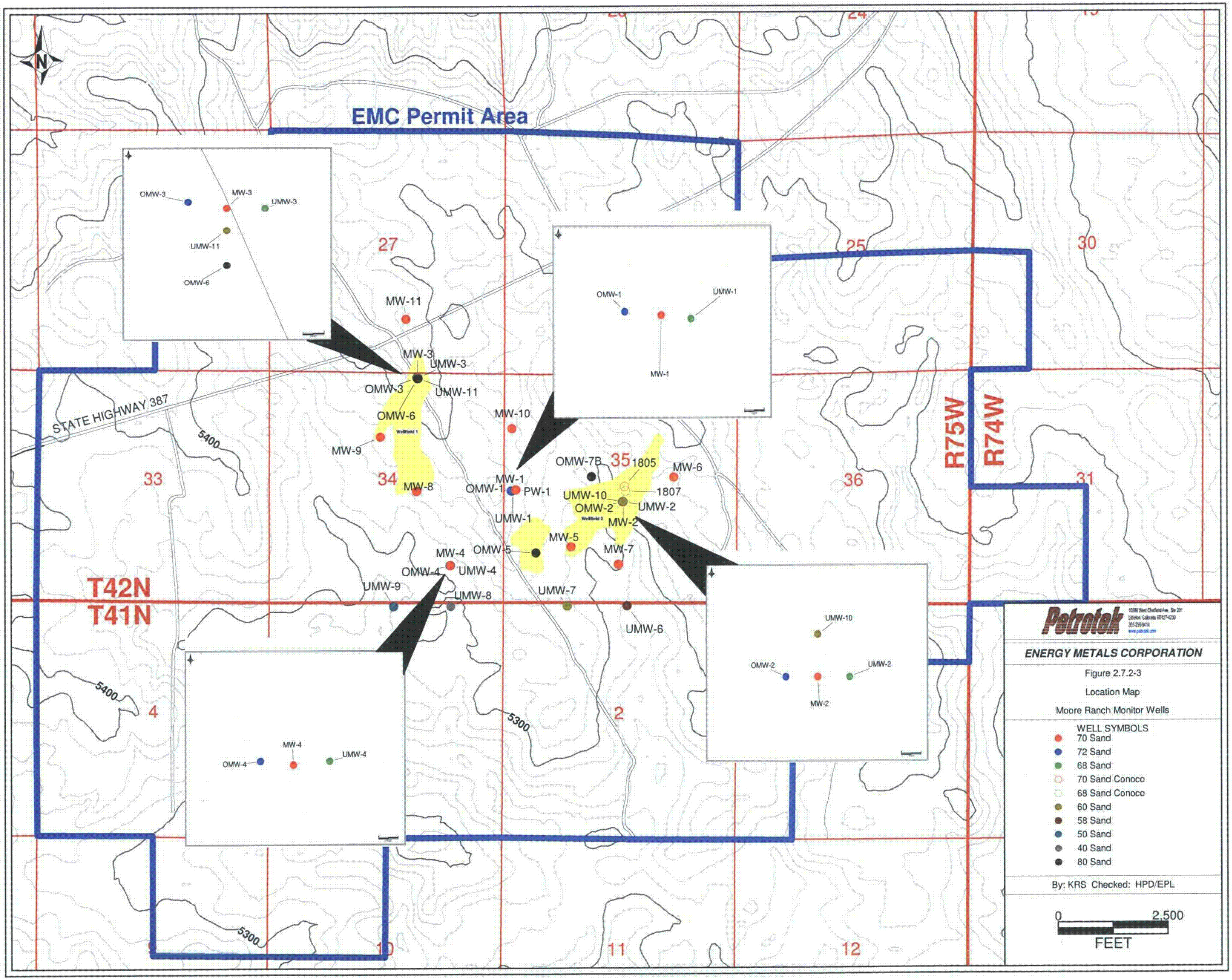
¶

EMC has continued monitoring of UMW3 to determine if the drawdown behavior is repeated or if a cause of the observed trend can be identified. Water level measurements were made at 15 minute intervals using a pressure transducer from 2/15/07 through 3/1/07, and 3/20/07 through 3/23/07, and then at 10 minute intervals from 5/8/08 through 7/1/08. A problem was identified with the transducer during the 2008 monitoring period, resulting in replacement of the instrument. Hand measurements were periodically made throughout the monitoring period. A hydrograph is attached that shows the water level elevation during the entire monitoring period (Figure 2.7.2-7k). In addition to the decline in water lev ... [1]

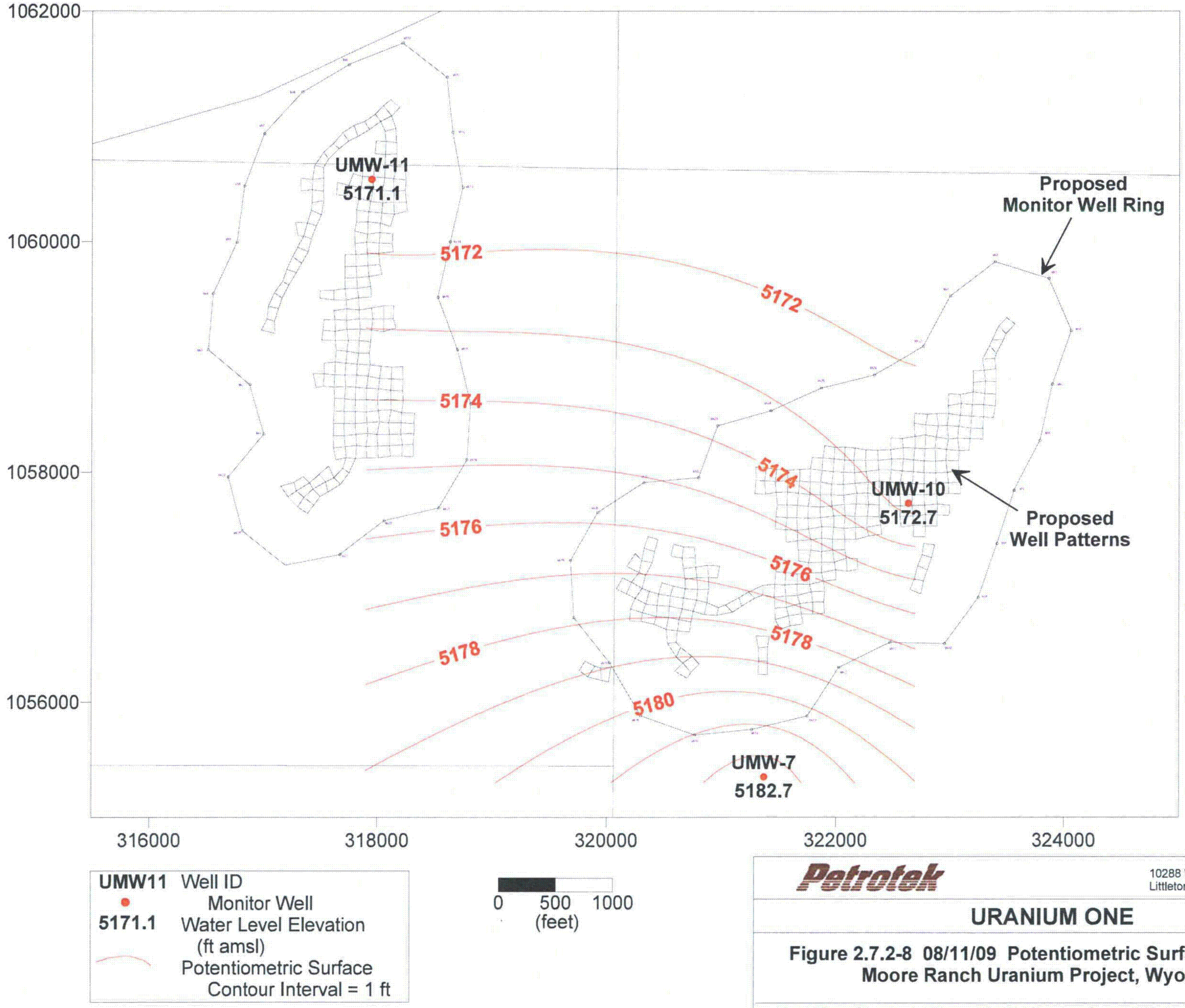
Deleted: Additional hydrologic testing is being performed to evaluate hydrologic properties of the other hydrostratigraphic units that could be potentially impacted by ISR operations including the shallowest occurrence of groundwater (80 Sand), the overlying aquifer (72 Sand), the underlying aquifer (68 Sand) and the unit underlying the area where the 70 and 68 Sands coalesce (60 Sand).

historical water quality collected by Conoco. Monitor wells 8-3 and 1808 are completed across both the 70 and 68 Sands. Monitor well 885 is only completed across the 70 Sand.

Deleted: Dames & Moore conducted an initial investigation (1978) for Conoco of the hydrologic properties within the Wellfield 1 and Wellfield 2 ore bodies. Conoco performed additional hydrologic evaluation in 1982 to determine the feasibility of in-situ and/or open pit production of those uranium ore bodies. ¶



EMC Permit Area
STATE HIGHWAY 387
T42N
T41N
R75W
R74W
27
25
30
33
34
35
36
31
4
2
10
11
12
5400
5300
MW-11
MW-3
UMW-3
OMW-3
UMW-11
OMW-6
MW-9
MW-8
MW-10
MW-1
OMW-1
PW-1
UMW-1
OMW-7B
1805
1807
MW-6
UMW-10
OMW-2
UMW-2
MW-2
MW-5
OMW-5
MW-7
MW-4
OMW-4
UMW-4
UMW-9
UMW-8
UMW-7
UMW-6
Petrotek
ENERGY METALS CORPORATION
Figure 2.7.2-3
Location Map
Moore Ranch Monitor Wells
WELL SYMBOLS
70 Sand
72 Sand
68 Sand
70 Sand Conoco
68 Sand Conoco
60 Sand
58 Sand
50 Sand
40 Sand
80 Sand
By: KRS Checked: HPD/EPL
0
2,500
FEET



Petrotek 10288 W.Chatfield Ave, Ste 201
Littleton, CO 80127-4239

URANIUM ONE

Figure 2.7.2-8 08/11/09 Potentiometric Surface, 60 Sand
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:MRpotsurfmap080108.srf Date: 08/02/08

Hydrology Open Issue No.2
The location of the area where the 60 sand is the underlying aquifer is not provided
May 11 2009 Teleconference

Open Issue discussion:

EMC has not identified on a map the locations in the wellfields where the "60 sand" will be considered the underlying aquifer. This information is needed to assess the proposed monitoring of the underlying aquifer.

Answer: The 60 Sand will be treated as the underlying aquifer in the areas of Wellfield 2 where the 68 and 70 Sands coalesce. An isopach map of the confining unit between the 68 and 70 sands is provided. The attached isopach map will be incorporated into the Technical Report revisions. Where the confining unit is absent (thickness of zero) the 60 Sand will be the underlying aquifer. The area shown on the attached isopach map is the only area identified within the Moore Ranch Project where the 68 and 70 coalesce.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

Under Section 2.6.2 Site Geology, next to last paragraph in the section

Figure 2.6-16 is an isopach map of the production 70 sand. In the vicinity of monitor well UMW-2 the sand thickens and coalesces with the underlying 68 sand. Isopach maps of the underlying shale (Figures 2.6-17 and 2.6-18) illustrate the disappearance of this shale in a small area around UMW-2 and a larger area just to the northeast of UMW-2 (see also cross sections C-C' and G-G').

Under Section 5.7.8.2 Groundwater Monitoring

Monitor wells will be installed within the overlying aquifer (72-Sand) and underlying aquifer (68-sand) at a density of one well per every four acres of pattern area. These wells will be used to obtain baseline water quality data to be used in the development of UCL's for these zones. In the areas of Wellfield 2 where a confining unit exists between the 70 and 68 sands, monitor wells will be placed in the 68 sand at the spacing described in this section (1 per 4 acres). Additional monitor wells may be placed around the area where the two sands coalesce to provide increased monitoring of any potential impacts to areas of the 68 sand outside of the coalescing area. Monitor wells will be placed in the underlying 60 sand in the areas where the 70 and 68 sand coalesce at a spacing of 1 well per 4 acres. The final number and location of these underlying wells will be determined during final wellfield planning.

Figure 2.6-17

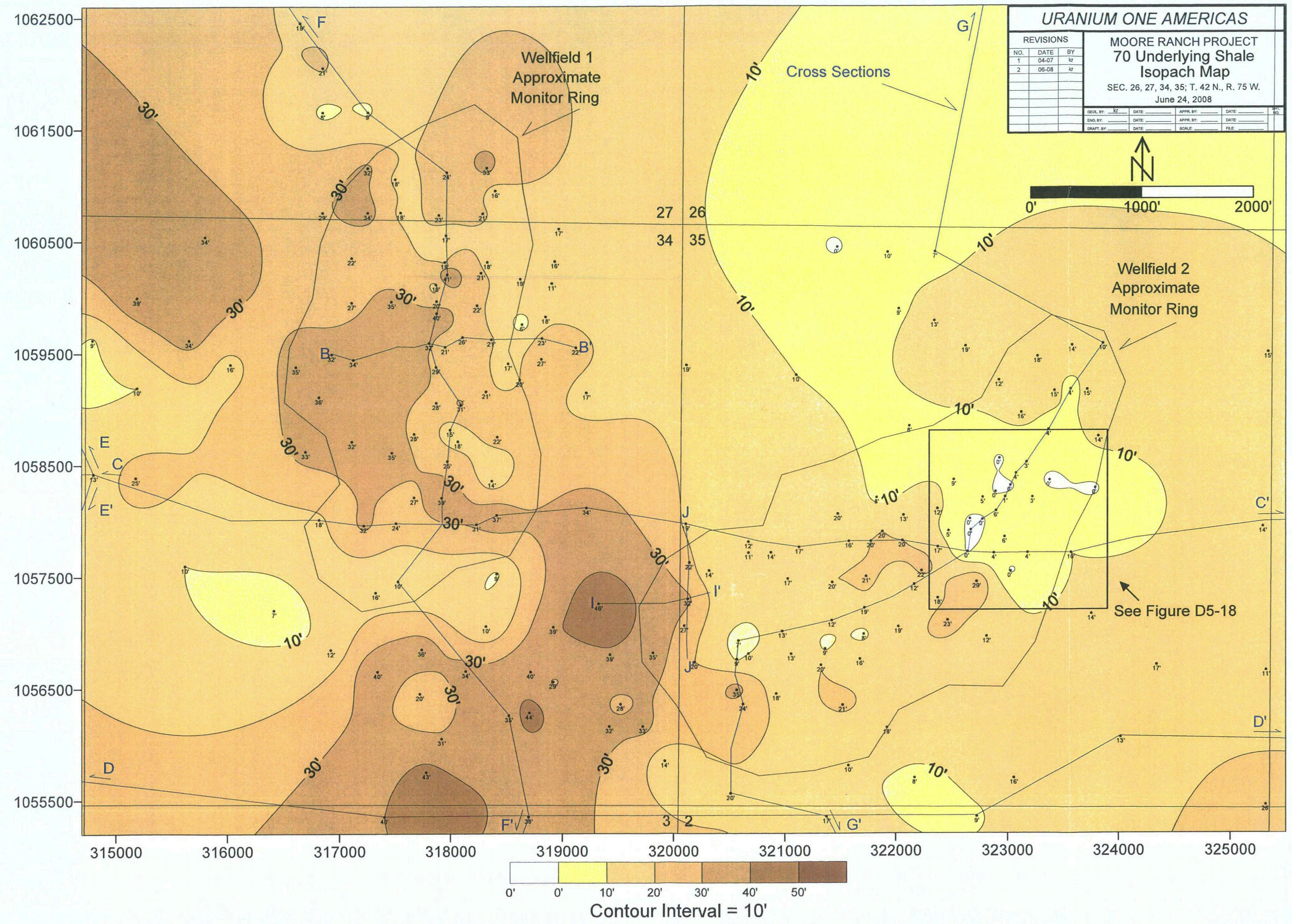
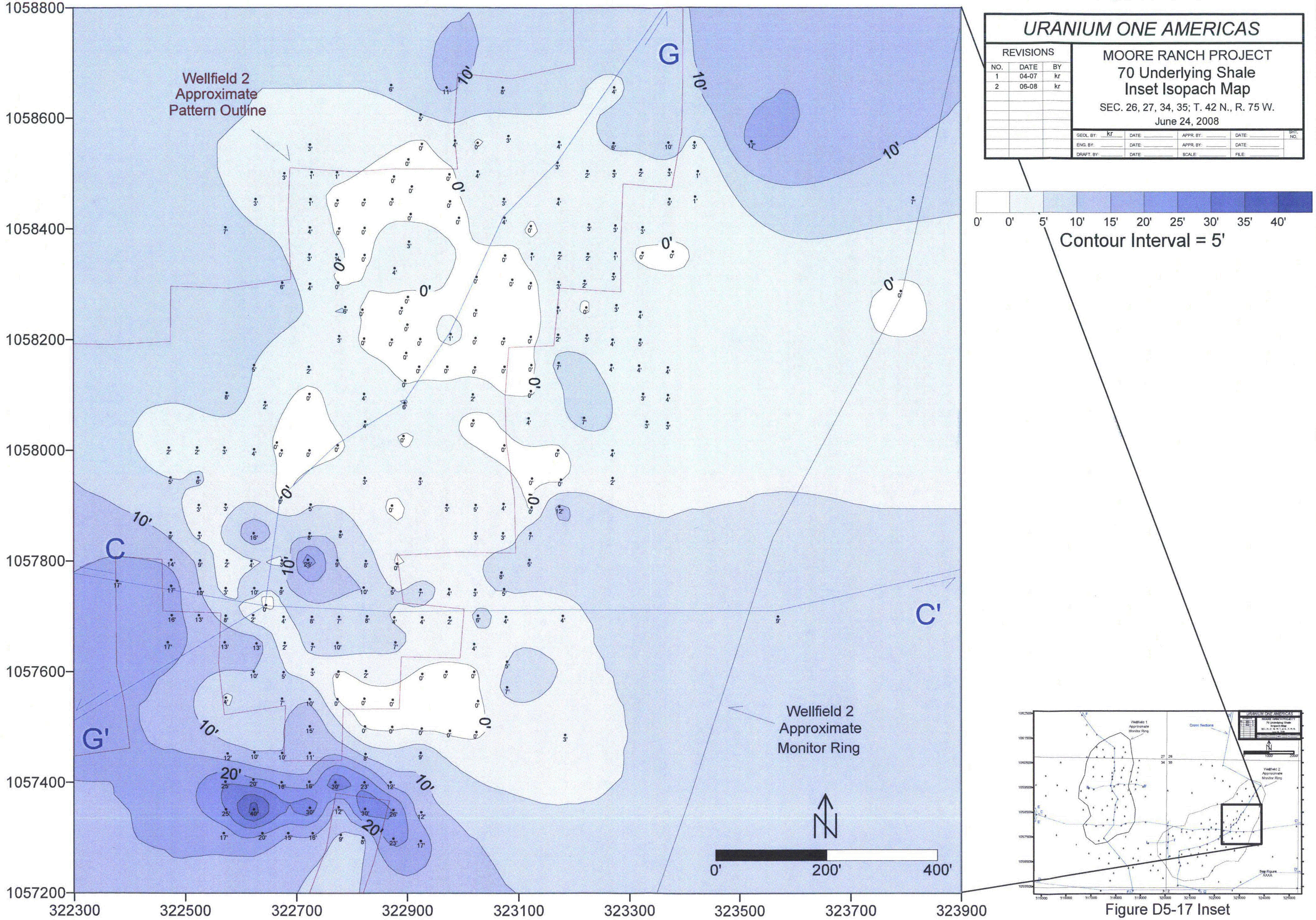

URANIUM ONE AMERICAS
REVISIONS
NO. DATE BY
1 04-07 kr
2 06-08 kr
MOORE RANCH PROJECT
70 Underlying Shale
Isopach Map
SEC. 26, 27, 34, 35; T. 42 N., R. 75 W.
June 24, 2008
N
0'
1000'
2000'
Wellfield 1
Approximate
Monitor Ring
Wellfield 2
Approximate
Monitor Ring
Cross Sections
See Figure D5-18
27
26
34
35
3
2
F
F'
G
G'
B
B'
C
C'
D
D'
E
E'
I
I'
J
J'
30'
10'
1062500
1061500
1060500
1059500
1058500
1057500
1056500
1055500
315000
316000
317000
318000
319000
320000
321000
322000
323000
324000
325000
0'
0'
10'
20'
30'
40'
50'
Contour Interval = 10'

Figure 2.6-18


URANIUM ONE AMERICAS
REVISIONS
NO. DATE BY
1 04-07 kr
2 06-08 kr
MOORE RANCH PROJECT
70 Underlying Shale
Inset Isopach Map
SEC. 26, 27, 34, 35; T. 42 N., R. 75 W.
June 24, 2008
GEOL. BY: kr
0' 0' 5' 10' 15' 20' 25' 30' 35' 40'
Contour Interval = 5'
Wellfield 2
Approximate
Pattern Outline
Wellfield 2
Approximate
Monitor Ring
G
G'
C
C'
1058800
1058600
1058400
1058200
1058000
1057800
1057600
1057400
1057200
322300
322500
322700
322900
323100
323300
323500
323700
323900
0'
200'
400'
N
Figure D5-17 Inset

Hydrology Open Issue No.3
The vertical gradient between the 68 sand and the 60 sand is not assessed
May 11 2009 Teleconference

Open Issue discussion:

EMC did not assess the vertical gradient across the confining layer between the "68 sand" and the "60 sand" in Wellfield 2, even though EMC indicated the "60 sand" was the underlying aquifer in portions of this wellfield where the 70 and 68 sands coalesce. It is, therefore, unknown if the shale under the "68 sand" has the integrity to protect the "60 sand" from excursions in this region.

Answer: Water level measurements have been collected at the new 60 Sand monitor wells. Two of the 60 Sand monitor wells are drilled in areas where well clusters (completed in the 72, 70 and 68 sands) are located. Revised Table 2.7.2-3 of the TR provides with the results of the water level measurements and gradient calculations. Vertical gradients between the 60 and 68 sands indicate a downward potential (i.e. water levels in the 68 Sand monitor wells are higher than in the 60 Sand monitor wells. The vertical hydraulic gradients range from 0.14 to 0.52 ft/ft. The water level in UMW-10 (a 60 Sand monitor well) was 15.4 and 16.1 feet lower than the corresponding 68 Sand monitor well (UMW2) and 16.1 feet lower than the corresponding 70 Sand monitor well (MW2). The water level in UMW-11 (a 60 Sand monitor well) was 51.2 and 6.7 feet lower than the corresponding 68 and 70 Sand monitor wells (UMW3 and MW3). However it should be noted that the water level in UMW-3 appears anomalously high.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

Under *Potentiometric Surface, Groundwater Flow Direction and Hydraulic Gradient*

Water levels at two 60 sand monitor wells were compared to levels in overlying wells in August 2009. The water levels indicate a downward hydraulic gradient between the 60 and overlying 68 and 70 Sands (Table 2.7.2-3).

Table 2.7.2-3 Vertical Hydraulic Gradient Calculations, Moore Ranch Permit Area, Wyoming

Well ID	Completion Zone	Ground Surface Elevation	Top of Screen	Bottom of Screen	Midpoint Elevation	Water Level Elevation	Vertical Gradient*	Water Level Elevation	Vertical Gradient*	Water Level Elevation	Vertical Gradient*	Water Level Elevation	Vertical Gradient*	Water Level Elevation	Vertical Gradient*
		(ft amsl)	(ft bgs)	(ft bgs)	(ft amsl)	8/11/2009		3/5/2008		2/21/2008		7/25/2007		7/17/2007	
						(ft amsl)	(ft/ft)	(ft amsl)	(ft/ft)	(ft amsl)	(ft/ft)	(ft amsl)	(ft/ft)	(ft amsl)	(ft/ft)
OMW-1	72 Sand	5379.70	148	168	5222	NM	NM	5238.42	-	5238.58	-	5238.55	-	5238.59	-
MW-1	70 Sand	5379.00	182	250	5163	NM	NM	5188.22	0.86	5188.45	0.85	5186.19	0.89	5187.88	0.86
UMW-1	68 Sand	5378.70	282	312	5082	NM	NM	5186.75	0.02	5186.81	0.02	5188.17	-0.02	5186.19	0.02
OMW-2	72 Sand	5312.50	60	78	5244	5245.74	-	5244.57	-	5244.60	-	5242.13	-	5240.72	-
MW-2	70 Sand	5312.30	130	195	5150	5188.74	0.61	5188.22	0.60	5188.44	0.60	5188.16	0.58	5188.10	0.56
UMW-2	68 Sand	5312.40	230	250	5072	5188.13	0.01	5187.78	0.01	5187.94	0.01	5187.66	0.01	5187.57	0.01
UMW-10[a]	60 Sand	5312.00	335	365	4962	5172.68	0.14								
OMW-3	72 Sand	5427.00	205	245	5202	5238.54	-	5238.99	-	5239.11	-	5239.27	-	5239.22	-
MW-3	70 Sand	5426.90	269	317	5134	5178.80	0.88	5177.78	0.90	5177.99	0.90	5177.77	0.90	5177.19	0.91
UMW-3	68 Sand	5426.50	353	378	5061	5222.29[b]	-0.60	5176.77	0.01	5177.21	0.01	5159.24	0.25	5159.89	0.24
UMW-11[a]	60 Sand	5427.00	450	480	4962	5171.06	0.52								
OMW-4	72 Sand	5312.60	76	91	5229	NM	NM	5245.76	-	5245.90	-	5245.97	-	5245.81	-
MW-4	70 Sand	5312.60	126	164	5168	NM	NM	5196.61	0.80	5196.81	0.80	5196.56	0.80	5196.59	0.80
UMW-4	68 Sand	5312.70	222	252	5076	NM	NM	5187.90	0.09	5188.09	0.09	5187.65	0.10	5187.37	0.10

a - ground surface and water level elevation are estimated-accuracy within one foot
b -water level elevation appears anomolously high
ft amsl - feet above mean sea level
ft bgs - feet below ground surface
* - Positive value indicates a downward hydraulic gradient (heads decrease with depth) and negative value indicates an upward hydraulic gradient (head increase with depth)

Table 2.7.2-3 Vertical Hydraulic Gradient Calculations, Moore Ranch Permit Area, Wyoming

Well ID	Completion Zone	Ground Surface Elevation	Water Level Elevation	Vertical Gradient*	Water Level Elevation	Vertical Gradient*	Water Level Elevation	Vertical Gradient*
		(ft amsl)	6/12/2007		2/14/2007		2/9/2007	
			(ft amsl)	(ft/ft)	(ft amsl)	(ft/ft)	(ft amsl)	(ft/ft)
OMW-1	72 Sand	5379.70	5238.59	-	5238.74	-	5238.70	-
MW-1	70 Sand	5379.00	5187.88	0.86	5187.95	0.87	5187.33	0.88
UMW-1	68 Sand	5378.70	5186.29	0.02	5185.81	0.03	5185.89	0.02
OMW-2	72 Sand	5312.50	5242.72	-	5244.97	-	5244.88	-
MW-2	70 Sand	5312.30	5183.00	0.64	5188.13	0.61	5188.14	0.61
UMW-2	68 Sand	5312.40	5187.47	-0.06	5187.59	0.01	5187.52	0.01
UMW-10[a]	60 Sand	5312.00						
OMW-3	72 Sand	5427.00	5239.12	-	5239.38	-	5239.37	-
MW-3	70 Sand	5426.90	5177.59	0.90	5177.69	0.91	5177.64	0.91
UMW-3	68 Sand	5426.50	5167.29	0.14	5185.22	-0.10	5187.04	-0.13
UMW-11[a]	60 Sand	5427.00						
OMW-4	72 Sand	5312.60	5246.01	-	5246.31	-	5246.30	-
MW-4	70 Sand	5312.60	5196.59	0.80	5196.54	0.81	5196.49	0.81
UMW-4	68 Sand	5312.70	5187.47	0.10	5187.31	0.10	5191.19	0.06

a - ground surface and water level ele
b -water level elevation appears anon
ft amsl - feet above mean sea level
ft bgs - feet below ground surface
* - Positive value indicates a downwar

Hydrology Open Issue No.4
Pump tests are lacking in the 68 sand where it is part of the ore zone
May 11 2009 Teleconference

Open Issue discussion:

EMC has stated that the "68 sand" will be included as part of the ore zone in portions of Wellfield 2 which will be determined by future hydrologic testing. EMC has not, however, conducted pumping tests in the "68 sand" to establish confinement of the underlying "60 sand" aquifer from the "68 sand" in these areas of Wellfield 2.

Answer: Two pump tests were conducted in the 68 Sand at monitor wells UMW-2 and UMW-3 in August 2009. Well UMW-2 is located in the area where the 68 and 70 Sands coalesce The tests were short-term tests. Wells completed in the overlying and underlying aquifers were monitored during the tests. Well UMW-2 was pumped for 113 minutes at 1.12 gpm. Total drawdown in the well was 63.5 feet at the end of the test. No response was observed in either the overlying 70 Sand monitor well (MW-2) or the underlying 60 Sand monitor well (UMW10). Estimated transmissivity from the UMW-2 test was from 0.53 to 0.71 ft^2/d. This range is almost an order of magnitude lower than the transmissivity determined for the 70 Sand is this area.

Well UMW-3 was pumped for 20 minutes at 0.8 gpm. Total drawdown in the well was 21.3 feet at the end of the test. The test was terminated because the water level in the pumped well dropped below the level of the pressure transducer. No response was observed in either the overlying 70 Sand monitor well (MW-3) or the underlying 60 Sand monitor well (UMW11) during the UMW-3 test. The test at UMW-3 did not run long enough to exceed the casing storage in the well. Therefore, transmissivity could not be estimated from this pump test. However, the initial response was similar to that seen during the UMW-2 test. It can be reasonably assumed that the transmissivity of the 68 Sand in the vicinity of UMW-3 is of the same magnitude as that estimated at UMW-2, both of which are significantly lower than the transmissivity of the 70 Sand aquifer.

Additional hydrologic testing will also be performed as part of the Wellfield Data Package that will be submitted and approved prior to mining. The 60, 68, 70 and 72 sands will be monitored before, during and after the pump test in order to assess the degree of hydraulic communication between these units (if any).

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method. A Technical Memorandum: Evaluation of Potential Impacts to the 68 Sand from ISR Production in Wellfield 2, Moore Ranch Uranium Projects, Wyoming, will be included in the revised Technical Report as Appendix B6.

Insert at end of section 2.7.2-2 TR

2009 Pump Test Results

A series of short term pump tests were conducted in August 2009 to evaluate hydrologic properties of the 72, 68 and 60 Sand aquifers. The tests were conducted in areas where well clusters are located in order to allow assessment of hydraulic communication between the pumped aquifer and overlying and underlying units. One of the well clusters is located within Wellfield 1 and includes monitor wells MW-3 (70 Sand), OMW-3 (72 Sand), UMW-3 (68 Sand) and UMW-11 (60 Sand). The other well cluster is located within Wellfield 2 and includes monitor wells MW-2 (70 Sand), OMW-2 (72 Sand), UMW-2 (68 Sand) and UMW-10 (60 Sand).

Two short term pump tests were conducted in the 72 Sand at monitor wells OMW-2 and OMW-3 in August 2009. Wells completed in the underlying aquifer were monitored during the tests. The OMW-3 pump test was repeated three times because of the short duration of the tests. The pumping rate ranged from 0.91 to 0.94 gpm for the tests and the length of the tests ranged from 15 to 31 minutes. Total drawdown in the well was rapidly stabilized at 0.6 feet for each test. No response was observed in the underlying 70 Sand monitor well (MW-3) during the test. Estimated transmissivity for the 72 Sand from the OMW-3 test is 280 to 300 ft^2/d. Well OMW-2 was pumped for 33 minutes at 0.84 gpm. The test was terminated when the flow dropped below the pressure transducer. There was less than 10 feet of water column in the well at the start of the test. Total drawdown in the well was 7.1 feet at the end of the test. No response was observed in the underlying 70 Sand monitor well (MW-2) during the test. The transmissivity of the 72 sand at OWW-2 was not estimated because the test was terminated before the casing storage was withdrawn.

Two short term pump tests were conducted in the 68 Sand at monitor wells UMW-2 and UMW-3 in August 2009. Well UMW-2 is located within Wellfield 2 in the area where the 68 and 70 Sands coalesce. Wells completed in the overlying and underlying aquifers were monitored during the tests. Well UMW-2 was pumped for 112 minutes at 1.1 gpm. Total drawdown in the well was 63.5 feet at the end of the test. No response was observed in either the overlying 70 Sand monitor well (MW-2) or the underlying 60 Sand monitor well (UMW10). Estimated transmissivity from the UMW-2 test is 0.5 to 0.7 ft^2/d. Well UMW-3 was pumped for 20 minutes at 0.8 gpm. Total drawdown in the well was 21.3 feet at the end of the test. The test was terminated because the water level fell below the level of the transducer. No response was observed in either the overlying 70 Sand monitor well (MW-3) or the underlying 60 Sand monitor well (UMW11). Transmissivity was not estimated from the UMW-3 test because the test did not run long enough to exceed the casing storage in the well. It can be reasonably assumed that the transmissivity of the 68 Sand in the vicinity of UMW-3 is of the same magnitude as that estimated at UMW-2, both of which are significantly lower than the transmissivity of the 70 Sand aquifer.

Two short term pump tests were conducted in the 60 Sand at monitor wells UMW-10 and UMW-11 in August 2009. Wells completed in the overlying aquifer (68 Sand) were monitored during the tests. Well UMW-10 was pumped for 26 minutes at 5.4 gpm. Total drawdown in the well was approximately 85 feet at the end of the test. No response was observed in the overlying 68 Sand monitor well (UMW-2). Estimated transmissivity from the UMW-10 test is 2.4 ft^2/d. Well UMW-11 was pumped for 141 minutes at 2.1 gpm. Total drawdown in the well was approximately 75 feet at the end of the test. No response was observed in the overlying 70 Sand monitor well (UMW-3) during the test. Estimated transmissivity from the UMW-11 test is 1.4 ft^2/d. Note that the transmissivity calculated from both 60 Sand pump tests is significantly lower than the transmissivity of the 70 Sand aquifer. A Technical Memorandum: Evaluation of Potential Impacts to the 68 Sand from ISR Production in Wellfield 2, Moore Ranch Uranium Projects, Wyoming, is presented Appendix B6.

Technical Memorandum

To: **Energy Metals Corporation**

From: **Petrotek Engineering Corporation**

Date: **10/01/09**

Subject: Evaluation of Potential Impacts to the 68 Sand from ISR Production in Wellfield 2, Moore Ranch Uranium Project, Wyoming

Introduction

Petrotek Engineering Corporation (PEC) has completed an evaluation of potential impacts to the underlying aquifer from the proposed insitu recovery (ISR) mining in Wellfield 2 of the Energy Metals Corporation (EMC) Moore Ranch Uranium Project in Campbell County, Wyoming. The production zone aquifer is referred to as the 70 Sand and the underlying aquifer is referred to as the 68 Sand. Delineation drilling has indicated the absence of a confining unit between the 70 and 68 Sands over the east central portion of Wellfield 2, as shown on Figure 1. A pump test was conducted in the 68 Sand near the area where confinement is absent to assess aquifer properties of that hydrostratigrahic unit. Results of the pump test indicate that the transmissivity of the 68 Sand is two to three orders of magnitude lower than the transmissivity of the overlying 70 Sand. The large difference in transmissivity (and hydraulic conductivity) implies that groundwater flow patterns within the 70 Sand during ISR operations will be dominated by horizontal flow, with minimal exchange between the 68 and 70 Sands. Numerical modeling was performed to simulate hydraulic stresses and responses that will occur during ISR operations in the area where the confining unit is absent. The numerical modeling confirms that minimal flow will occur into or out of the 68 Sand during ISR production and restoration operations. Additional discussion follows.

Pump Test Results for the 68 and 70 Sands

EMC and PEC conducted short-term pump tests in the 68 Sand in August 2009 at two locations within Moore Ranch. One location was in Wellfield 1 (at monitor well UMW3) and the other was in Wellfield 2 (at monitor well UMW2). The location of the pump tests are shown on Figure 2. The aquifer properties of the 68 Sand at Wellfield 2 are of particular interest because there is no confining unit present between the production zone (70 Sand) and the underlying aquifer (68 Sand) over the east central portion of that wellfield.

Well UMW2 is located in the area of Wellfield 2 where the 68 and 70 Sands coalesce. The pump test at UMW-2 was run for 113 minutes at 1.1 gpm. Wells completed in the overlying and underlying aquifers were monitored during the test. Total drawdown in UMW2 was 63.5 feet at the end of the test. No response was observed in either the overlying 70 Sand monitor well (MW-2) or the underlying 60 Sand monitor well (UMW10).The 68 Sand is approximately 61 feet thick at UMW2. Estimated transmissivity of the 68 Sand from the UMW-2 test was from 0.53 to 0.71 ft^2/d. This range is more than three orders of magnitude lower than the transmissivity determined for the 70 Sand in this area. The hydraulic conductivity of the 68 Sand (determined by dividing the transmissivity by the saturated thickness of the aquifer) is from 0.0086 ft/d to 0.012 ft/d.

Well UMW-3 was pumped for 20 minutes at 0.8 gpm. Total drawdown in the well was 21.3 feet at the end of the test. The test was terminated because the water level in the pumped well dropped below the level of the pressure transducer. No response was observed in either the overlying 70 Sand monitor well (MW-3) or the underlying 60 Sand monitor well (UMW11) during the UMW-3 test. The test at UMW-3 was not run long enough to exceed the casing storage in the well. Therefore, transmissivity could not be estimated from this pump test. However, the initial response was similar to that seen during the UMW-2 test. It can be reasonably assumed that the transmissivity and hydraulic conductivity of the 68 Sand in the vicinity of UMW-3 are of similar magnitude as that estimated at UMW-2.

Previous pump tests had been conducted on the 70 Sand at multiple locations within Moore Ranch and were reported in the "Moore Ranch Hydrologic Testing Report" (PEC, revised July 2009) and the "Moore Ranch, 5-Spot Hydrologic Test Report, Volume 1, Test Design, Results and Analysis" (PEC August 2008). One of those tests was conducted at monitor well MW2 which is located approximately 10 feet from monitor well UMW2.

The MW2 pump test conducted in March 2007 was run for 1 full day at 26 gpm with a total drawdown at the end of the test of only 19.3 ft. Transmissivity calculated for the 70 Sand from the MW2 test was 724 ft^2/d. Although the total thickness of the 70 Sand at MW2 is approximately 100 feet, the saturated thickness is only 78 feet because of unconfined conditions in the 70 Sand aquifer in that area.

Additional hydrologic testing of a 5-Spot Pattern within Wellfield 2, conducted in July 2008, provided a lower transmissivity estimate of the 70 Sand, averaging around 400 ft^2/d. This transmissivity value is considered a more reliable value for the 70 Sand as the test included analyses from 7 observation wells. Numerical modeling of the test results provided a best fit to the pump test data using a transmissivty of 300 ft^2/d and an hydraulic conductivity of 4.0 ft/d as described in the "Moore Ranch, 5-Spot Hydrologic Test Report, Volume 2, Model Development and Simulations, " (PEC August 2008).

Based on the hydrologic testing performed to date, the transmissivity of the 70 Sand is more than three orders of magnitude greater than the transmissivity of the 68 Sand within the Wellfield 2. Evaluation of the electric log for UMW2 indicates an apparent increase in finer-grained sediments within the 68 Sand compared to the 70 Sand (Figure 3). Personal communication with EMC geologists confirm that the 68 Sand has a much higher percentage of fine-grained materials than the 70 Sand. These analyses corroborate the lower transmissivity values derived from the 68 sand aquifer tests.

Numerical Modeling of ISR Operations

Numerical models have been developed to simulate ISR impacts to groundwater at Moore Ranch, as described in the "Moore Ranch, 5-Spot Hydrologic Test Report, Volume 2, Model Development and Simulations" (PEC August 2008) and the "Numerical Modeling of Groundwater Conditions Related to Insitu Recovery at the Moore Ranch Uranium Project, Wyoming" (PEC 2008). A model that was developed to evaluate potential dewatering of the 70 Sand during ISR operations in Wellfield 2 was modified to address the issue of potential impacts to the 68 Sand.

The original model simulated a wellfield consisting of 9 recovery wells and sixteen injection wells configured in 5-spot well patterns. The model contained a single layer representing the 70 Sand. The model simulated unsaturated conditions within the 70 Sand and was run for a period of 18 months to represent the full production cycle. The model code was MODFLOW SURFACT (HydroGeologic 2008). Details of the model are described in the "Moore Ranch, 5-Spot Hydrologic Test Report, Volume 2, Model Development and Simulations" (PEC August 2008).

That single layer model was expanded to include a second layer representing the 68 Sand. Model thickness of the 70 Sand is 100 feet and thickness of the 68 Sand is 60 feet. The model extends for 1,980 feet in the north-south and east-west directions. In the central portion of the model, the cell dimensions are 1 foot by 1 foot. Out toward the perimeter of the model the cell size increases to 5 feet by 5 feet. The model consists of 629 rows, 629 columns, 2 layers and 842,402 cells. The model domain is shown on Figure 4. The model grid is centered over the area where the 68 and 70 Sands coalesce in Wellfield 2. General head boundaries are placed along the south and north edges of the model domain (with head values of 5195.15 and 5188.75 ft respectively) to simulate a baseline (non-pumping) hydraulic gradient of 0.00323 ft/ft to the north, consistent with water level data collected prior to the 5-Spot hydrologic test.

The hydraulic conductivity of the 70 Sand is simulated as 4 ft/d and the hydraulic conductivity of the 68 Sand is simulated as 0.01 ft/d. No confining unit is simulated. The pumping rate of each of the recovery wells is 20 gpm (3,850 ft^3/d) for a total extraction rate of 180 gpm (34,652 ft^3/d). Injection was simulated as 178.2 gpm (34,306 ft^3/d) to represent a one percent bleed during production. The configuration of the wellfield is illustrated in Figure 5. The model simulation was run for a period of 18 months (548 days) to represent the full production cycle.

The simulated head distribution in the 70 Sand at the end of production is presented in Figure 6. As expected, production operations have resulted in a cone of depression around each extraction well and a recharge mound at each injection well. Changes within the 68 Sand as a result of ISR production are significantly less. Figure 7 shows a comparison of the head distribution at the start (baseline pre-production) and end of production in the 68 Sand. Results of the model simulation indicate that changes in head within the 68 Sand will be negligible (less than 1 foot) at the end of the production cycle. Figure 8 shows the drawdown at observation points in the 70 and 68 Sands at the center of the wellfield (identified as OB1 on the previous figures). The maximum drawdown within the 70 Sand is over 12 feet whereas in the 68 Sand, drawdown is approximately two orders of magnitude lower (at less than 0.13 feet). Figure 9 shows drawdown at observation point 2 (OP2) in the 70 and 68 Sands at the northwest edge of the wellfield. There is a net rise in the 70 Sand water level because of the injection at this location. The 68 Sand shows a very slight decrease of approximately 0.05 ft by the end of production

A second simulation was run to evaluate potential impacts during aquifer restoration. The total projected rate of production for Wellfield 2 is 3,000 gpm (577,540 ft^3/d). This model represents only a portion of the total wellfield, with a production rate of 180 gpm (34,652 ft^3/d), or 6 percent of the total projected rate. Reverse Osmosis (RO), the primary method of water treatment to be utilized during restoration, is to be applied to the entire wellfield at a rate of 250 gpm (48,130 ft^3/d). To keep the proportions consistent, for this simulation 6 percent of 250 gpm (15 gpm or 2,888 ft^3/d)) will be extracted for RO during restoration. Approximately 80 percent of the RO will be reinjected into the aquifer after treatment. The remaining 20 percent (3 gpm) is the net loss to the aquifer during restoration. The model simulates the net loss of 3 gpm evenly divided between the 9 recovery wells (at 0.33 gpm or 64 ft^3/d per well). This simulation only shows the net loss in the aquifer and does not include the reinjection of the treated water. The well configuration for this simulation is shown on Figure 10.

The simulated head distribution in the 70 Sand at the end of restoration is presented in Figure 11. Figure 12 shows a comparison of the head distribution in the 68 Sand at the start (baseline pre-restoration) and end of restoration. Results of the model simulation indicate that changes in head within the 68 Sand will be negligible (less than 1 foot) at the end of the restoration cycle. Figure 13 shows the drawdown at observation points in the 70 and 68 Sands at the center of the wellfield (identified as OB1 on the previous figures). Figure 14 shows drawdown at observation point 2 (OP2) in the 70 and 68 Sands at the northwest edge of the wellfield. The maximum drawdown within the 68 Sand is approximately 0.3 feet throughout restoration.

Summary

EMC and PEC conducted pump tests in the 68 Sand in August 2009 within the Moore Ranch Uranium Project. Results of the pump tests indicate that the transmissivity of the 68 Sand is several orders of magnitude lower than that of the 70 Sand. Log data and core data confirm that the 68 sand has a much higher percentage of finer grained materials than the 70 Sand.

Numerical modeling was performed to estimate potential impacts to the 68 Sand during ISR operations. Input values for transmissivity and hydraulic conductivity were derived from the pump test results and analyses. A portion of Wellfield 2 was modeled, simulating the area where there is a lack of confinement between the 68 and 70 Sand. Production and restoration phases were both simulated. Results of the modeling indicate minimal impacts on the 68 Sand during ISR operations. Less than 1 foot of drawdown occurred within the 68 Sand at any location within the model domain throughout the production and restoration simulations.

Based on the pump test results and numerical model simulations, impacts to the 68 Sand are anticipated to be minimal during ISR production and restoration operations at the rates projected in the WDEQ Permit to Mine Application and the NRC License Application. However, EMC intends to increase the density of monitor wells within the 68 Sand (to one well per 3 acres) and to monitor the underlying 60 Sand (at a density of one monitor well per 4 acres) in the area where the confining unit between the 70 and 68 Sand appears absent as described in the revised applications.

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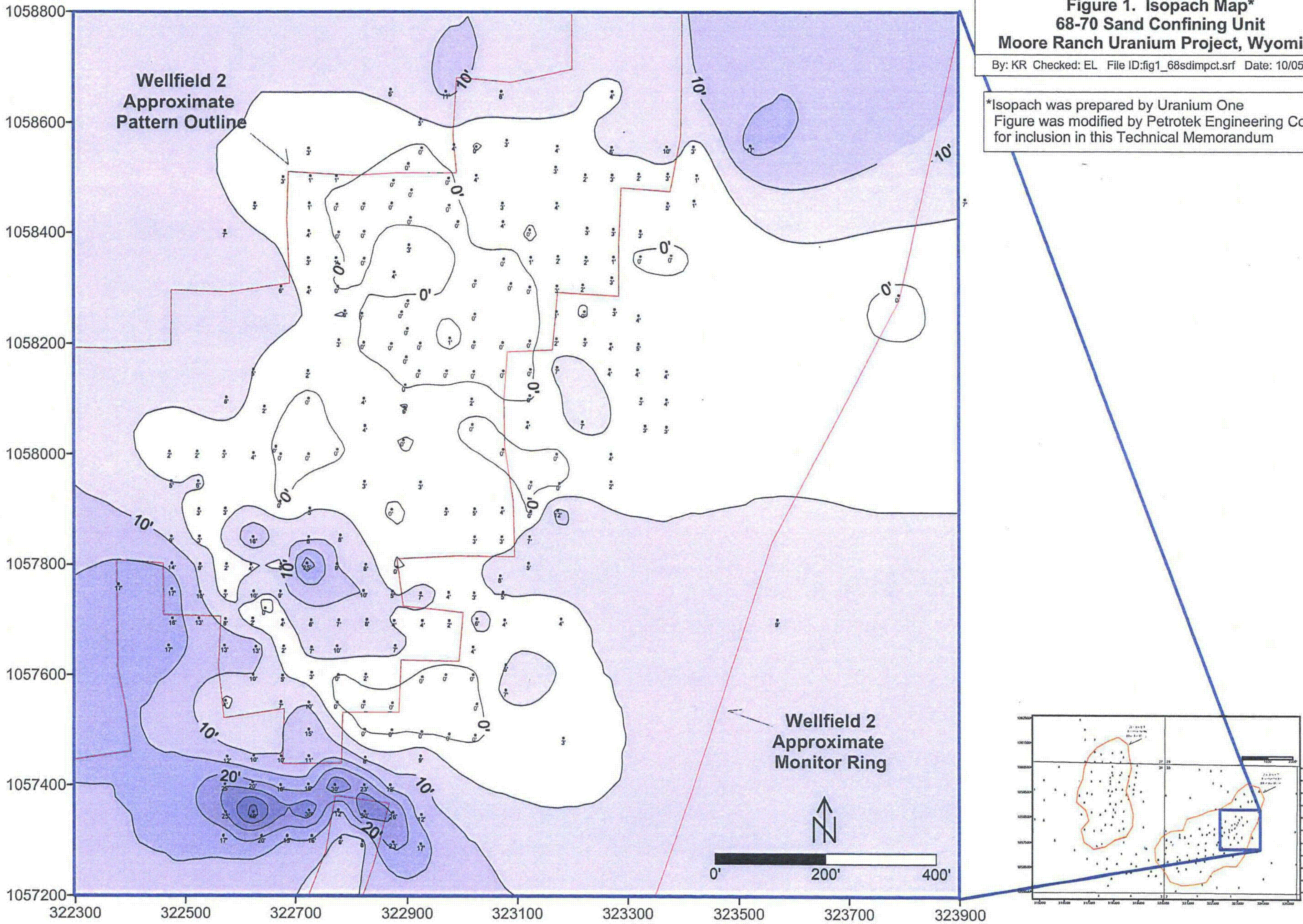
Figure 1. Isopach Map*
68-70 Sand Confining Unit
Moore Ranch Uranium Project, Wyoming

By: KR Checked: EL File ID:fig1_68sdimpct.srf Date: 10/05/09

*Isopach was prepared by Uranium One
Figure was modified by Petrotek Engineering Corp for inclusion in this Technical Memorandum



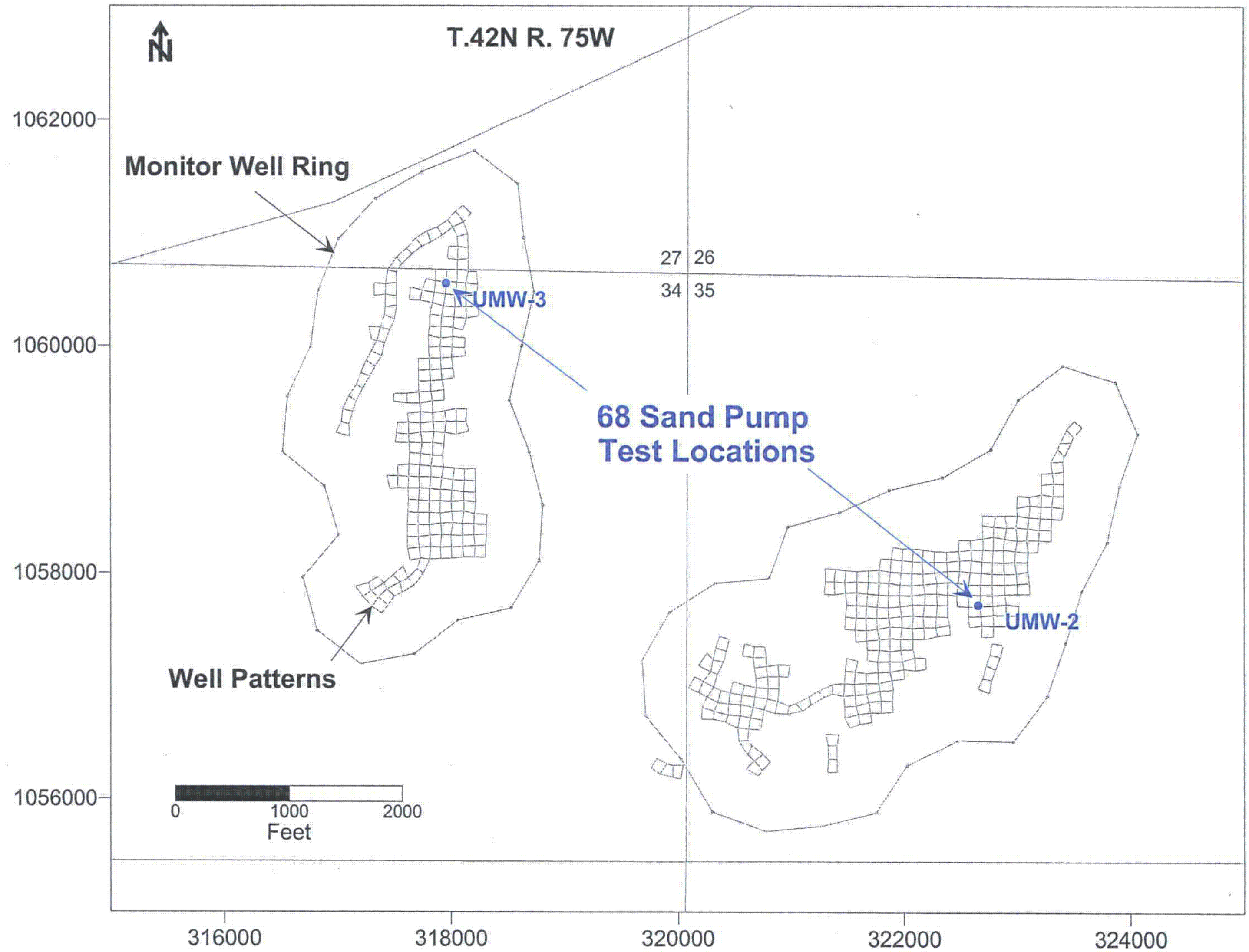


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Figure 2. 68 Sand Pump Test Locations
Moore Ranch Uranium Project, Wyoming

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Monitor Well UMW-10

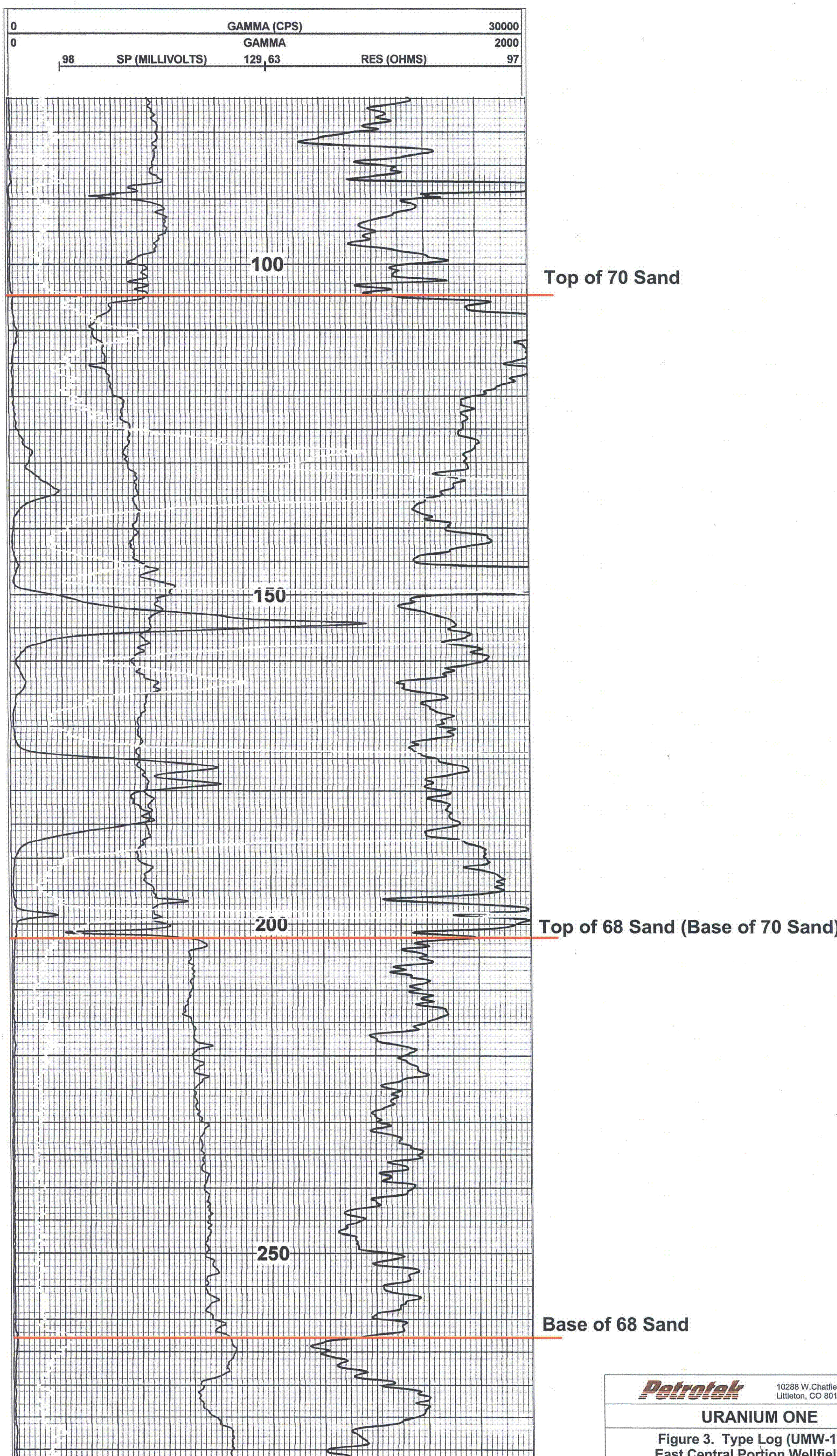

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Figure 3. Type Log (UMW-10)
East Central Portion Wellfield 2
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig3_68sd.srf Date: 10/05/09

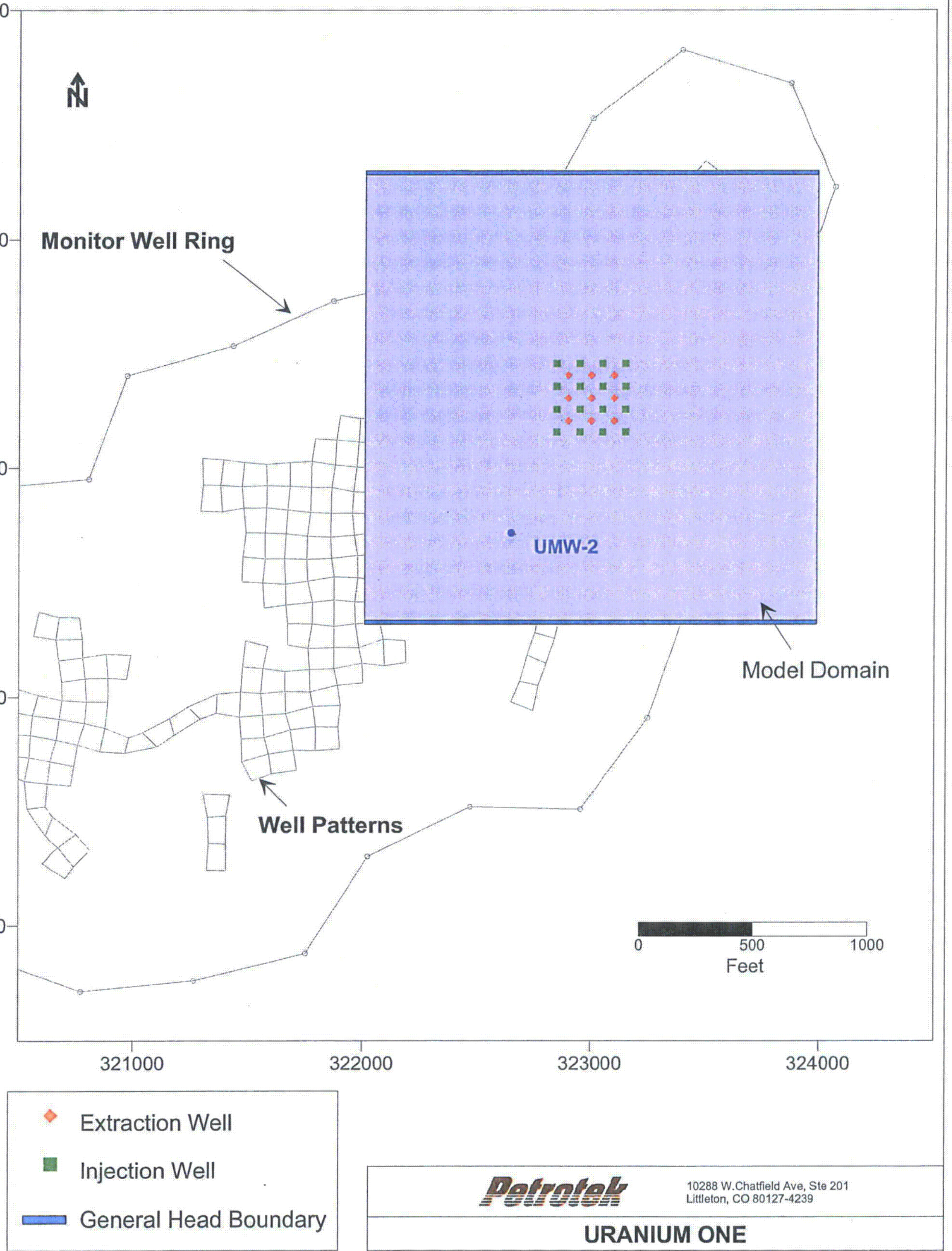

Figure 4. Model Domain and Boundary Conditions 68 Sand Impact Simulations Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig4_68sdimpact.srf Date: 10/05/09

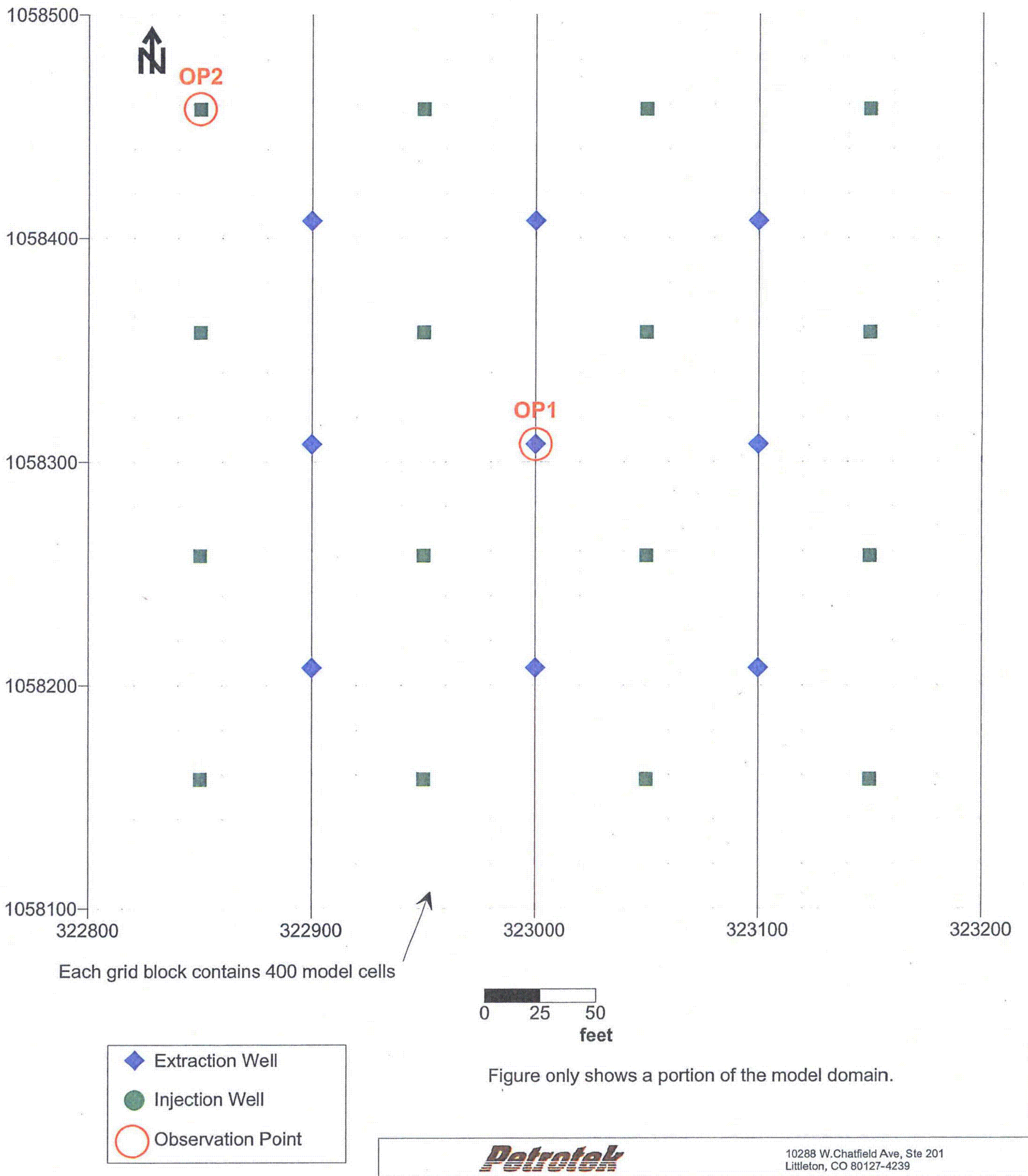

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Figure 5. Well Configuration, ISR Production Simulation
Moore Ranch Uranium Project, Wyoming

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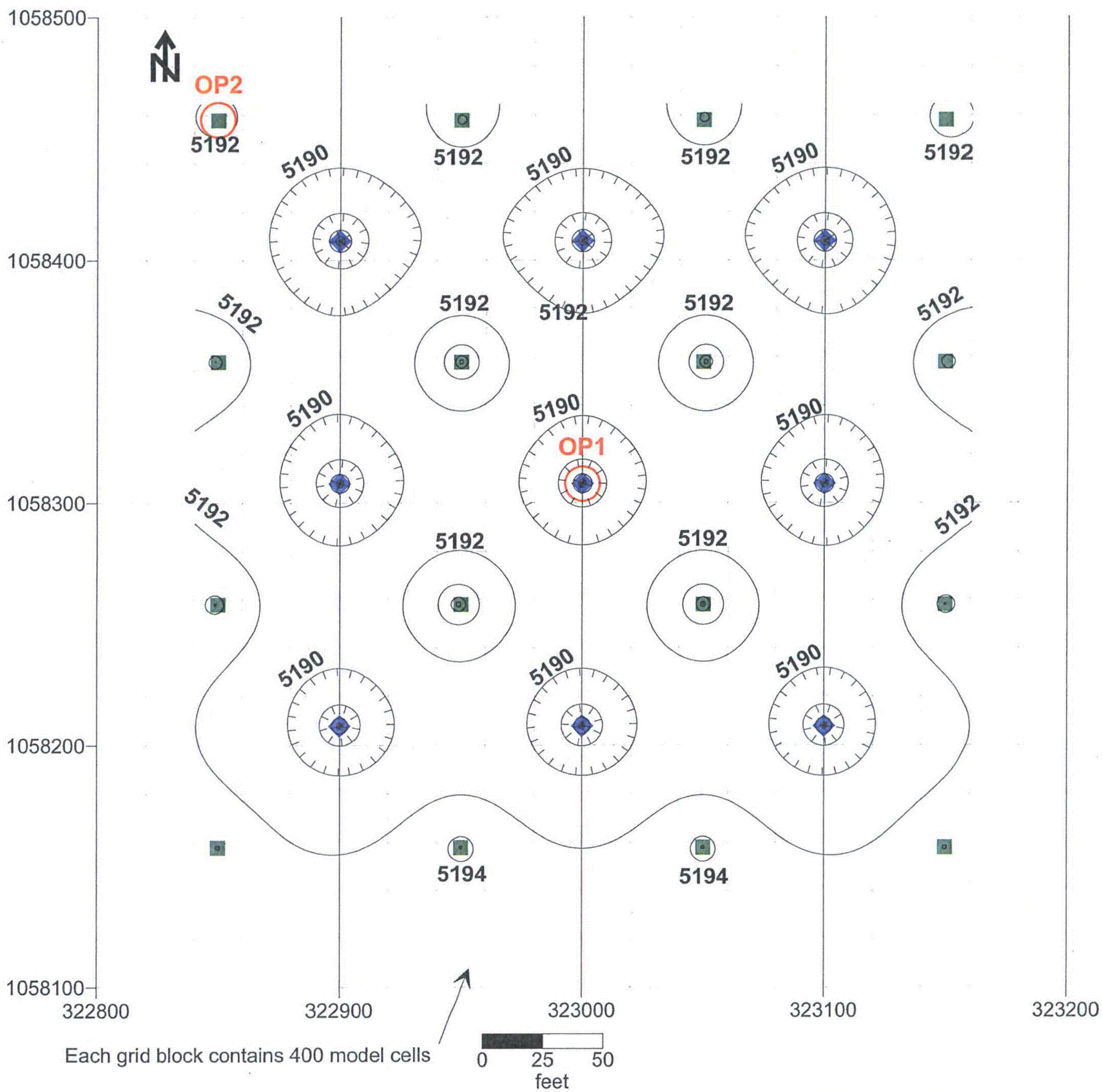
Figure only shows a portion of the model domain.



Extraction Well

Injection Well

Observation Point

Equipotential Contour (ft amsl)
Contour interval = 2 ft

Pumping rate for each Extraction well is 20 gpm - 180.0 gpm total
Injection rate for each injection well is variable,
dependent on location within well pattern - 178.2 gpm total

Pre-pumping hydraulic gradient is 0.0323 ft/ft to the north

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Figure 6. Simulated Potentiometric Surface - 70 Sand After 18 Month of ISR Production Moore Ranch Uranium Project, Wyoming

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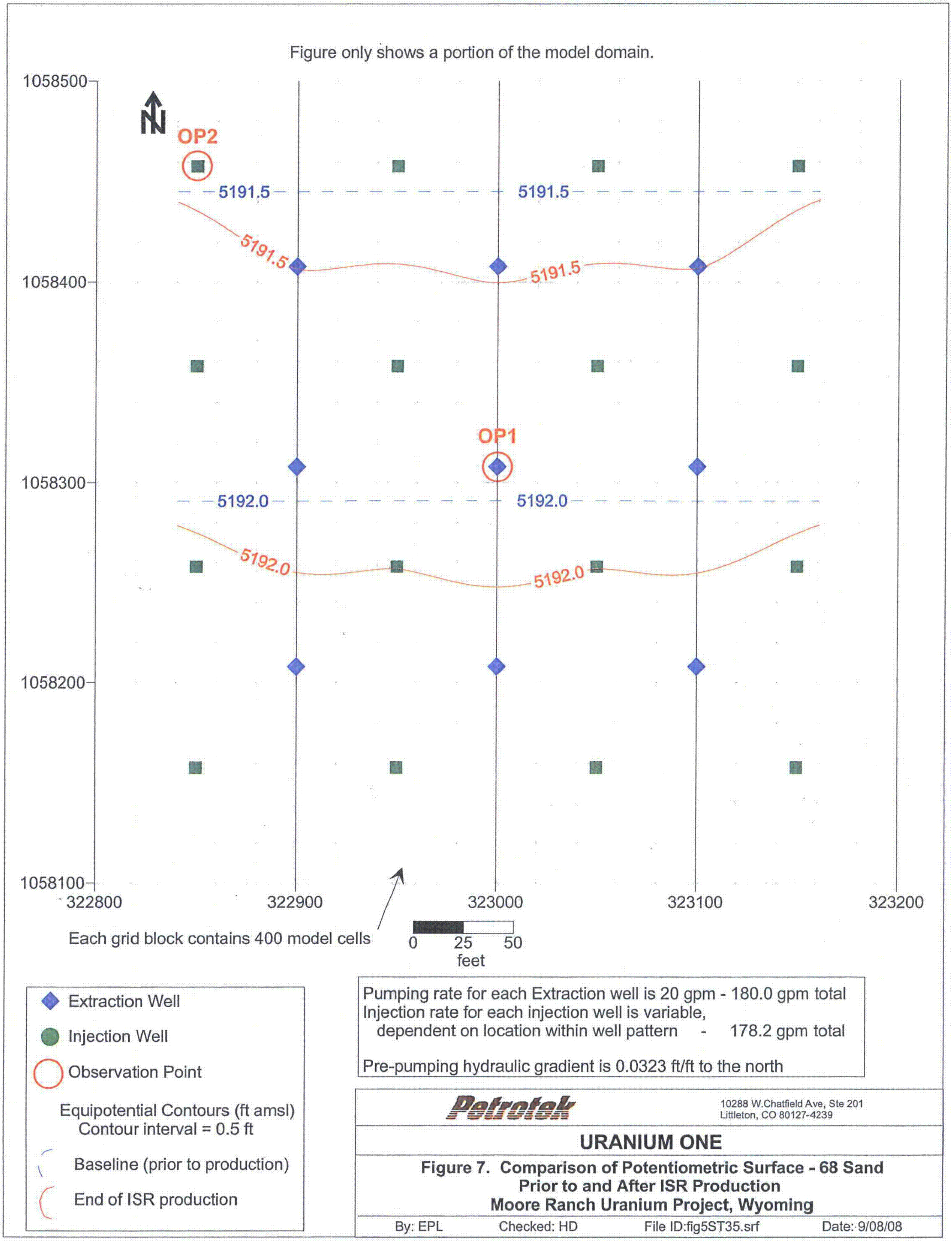

Figure 7. Comparison of Potentiometric Surface - 68 Sand Prior to and After ISR Production Moore Ranch Uranium Project, Wyoming

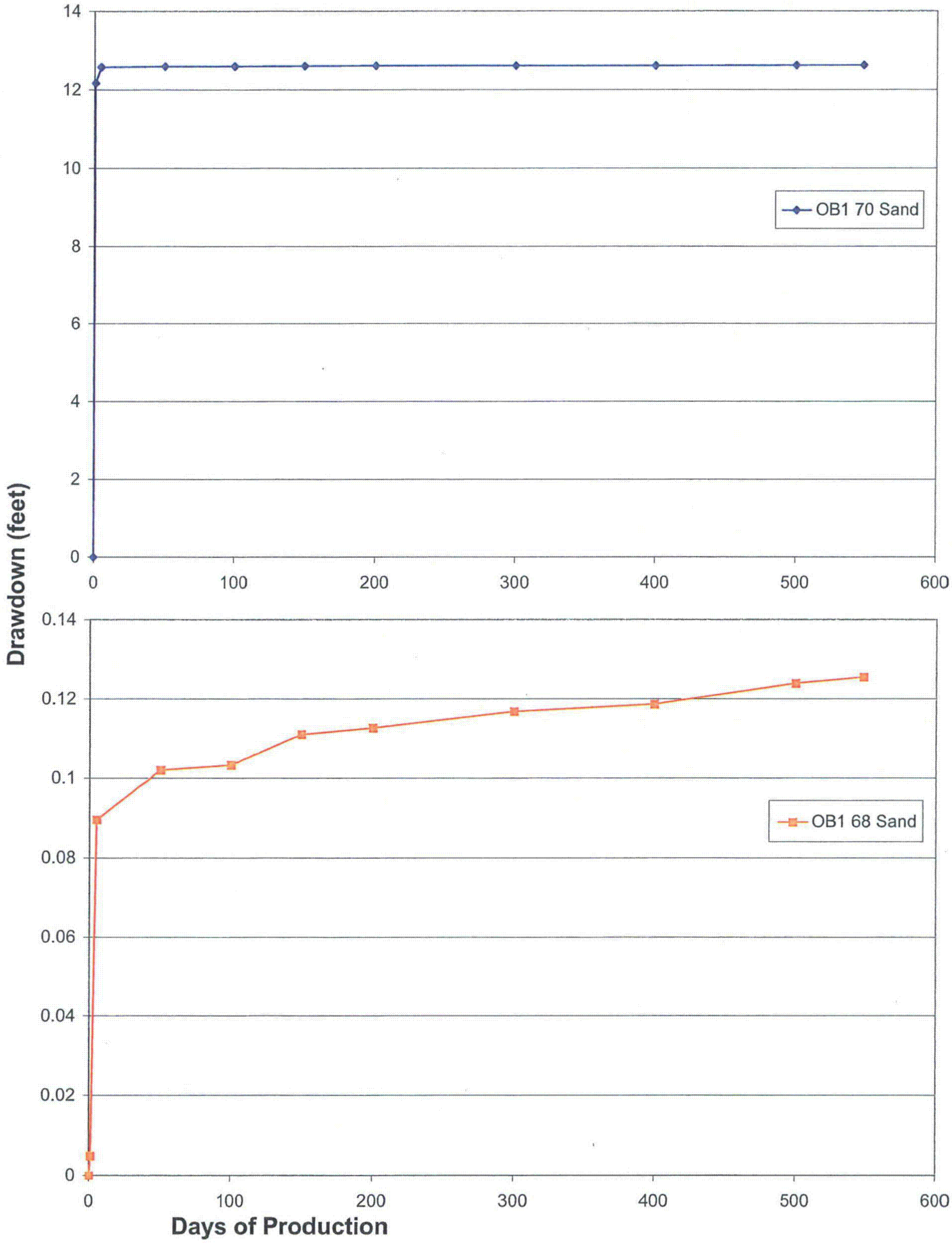

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Figure 8. Simulated Drawdown, End of ISR Production
68 and 70 Sand Observation Point 1
Moore Ranch Uranium Project, Wyoming

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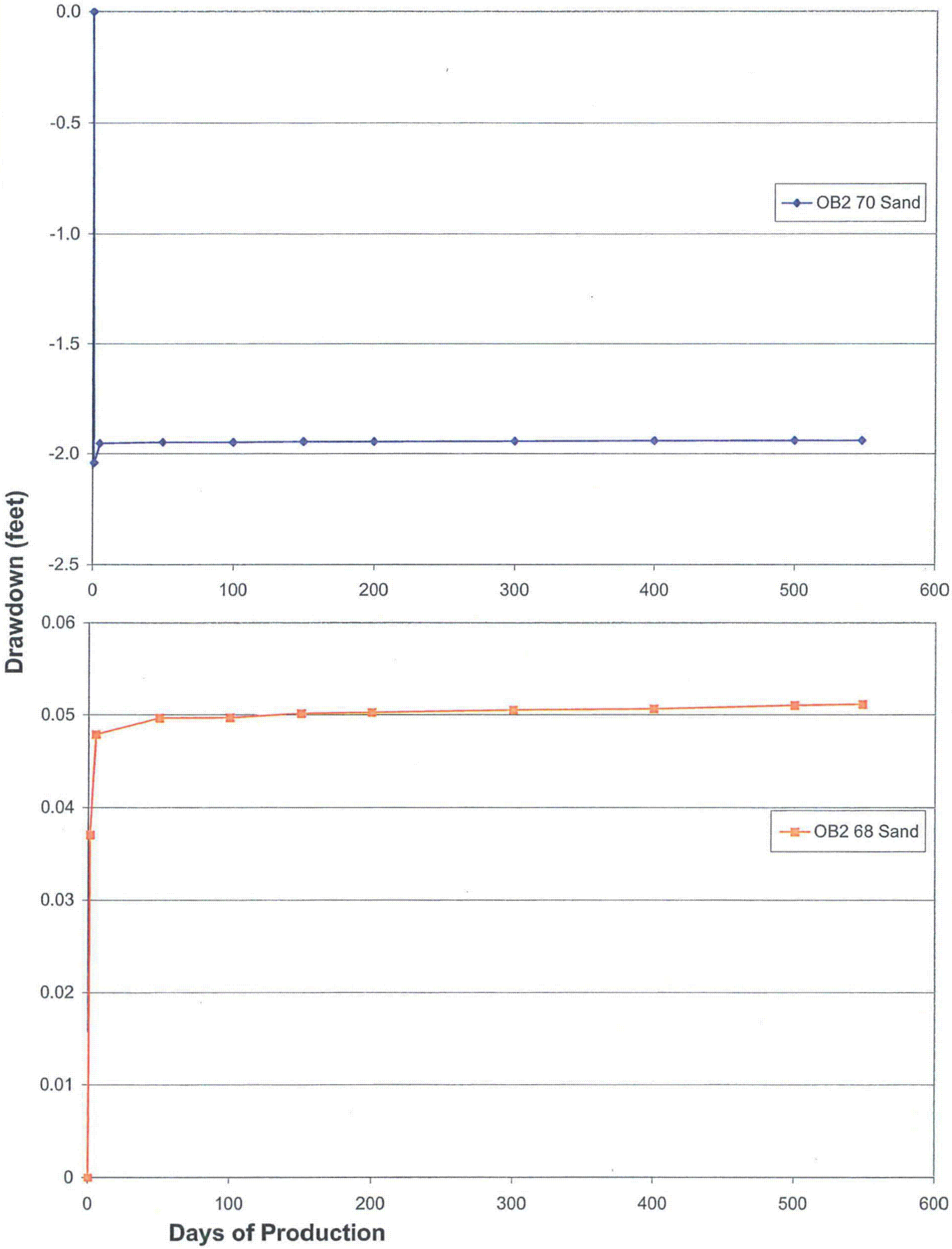

* Note: a negative number indicates a net rise in water level

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Figure 9. Simulated Drawdown, End of ISR Production
68 and 70 Sand Observation Point 2
Moore Ranch Uranium Project, Wyoming

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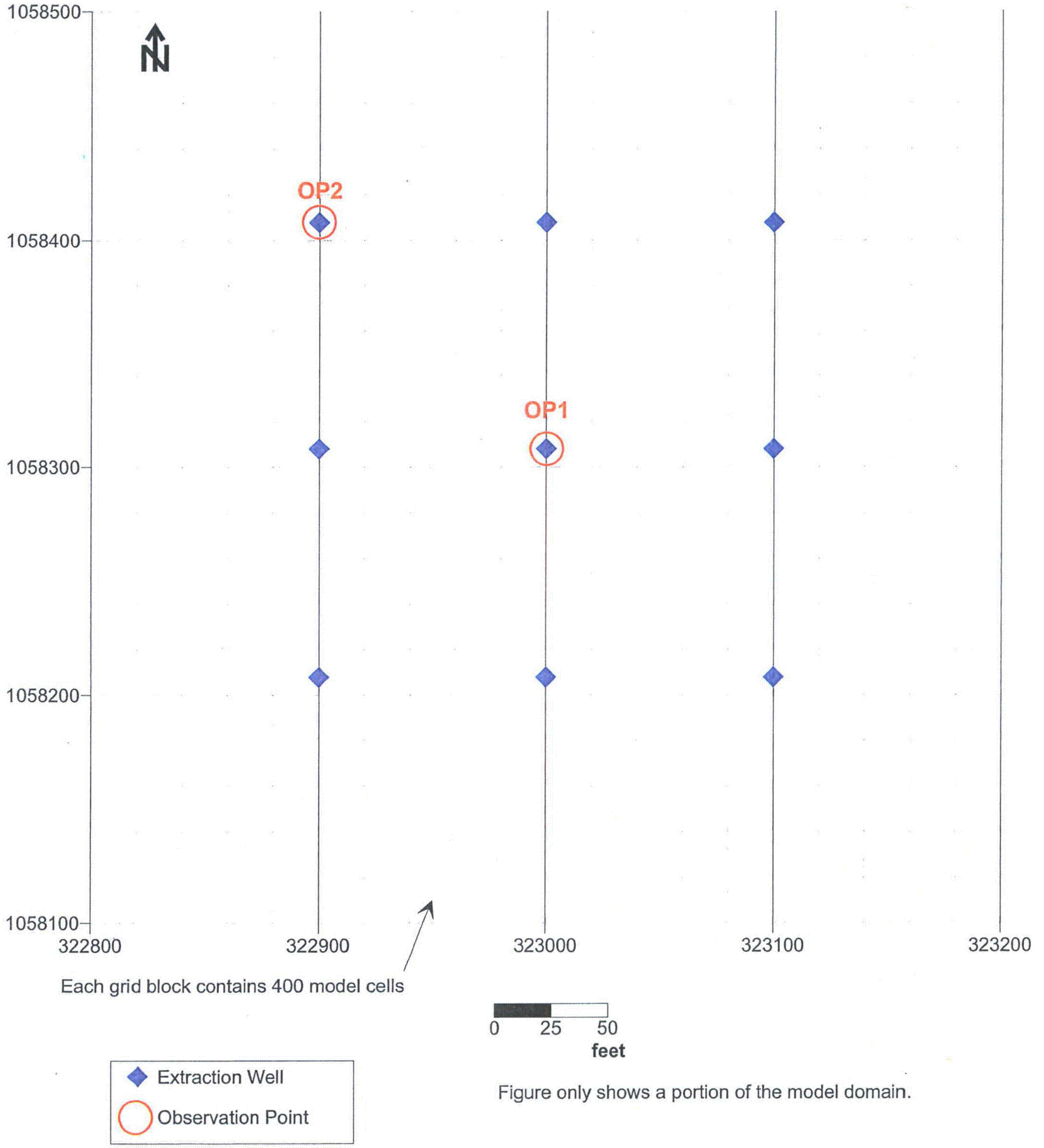

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Figure 10. Well Configuration, ISR Restoration Simulation
Moore Ranch Uranium Project, Wyoming

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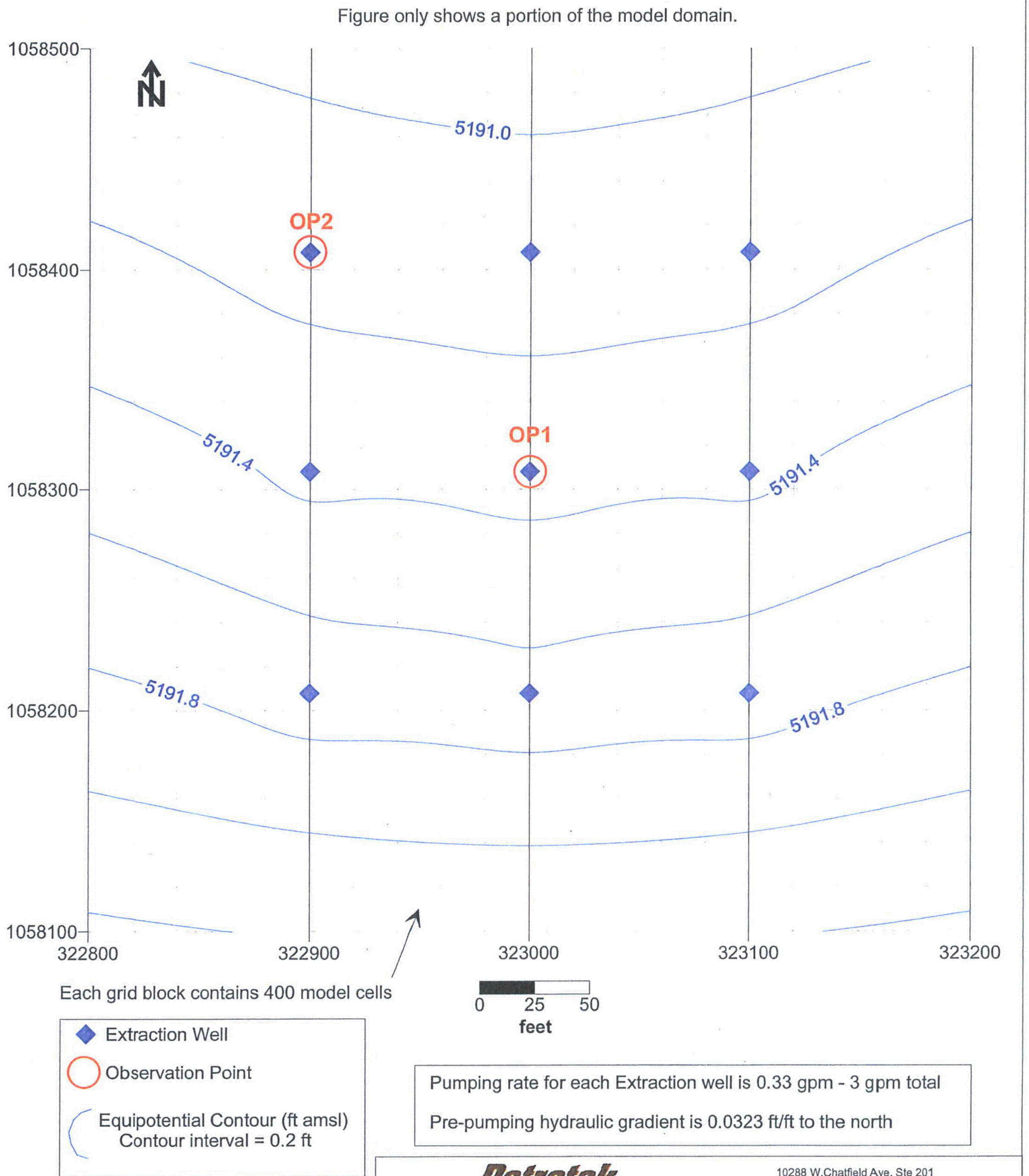

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Figure 11. Simulated Potentiometric Surface - 70 Sand
End of ISR Restoration
Moore Ranch Uranium Project, Wyoming

By: EPL | Checked: HD | File ID:fig11_68sdimpact.srf | Date: 9/08/08

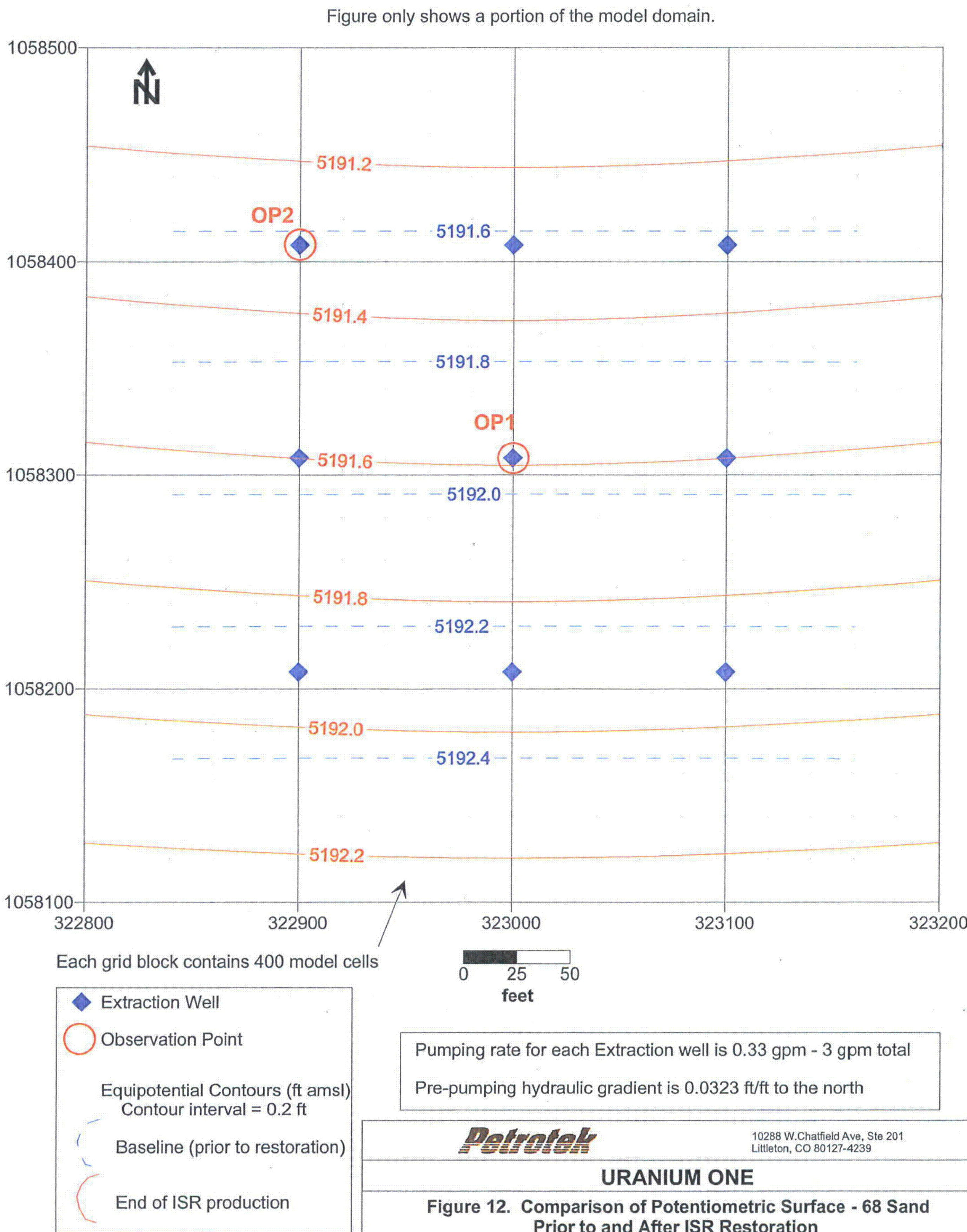

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Figure 12. Comparison of Potentiometric Surface - 68 Sand Prior to and After ISR Restoration Moore Ranch Uranium Project, Wyoming

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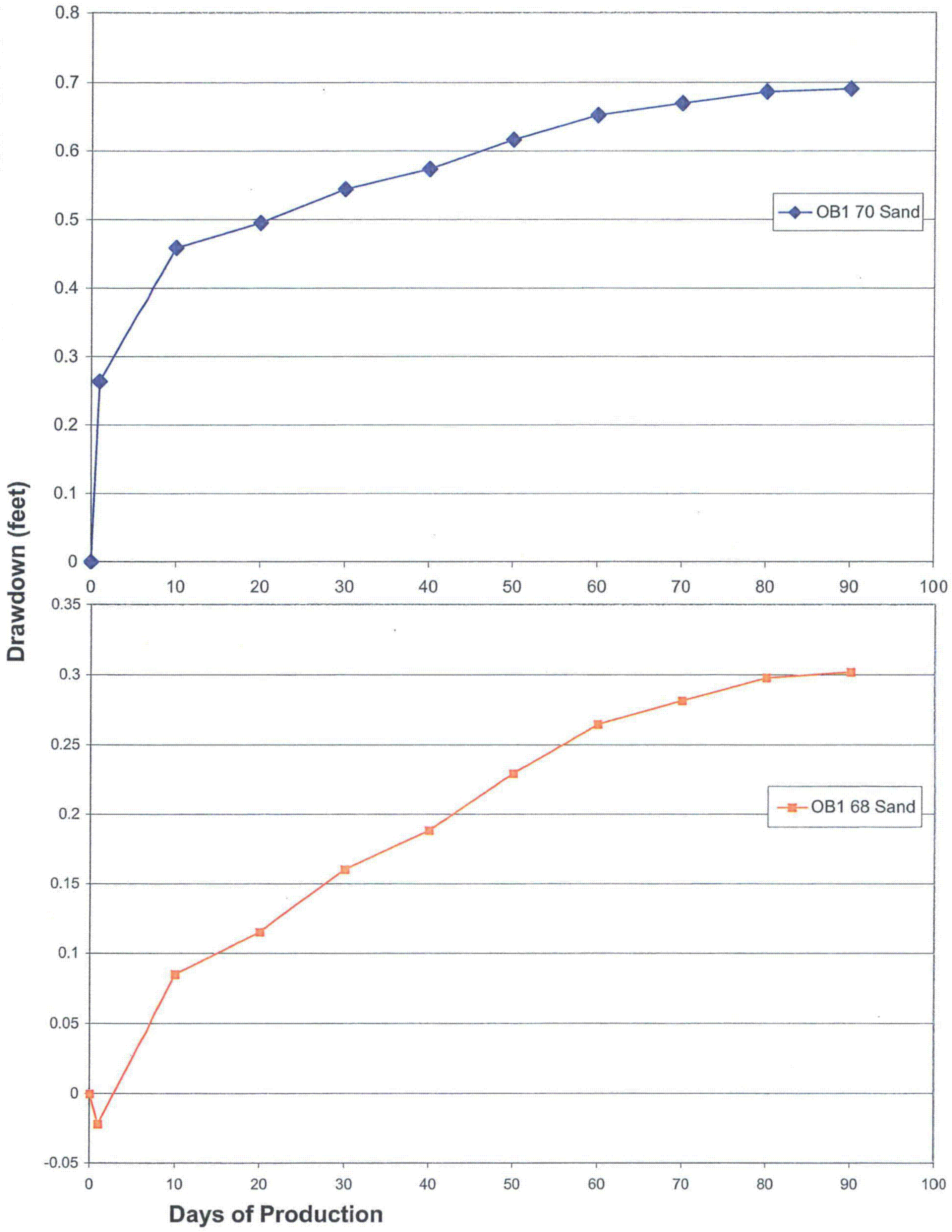

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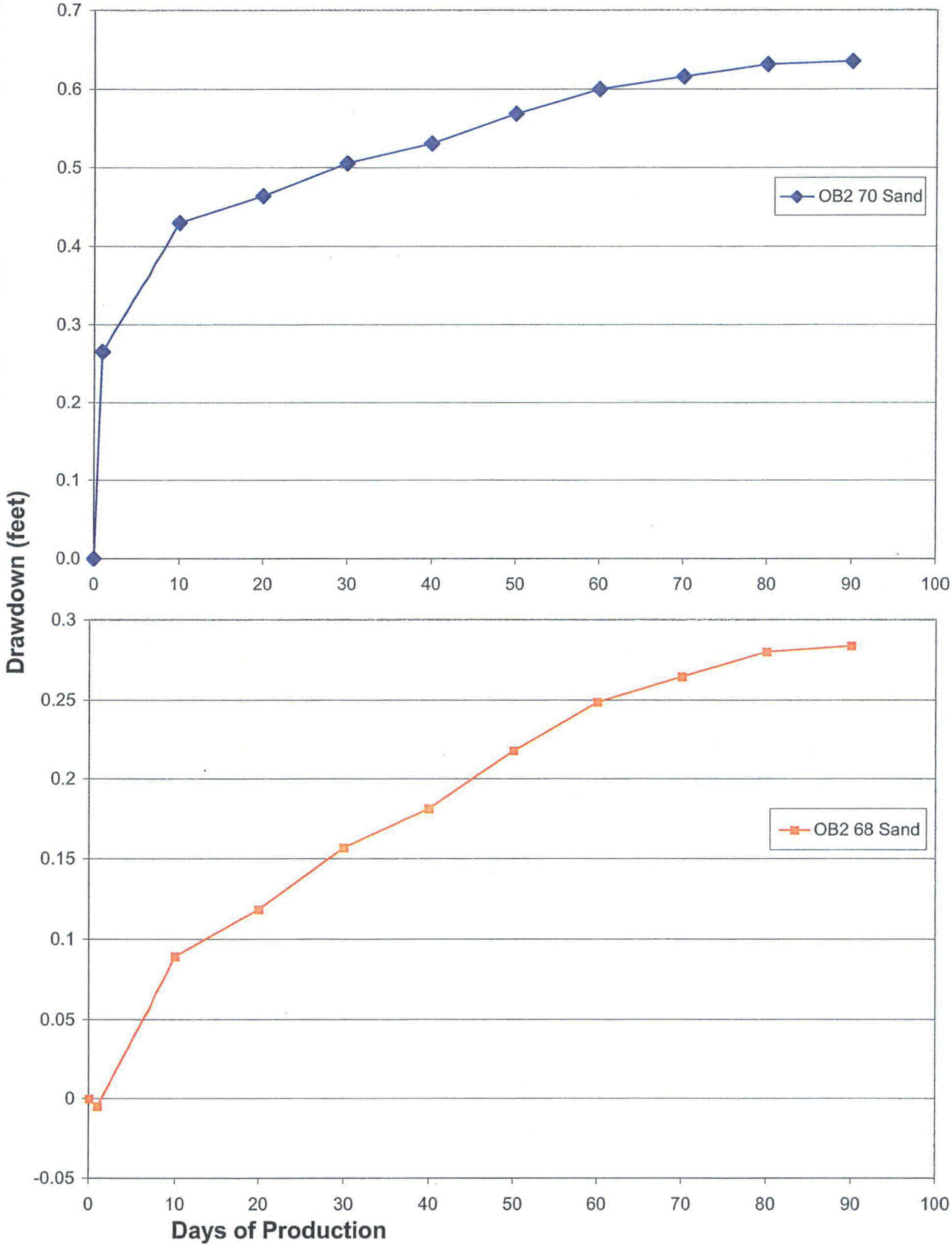
Figure 13. Simulated Drawdown, End of ISR Restoration
68 and 70 Sand Observation Point 1
Moore Ranch Uranium Project, Wyoming

By: EPL | Checked: HD | File ID:fig13_68sdimpact.srf | Date: 10/08/09



* Note: a negative number indicates a net rise in water level

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Figure 14. Simulated Drawdown, End of ISR Restoration
68 and 70 Sand Observation Point 2
Moore Ranch Uranium Project, Wyoming

By: EPL | Checked: HD | File ID:fig149_68sdimpact.srf | Date: 10/08/09

Hydrology Open Issue No.5
The baseline water quality of the 60 sand is not assessed
May 11 2009 Teleconference

Open Issue discussion:

EMC did not assess the average pre-operational baseline water quality in the "60 sand" in the proposed license area. The "70 sand" ore zone coalesces with the "68 sand" in several regions of Wellfield 2. EMC has stated that the "60 sand" will be the underlying aquifer in these areas of Wellfield 2. EMC must, therefore, assess the baseline water quality in the "60 sand."

Answer: Three additional monitor wells have been drilled and completed in the 60 Sand within the project area. The locations of the wells are shown on revised Figure 2.7.3.2. Initial samples were collected from these wells in May 2009. A total of four quarterly rounds of water quality samples will be collected to evaluate water quality for the 60 Sand representative of the Moore Ranch License Area. One of the wells (UMW-10) is located within proposed Wellfield 2 in the area where the 72 and 68 Sands coalesce. Results of the initial sampling of the 60 Sand are summarized in the following table.

Of note is that the selenium levels in all three wells exceed the Wyoming Class I Standard of 0.05 mg/l and the uranium levels in all three wells exceed the US EPA MCL of 0.03 mg/l. Sulfate and TDS exceed the Wyoming Class I Standard in UMW-11.

In the area of Wellfield 2 where the 70 and 68 sands coalesce, the 60 sand will be considered the underlying aquifer. Monitor wells will be placed in the underlying 60 sand in the areas where the 70 and 68 sand coalesce at a spacing of 1 well per 4 acres. The number and location of these underlying wells will be determined during final wellfield planning.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

Under SECTION 2.7.2.4 Groundwater Quality

EMC has installed a monitor well network to evaluate pre-mining baseline conditions within the Permit Area. The location of the monitor wells are shown on Figure 2.7.3-2. Four well groups or clusters were constructed, each including a completion in the Production Zone aquifer (70 sand), the overlying aquifer (72 Sand), and the underlying aquifer (68 Sand). In addition to the well groups, four wells completed in the 70 Sand are included in the baseline water quality monitoring network. Three monitor wells have also been installed in the 60 Sand which underlies the 68 Sand. One of those 60 Sand monitor wells is located in the area where the 68 and 70 Sands coalesce. A row of monitor wells completed in the 58, 50 and 40 Sands was installed in the southern portion of the Permit Area. Three wells were also installed in the 80 Sand that overlies the 72 Sand. Only one of those 80 Sand monitor wells contains sufficient water for sampling. Table 2.7.3-15 provides a summary of well construction information. The parameters included in the EMC Monitoring Program are listed in 2.7.3-16.

Under Section Groundwater Quality Sampling Results

Results of the Conoco monitoring programs are summarized in Tables 2.7.3-17 and 2.7.3-18. The Conoco data are provided as background water quality and are not intended as baseline characterization. Results of the EMC baseline monitoring program (72, 70, and 68 Sands) are summarized in Table 2.7.3-19a. Results of additional EMC groundwater monitoring from non-baseline wells (deeper Wasatch sands, the 80 Sand, private wells and wells with unknown or multiple horizon completions) are included in Table 2.7.3-19b. Overall water quality determined from the monitoring programs indicates a predominately calcium sulfate to calcium bicarbonate water, although significant differences are apparent between the Production Zone and overlying and underlying aquifers. Figure 2.7.3-3a is a Piper diagram of the average ion concentration for each of the monitor wells included in the EMC baseline sampling program (completed in the 68 through 72 Sands). Groundwater within the production zone aquifer is generally a calcium sulfate type. The overlying monitor wells exhibit a generally calcium sulfate type water with the exception of OMW3, which is a calcium bicarbonate type. The underlying monitor wells are more variable, ranging from calcium-to-sodium-sulfate and calcium-to-sodium-bicarbonate. Chloride and carbonate are generally very low in all of the wells. A Piper Diagram for the non-baseline wells included in the EMC monitoring program (including wells completed across multiple sands or sands other than the 72, 70 and 68 Sands) is shown on Figure 2.7.3-3b

Figure 2.7.3-4 is a Piper diagram for the average ion concentration for each of the aquifers (including a category for those wells screened in both the 68 and 70 Sands) for the EMC groundwater monitoring program. Historic and current data from the wells completed in the 40, 50, 58, 60 and 80 Sands and the Roland Coal are also included on the diagram for reference. The Roland coal sample is clearly a sodium bicarbonate water type. The typical 68 Sand (underlying aquifer) water type appears more like the 40-50 Sand and Roland Coal type water than the 70 (production zone) and 72 Sands (overlying aquifer). A Stiff diagram of the water quality for the different aquifers shows the transition with depth from a calcium sulfate water to a sodium bicarbonate water (Figure 2.7.3-5)

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Table 2.7.3-21 is a summary of the analytical results for the current EMC baseline monitoring for wells completed in the production zone and the overlying and underlying aquifers. Recent sampling from the 80 Sand (1 well) and the 60 Sand (3 wells) are also

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Deleted: baseline sampling

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Deleted: (wells 1822 and 1821 respectively)

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Deleted: *Three wells that were installed and monitored by Conoco (1982) were included in the current monitoring program. One of the wells, 885, is completed in the production zone aquifer and the other two wells are completed across the production zone and underlying aquifers. Table 2.7.3-20a compares the analytical results of these monitor wells from the Conoco and EMC baseline monitoring programs. The table shows that two of the monitor wells, 885 and 1808 have shown reasonably consistent water quality since the initial sampling began in 1978. Well 8-3 appears to have anomalous values as described below.* ¶
¶
The two wells completed across multiple aquifers, 1808 and 8-3, would be expected to have water quality that falls within the range observed in those two sands. That is the case for well 1808 (Figure 2.7.3-3). However, well 8-3 plots outside of the range observed within either the 68 or 70 sand. The calcium, magnesium and sulfate levels in that well are much higher than the values observed in other monitor wells included in the EMC program. Correspondingly, TDS for 8-3 was over twice as high as for any other production zone or underlying monitor well. In addition, the calcium, magnesium and sulfate levels in well 8-3 are much higher in the recent sampling events than when the well was first sampled by Conoco in 1979 (Table 2.7.3-20a). Other parameters show relatively good consistency with other wells and historic data. A potential cause of these anomalous values for calcium, magnesium, and sulfate could be related to impacts from small mammals falling into the well. This well was covered by a box that contained an old strip ch ... [1]

Deleted: Table 2.7.3-20b compares the analytical results from the private wells that have been sampled under both the Conoco and EMC baseline monitoring programs. The list of constituents common to both data sets is not as ... [2]

included. Wells that are screened across multiple aquifers or that are of unknown completion intervals are not included in the table. The results are compared to WDEQ Class I Standards and USEPA MCLs.

As shown on the table, over half of the samples exceeded the WDEQ Class I standard for TDS (500 mg/l), with the greatest proportion of exceedances occurring in samples from the production zone aquifer. Figure 2.7.3-6 shows the distribution of TDS in the production zone and the overlying and underlying aquifers. The range of TDS within wells completed in either the production zone or the underlying or overlying aquifers was 240 to 1350 mg/l with an average of 654 mg/l. The single 80 Sand monitor well and one of the 60 Sand monitor wells also exceeded the TDS standard.

Similarly, almost half of the production zone samples exceeded the WDEQ Class I standard for sulfate of 250 mg/l (Figure 2.7.3-7 Sulfate ranged from 65 to 743 mg/l with an average of 307 mg/l for the wells included in the baseline monitoring. One of the 60 Sand monitor wells exceeded the sulfate standard.

Ammonia, iron, manganese, and selenium were the only trace minerals to exceed standards. The ammonia WDEQ Class I standard of 0.05 mg/l was exceeded at two overlying monitor wells (OMW1 and OMW2). Iron exceeded the WDEQ Class I standard (0.3 mg/l) in one underlying well (UMW4), one overlying monitor well (OMW4), and two production zone monitor wells (MW11 and PW-1). Iron ranged from below detection to 0.85 mg/l. Manganese slightly exceeded the WDEQ Class I standard (0.05 mg/l) in two production zone monitor well (885 and MW4) and two overlying monitor well (OMW2 and OMW4). The selenium standard (0.5 mg/l for WDEQ Class I and EPA MCL) was exceeded in two wells in the underlying aquifer (UMW2 and UMW4) and two wells in the production zone aquifer (MW2 and MW7). The selenium standard was exceeded in all three of the 60 Sand monitor wells.

The majority of the samples collected from the production zone and underlying aquifers exceeded the USEPA MCLs for uranium (0.03 mg/l). Most of the samples from the 70 Sand (Production Zone) exceeded the Wyoming Class I and USEPA MCL standards for radium 226+228 (5 pCi/l).). Two of the underlying aquifer wells exceeded the radium 226+228 standards (UMW2 and UMW4). None of the samples from the overlying monitor wells exceeded the standard for uranium and only one exceeded the radium standard (OMW3). Figure 2.7.3-8 shows the distribution of uranium within the three aquifers. Uranium ranged from below detection (<0.0003) to 0. 884 mg/l. Radium 226 distribution is shown in Figure 2.7.3-9. The average uranium concentration for the production zone aquifer was 0.16 mg/l, over five times the USEPA MCL. For the 68 Sand aquifer, uranium concentration averaged 0.056 mg/l. The uranium standard was exceeded in all three of the 60 Sand monitor wells.

Radium 226 distribution is shown in Figure 2.7.3-10. For the baseline wells, radium 226 ranged from below detection (<0.2) to 335 pCi/l with an average of 57 pCi/l Radium-228 values were much lower, ranging from below detection (<1.0) to 9.5 pCi/l. The combined

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radium 226+228 concentration in the production zone aquifer averaged 97 pCi/l, over an order of magnitude greater than the Wyoming Class I Standard or the USEPA MCL.

In summary, general water quality in the shallow Wasatch aquifers within the Moore Ranch License area commonly exceeds WDEQ Class I standards for TDS and SO_4. Radionuclides radium-226 and uranium are elevated above EPA MCLs in the majority of the samples collected from the production zone aquifer and the underlying aquifer. The average radium 226-228 concentration in the production zone is an order of magnitude greater than the USEPA MCL. Elevated concentration of these constituents is consistent with the presence of uranium ore-bodies. Current data collected from wells included in the historic monitoring by Conoco show relatively consistent results with the previous data, indicating consistent water quality for the past 25 years (with the exception of the three anomalous values and potential causes for well 8-3 as previously described).

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¶

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Deleted: As a result, EMC does not anticipate any significant changes in water quality for the next two sample rounds and believes that sampling data collected to date and presented in this application are representative of site groundwater quality, unless otherwise noted

Figure 2.7.2-1a Water Quality Results from 60 Sand Monitoring Wells

		UMW-7			UMW-10		UMW-11	
		5/12/2009	5/21/2009	7/22/2009	5/18/2009	8/17/2009	5/20/2009	8/20/2009
Major Cations and Anions								
Na	(mg/l)	62	68	59	64	63	86	90
K	(mg/l)	6	7	6	11	9	11	8
Ca	(mg/l)	48	49	50	44	53	70	68
Mg	(mg/l)	6	6	6	5	5	8	7
Cl	(mg/l)	<1	<1	2	1	2	5	3
HCO3	(mg/l)	280	241	274	236	267	148	135
CO3	(mg/l)	<1	<1	<5	12	<1	8	3
SO4	(mg/l)	67	93	51	67	64	284	273
F	(mg/l)	0.2	0.2	0.2	0.2	0.2	0.2	0.2
General Chemistry								
TDS	(mg/l) @180F	337	359	374	354	359	573	545
Conductivity	(umhos/cm)	522	594	550	528	551	807	795
pH	(s.u.)	7.87	7.97	7.81	8.77	8.34	8.77	8.51
Trace Metals								
As	(mg/l)	0.002	<0.001	0.001	0.001	0.001	0.001	0.002
Mn	(mg/l)	0.03	0.02	<0.01	<0.01	<.01	<.01	0.01
Se	(mg/l)	0.076	0.075	0.087	0.102	0.1	0.074	0.072
Radionuclides								
G Alpha	(pCi/l)	64.5	50.6	79.1	93.9	81.7	70.6	83
G Beta	(pCi/l)	14.8	13.9	16.8	27.5	2.05	21.5	18.5
Pb-210	dissolved (pCi/L)	<2.0	<0.5	0	<3.0	<2.0	<0.4	0.3
Po-210	dissolved (pCi/L)	0.1	2.8	0	0.2	3.6	0.3	0.06
Ra-226	dissolved (pCi/L)	0.35	0.4	0.56	1.1	0.72	0.99	0.87
Ra-228	dissolved (pCi/L)	1.4	0.4	1.3	1.5	1.3	0.9	2.5
Th-230	dissolved (pCi/L)	<0.04	0	0.08	0.1	0.01	0.05	<0.04
U	(mg/l)	0.0524	0.0484	0.0581	0.0645	0.0775	0.0360	0.0355

All 60 Sand samples were < detection for NH4 as N, Ba, B, Cd, Cr, Cu, Fe, Pb, Hg, Mo, Ni, V and Zn

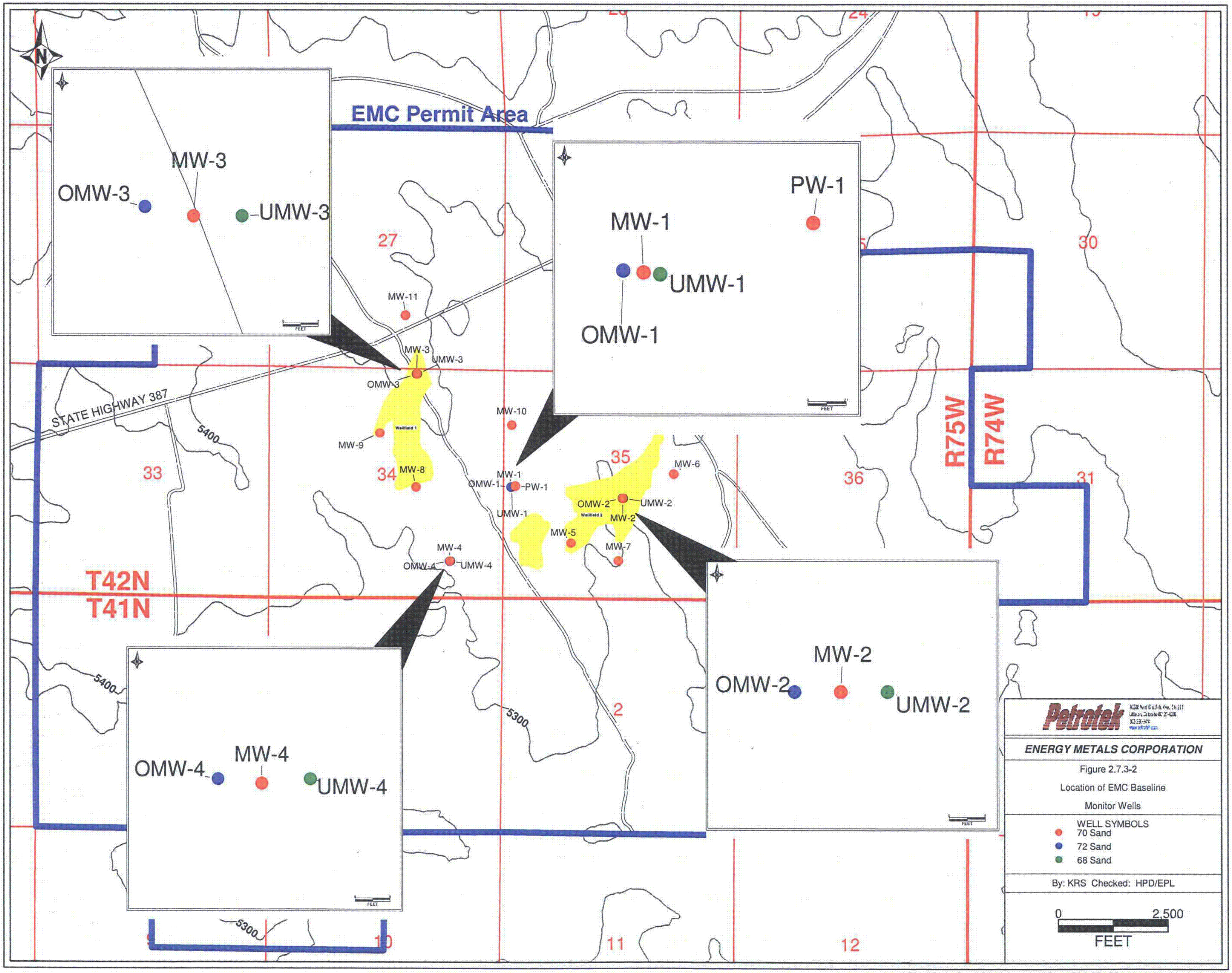


Figure 2.7.3-2
Location of EMC Baseline Monitor Wells

Hydrology Open Issue No. 6
The impact of CBM water on the 72 sand is not completely evaluated
May 11 2009 Teleconference

Open Issue discussion:

NRC staff recognizes the apparent lack of evidence of impact to the "72 sand" aquifer from coal bed methane (CBM) produced water based on a comparison of the type of water. However, NRC staff notes that EMC stated that there was an impact to surface water quality and in some locations (MRSW-10 and 11) there is infiltration of CBM produced water to groundwater at the site. NRC staff also reviewed the water quality from the four "72 sand" wells currently sampled in the proposed license area and found that OMW-2, which is near a drainage with CBM produced water discharge points, showed higher values for sodium, calcium, magnesium, sulfate, TDS, conductivity, manganese, total iron, total manganese and radium 226 as compared to OMW-1 and OMW-3 which are not close to discharge points and in topographic highs. OMW-4, which is also located near CBM water discharge points showed water quality which was elevated similar to OMW-3 with the exception of sodium. This sampling may show that CBM produced water has impacted the surficial aquifer water quality in the "72 sand" at Moore Ranch. EMC should continue to evaluate the impact of CBM discharge on the "72 sand" through well installation and water quality testing. This baseline is important to allow EMC and NRC to distinguish the impact of CBM produced water from surface spills, well/pipeline leaks or excursions to the "72 sand" from ISR operations.

Answer: Additional analysis and evaluations were completed to address NRC concerns regarding impacts to shallow aquifers from discharge of CBNG co-produced water. Investigation methods included a more rigorous evaluation of discharge water quality and quantity, a mass balance mixing analysis, a temporal evaluation of 72 sand geochemistry and water elevations, significance of Conoco's 72 sand data and a spatial analysis between the 72 sand groundwater flow direction and outfall locations. These four investigations are presented below.

1. Discharge Water Quality and Quantity in the Moore Ranch Project Area

The included spreadsheets provide the water quality statistics and discharge volumes from permits within and upstream of the Moore Ranch permit boundary (see revised Figure 2.7.1-2). Additionally, each spreadsheet provides the permit limits and anticipated water quality, based on preliminary samples submitted with each initial WYPDES application. Overall, we observed little deviation from the anticipated water quality and few exceedances of the permit limits have been detected. The following briefly summarizes water quality/quantity characteristics for each permit.

- WY0040436 (Devon's East Pine Tree Draw) – This permit includes 23 outfalls within or upstream of the Moore Ranch project boundary. Analysis of the water quality statistics confirms the water type to be sodium bicarbonate, typical of CBNG co-produced water. Compared to nearby outfalls, four outfalls (011, 012, 017, and 024) measured elevated cation concentrations including barium, calcium, magnesium, potassium and sodium. In addition, bicarbonate and specific conductance were also high compared to measurements at other outfalls. Although these concentrations were elevated, few exceeded the permit limits.

- WY0051217 (BBC's Palm Tree Project) – Three of BBC's Palm Tree Project outfalls are located within the southern portion of the Moore Ranch project boundary. A statistical analysis of the water quality data collected at the three outfalls demonstrates that water quality does not vary and is a sodium bicarbonate based water type. Additionally, discharge rates have steadily declined throughout the life of each outfall with detailed statistics included in the June 08 response package. Overall, the water chemistry demonstrated lower than anticipated concentrations of bicarbonate, chloride, sodium, and barium when compared to the representative water quality presented in the initial WYPDES permit application.

- WY0055131 (BBC's BBC Pine Tree Area) – Five of the outfalls associated with this permit discharge to tributaries within or flowing through the Moore Ranch project. The water quality data confirm that two outfalls have not received discharge water, while the remaining three outfalls have discharged water with concentrations similar to the initial WYPDES application sample. Again, the dominant inorganic complexes are sodium and bicarbonate at these locations. Permit WY0055131 is a newer permit and the higher statistical concentrations may be based on the limited number of samples that have been collected.

2. Mixing Analysis

A mixing analysis was completed to determine the impacts CBNG co-produced discharges would have on the 72 sand aquifer. The mixing analysis was based on the "Conservation Law" and utilized the following mass balance equation:

$$C_{mixed} = [(V_{CBM} * C_{CBM}) + (V_{72} * C_{72})] / V_{mixed}$$

Where:

C_{mixed}: Concentration of the mixed 72 sand with CBNG co-produced water
V_{CBM}: Volume of CBNG co-produced water discharged in the vicinity of the wellfields
C_{CBM}: Average concentration of key constituents in the CBNG co-produced water
V_{72}: Volume of water present in the 72 sand
C_{72}: Average concentration of key constituents in the 72 sand
V_{mixed}: Total volume of discharge and 72 Sand water

It should be noted that this mixing analysis method does not take into consideration any evolution of the water as it moves through the subsurface. Additionally, the mixing analysis was completed for an area in the vicinity of the wellfields and only includes WYPDES discharges within a half-mile of the well field study area.

The volume of water in the 72 sand was estimated using the saturated thickness of the sand and porosity typical of Wasatch Formation sandstones (25%). Saturated thickness was calculated using the water level elevation measured in each overlying sand well in conjunction with the elevation of the base of the 72 sand as presented in previously submitted cross-sections and electric logs. An area encompassing the near well field locale was measured and AutoCad was used to calculate the volume of the 72 sand. Because water will only occupy the pore space of the sand, the calculated volume was multiplied by a porosity of 25 percent. Water chemistry for the 72 sand was based on four quarterly samples collected at each overlying sand well.

To determine the impact CBNG discharges could potentially have on the 72 sand, WYPDES data for the outfalls in the vicinity of the OMW wells was tabulated and analyzed. Key constituents including; sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), chloride (Cl), bicarbonate (HCO3), and sulfate (SO4) were averaged and the cumulative discharge was calculated.

The following tables summarize the water volumes and water chemistry.

WATER VOLUME		
72 Sand		
Study Area Volume	264,929,689	cu. ft.
Porosity	25%	
Volume of water in study area	66,232,422	cu. ft.
	495	mgal
CBNG Wells		
Cumulative Discharge	37,994	mgal

WATER CHEMISTRY							
OMW Wells							
	Na	**K**	**Ca**	**Mg**	**Cl**	**HC03**	**SO4**
Number of Samples	16	16	16	16	16	16	16
Average (mg/L)	***32***	***17***	***137***	***37***	***4***	***208***	***401***
Max (mg/L)	73	26	250	89	8	333	743
Min (mg/L)	14	10	53	9	1	45	65
CBNG Outfalls in Vicinity of OMW Wells							
	Na	**K**	**Ca**	**Mg**	**Cl**	**HC03**	**SO4**
Number of Samples	107	34	112	112	57	103	24
Average (mg/L)	***249***	***13***	***80***	***25***	***8***	***1002***	***7***
Max (mg/L)	340	18	170	59	46	1660	42
Min (mg/L)	144	10	6	5	4	483	1

Based in the above water quality statistics an analysis was completed to determine the minimum quantity of CBNG water required to impact the 72 sand water chemistry. The following table presents the volume of CBNG water that will increase the mixed bicarbonate concentration to 432 mg/L. This concentration is based on the maximum 72 sand aquifer bicarbonate concentration plus one standard deviation.

WATER VOLUME		
72 Sand		
Study Area Volume	264,929,689	cu. ft.
Porosity	25%	
Volume of water in study area	66,232,422	cu. ft.
	495	mgal
CBNG Outfalls		
Minimum Infiltration from Discharges	194	mgal

Mixed Water Chemistry							
	Na	K	Ca	Mg	Cl	HC03	SO4
Mixed Concentration (mg/L)	94	16	121	34	5	432	290
Mixed Concentration (meq/L)	4.1	0.4	6.0	2.8	0.1	7.1	6.0

The analysis demonstrates that infiltration of only 0.5% of the cumulative discharge would be required to alter the chemistry of the 72 sand aquifer. The infiltration of 194 mgal of CBNG co-produced water changes the 72 sand water chemistry from calcium sulfate to a calcium/sodium bicarbonate dominated water. These results show that although a significant amount of CBNG water has been discharged in the vicinity of the proposed well fields there is no evidence that the water has infiltrated to the 72 sand based on the current water quality characteristics exhibited in the aquifer.

3. Temporal Evaluation of 72 Sand Aquifer Baseline Water Quality and Quantity

Predicted behavior in an aquifer receiving infiltration would likely be an increase in water levels due to local mounding as well as fluctuations in water quality. The time series graph provided in the June 2008 responses detailed these phenomena. Time series and water type characterization of the 72 sand at the Moore Ranch project reveal both geochemical and water level stability in the aquifer. The included time series graphs and trilinear plot depict the steady nature of these critical parameters as well as the average concentrations of the WYPDES permits in the area. With one exception, water quality indicators such as sodium, calcium, total dissolved solids (TDS), sulfate and bicarbonate have remained consistent throughout baseline data acquisition. The only exception to these trends has been observed in the HCO3 and TDS concentrations at OMW-1. The HCO3 concentration dropped after the initial baseline sampling event then increased at the last sampling event (above the initial result). TDS was influenced by the change in the HCO3 concentration, however, basic water type remained calcium sulfate at this location. Note that water elevations in OMW-1 decreased during the period that HCO3 increased. Similarly, water level elevations in OMW-2, OMW-3 and OMW-4 all decrease over time, further indicating that there is no infiltration occurring at these sites.

The June 2008 responses noted that several piezometers were installed into the 72 sand for evaporation pit and tailings pond site characterization by Conoco in 1979-1980. The two piezometers (35N-6 and 35N-7C) were installed southwest and northwest of OMW-2. While saturated thickness levels are less than at OMW-2, May 1980 elevations of the water surface in the two piezometers are consistent with the potentiometric surface elevations as depicted from March 2008 (35N-6 = 5,236.5' amsl and 37N-7C = 5,229.3' amsl). The lower saturated thicknesses could easily be a result of the decreased screen lengths used (10' versus the 20' in the OMW wells) and more likely is due to the piezometers only partially penetrating the 72 sand aquifer. Fundamentally, if 35N-6 and 35N-7C were included in potentiometric maps of the 72 sand, little modification would be necessary. Fundamentally, the presence of the water in the two piezometers in 1979 and 1980 indicate the aquifer was present in the area prior to CBNG development and the subsequent water discharges to the surface.

4. Spatial Distribution of CBNG Co-Produced Water Discharge Locations and Groundwater Flow Direction in the 72 Sand

Potential impacts to the 72 sand by direct infiltration from discharge of CBNG co-produced water would be nearly impossible for the majority outfalls permitted in or near the permit boundary. Groundwater flow direction in the 72 sand has consistently been in a northward direction (similar to the 70 sand). More than 20 outfalls lie down-gradient or side-gradient to the flow direction. Infiltrating water from these facilities has a very low probability of impacting the measured water quality in the 72 sand as any infiltration will move northward away from the monitor wells. In addition, infiltration into the 72 sand directly at or near the formation sub-crop would require 53,000 to 570,000 years based on the travel time estimates detailed in the June 2008 response package. Twelve outfalls are located up-gradient from the site and based on the conservative travel time estimates cannot have impacted the aquifer. With this in mind, only six outfalls (011 EPTD, 012 EPTD, 020 EPTD, 021 EPTD, 022 EPTD and 023 EPTD) have the potential to directly infiltrate into the 72 sand. Outfall 023 EPTD has not been utilized by Devon as of December 2008. Of the remaining five outfalls, only 012 EPTD, 021 EPTD and 022 EPTD have the potential to impact the 72 sand. Outfall 011 EPTD lies upgradient of an area that lacks the 72 sand as depicted on geologic cross-section a-a'. The lack of a communication pathway north and west of the outfall makes any infiltration to the 72 sand highly unlikely. Outfall 020 EPTD lies within the proposed wellfield but down-gradient from all monitor wells completed in the 72 sand. Outfalls 012 EPTD, 021 EPTD and 022 EPTD have the potential to infiltrate and potentially impact the 72 sand as measured at OMW-1. However, horizontal travel time calculations indicate a <u>minimum</u> of 130,000 years for infiltrated water to reach OMW-1 from the nearest outfall (021 EPTD) and 220,000 years to reach OMW-1 from outfall 022 EPTD. With these considerations in mind, EMC continues to contend that there is very little potential for infiltrated waters to have reached the monitoring points in the 72 sand aquifer.

Based on the information presented in the four analyses presented above, the impact of CBNG waters on the 72 Sand is unlikely. However, it is recognized that models are simply tools used to predict an outcome based on a given set of input variables. Based on the correlations between the water quality from monitoring wells OMW-2 and OMW-4 and their locations close to CBNG discharge points identified by the NRC, the possibility of a impact from CBNG infiltrated waters can not be completely ruled out. In light of this fact, Uranium One discusses in the May Open Issue # 13 response, the evaluation process if an indication of impacts is observed.

Proposed Revisions to License Application

No changes are proposed for the License Application – Technical Report.

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED: "FIGURE 2.7.1-2 MOORE RANCH URANIUM PROJECT COAL BED METHANE WELLS & OUTFALL LOCATIONS. PORTIONS OF T. 41 & 42 N., R.74 & 75W."

WITHIN THIS PACKAGE... OR BY SEARCHING USING THE DOCUMENT/REPORT NO.

D-01X

Devon - East Pine Tree Draw (WY0040436) Water Quality and Discharge Statistics

Parameter	Unit	Permit Limit1	Anticipated Water Quality[2]	Statistic	001	002	004	005	006	007	008	010	011[3]	012[3]
Alkalinity	mg/L			Avg	609	633	468	615	762	670	663	572	1,217	995
				Min	249	405	190	571	678	555	486	493	1,050	823
				Max	829	800	730	682	896	810	763	740	1,360	1,140
				StDev	167	90	208	28	47	72	56	53	91	87
				n	24	27	24	22	19	24	23	20	19	17
Arsenic	ug/L	**2.4**	0.59	Avg	1.3	1.2	0.8	1.4	0.9	1.6	1.3	1.4	2.6	1.4
				Min	1.0	0.5	0.2	0.5	0.6	0.9	0.8	0.6	2.1	0.7
				Max	2.6	2.4	1.2	3.4	1.1	2.4	1.7	2.4	3.0	2.0
				StDev	0.5	0.5	0.3	0.9	0.2	0.6	0.3	0.7	0.4	0.6
				n	9	10	7	7	6	8	6	5	5	5
Barium	ug/L	**1,800**	700	Avg	622	784	628	1,032	1,092	902	883	486	2,476	1,694
				Min	190	474	100	710	850	500	700	50	2,200	1,420
				Max	1,100	1,100	1,400	2,500	1,400	1,300	1,020	700	2,780	2,100
				StDev	409	173	467	655	191	270	128	259	272	296
				n	9	10	8	7	6	8	6	6	5	5
Bicarbonate	mg/L			Avg	726	771	660	741	921	817	804	695	1,471	1,190
				Min	304	494	231	651	781	677	593	590	1,280	999
				Max	884	975	2,438	805	1,090	989	931	902	1,660	1,390
				StDev	192	110	450	39	68	88	67	65	110	122
				n	24	27	24	22	19	24	23	20	21	19
Calcium	mg/L			Avg	41	49	29	42	52	51	46	36	131	103
				Min	12	28	7	24	22	39	28	19	93	67
				Max	64	71	57	54	71	68	67	43	170	130
				StDev	19	12	19	9	18	9	12	7	19	16
				n	18	22	21	18	14	20	19	19	23	20
Chlorides	mg/L	**46**	18	Avg	10	9	10	9	9	10	9	10	8	11
				Min	2	7	8	2	2	7	8	2	5	7
				Max	15	13	13	18	12	14	13	15	12	46
				StDev	3	2	2	3	2	2	2	3	2	9
				n	24	27	24	22	19	23	22	20	21	19
Dissolved Iron	ug/L	**1000**		Avg	1,716	876	189	482	1,043	1,089	60	671	380	174
				Min	30	52	30	30	30	30	30	101	36	30
				Max	3,210	1,620	322	956	2,840	4,000	132	1,640	790	667
				StDev	1,599	640	132	484	1,375	1,558	49	630	384	222
				n	7	8	7	4	5	7	4	5	7	7
Dissolved Cadmium	ug/L		<0.1	Avg	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	0.6	0.6
				Min									0.1	0.1
				Max									1.0	1.0
				StDev									0.6	0.6
				n									2.0	2.0
Dissolved Manganese	ug/L			Avg	37	47	109	50	66	176	50	143	117	114
				Min	2	7	28	10	10	20	10	38	102	79
				Max	86	89	500	101	145	900	112	500	150	160
				StDev	33	35	160	39	64	294	47	200	23	35
				n	8	8	8	6	6	8	4	5	4	4
				Avg	0.0284	0.0415	0.0443	0.0239	0.0109	0.0213	0.0256	0.0348	0.0283	0.0290
				Min	0.0000	0.0008	0.0021	0.0003	0.0000	0.0021	0.0000	0.0002	0.0069	0.0001

Devon - East Pine Tree Draw (WY0040436) Water Quality and Discharge Statistics

Parameter	Unit	Permit Limit1	Anticipated Water Quality[2]	Statistic	001	002	004	005	006	007	008	010	011[3]	012[3]
Flow - MAX	MGD	**0.68**		Max	0.0897	0.5940	0.1920	0.5630	0.0672	0.1423	0.0724	0.1757	0.1423	0.7120
				StDev	0.0257	0.0724	0.0371	0.0644	0.0145	0.0269	0.0236	0.0376	0.0245	0.0927
				n	84	77	85	78	70	78	76	65	62	58
Flow - AVG	MGD			Avg	0.0230	0.0339	0.0367	0.0150	0.0096	0.0206	0.0232	0.0266	0.0217	0.0135
				Min	0.0000	0.0003	0.0011	0.0001	0.0000	0.0011	0.0000	0.0001	0.0046	0.0000
				Max	0.0777	0.6050	0.1286	0.0697	0.0682	0.1444	0.0869	0.0927	0.1043	0.0637
				StDev	0.0229	0.0714	0.0314	0.0178	0.0148	0.0315	0.0229	0.0264	0.0194	0.0136
				n	84	76	85	78	70	78	76	65	62	58
				Sum	1.9283	2.5759	3.1183	1.1694	0.6742	1.6066	1.7604	1.7280	1.3484	0.7854
Cumulative Average Discharge	mgal				4,989	6,030	8,061	2,771	1,375	3,811	4,065	3,421	2,784	1,527
	ac-ft				15,310	18,508	24,739	8,506	4,221	11,696	12,475	10,501	8,546	4,686
Fluorides	mg/L			Avg	0.5	0.6	0.6	0.5	0.5	0.7	1.4	0.7	0.6	0.5
				Min	0.2	0.4	0.4	0.1	0.1	0.5	0.4	0.1	0.5	0.4
				Max	0.7	0.7	0.8	0.7	0.6	0.9	11.0	0.9	0.7	0.6
				StDev	0.1	0.1	0.1	0.1	0.1	0.1	2.9	0.2	0.1	0.1
				n	21	24	24	22	19	24	23	20	17	16
Magnesium	mg/L			Avg	13	10	8	9	16	11	13	9	44	29
				Min	2	4	1	6	12	7	7	6	34	21
				Max	22	16	15	11	20	17	16	16	59	41
				StDev	5	3	5	1	3	3	2	2	5	5
				n	21	23	25	22	19	24	23	20	23	20
pH	SU	**6.5 - 9.0**	7.9	Avg	7.81	7.71	7.85	7.94	7.86	7.77	7.86	7.71	7.55	7.62
				Min	7.09	6.99	7.20	6.97	7.14	7.01	6.98	7.17	7.15	6.96
				Max	8.58	8.09	8.43	8.42	8.46	8.31	8.41	8.25	7.93	8.20
				StDev	0.52	0.40	0.38	0.56	0.47	0.43	0.54	0.33	0.28	0.32
				n	13	14	15	12	11	15	12	12	13	12
Potassium	mg/L			Avg	6	6	5	6	7	7	7	6	15	11
				Min	3	4	2	5	6	5	5	4	13	10
				Max	10	14	8	10	9	15	8	8	18	15
				StDev	2	2	2	1	1	2	1	1	1	1
				n	21	24	24	22	19	24	22	20	18	16
Sodium	mg/L			Avg	224	207	146	215	256	221	231	199	305	274
				Min	101	7	7	197	232	8	179	8	269	251
				Max	310	280	239	236	284	293	252	270	340	300
				StDev	48	49	76	9	15	51	16	48	19	15
				n	22	26	25	22	16	24	23	20	22	20
Sodium Adsorption Ratio	Unitless	**10**		Avg	8.3	17.1	7.6	7.9	8.0	7.6	7.9	8.1	5.9	6.2
				Min	6.7	6.9	6.8	7.3	6.8	7.0	6.5	7.3	5.1	5.6
				Max	11.7	192.0	9.1	9.7	10.4	8.8	9.3	10.2	7.0	7.2
				StDev	2.0	42.3	0.7	0.7	1.3	0.5	0.9	0.9	0.4	0.4
				n	15	19	15	15	12	16	16	16	23	20
Specific Conductance	umhos/cm	**2,000**	1,130	Avg	1,141	1,114	859	1,093	1,348	1,204	1,175	1,008	2,068	1,665
				Min	483	744	445	999	1,200	1,022	878	889	1,790	1,400
				Max	1,460	1,440	1,260	1,190	1,480	1,470	1,340	1,070	3,360	1,940
				StDev	234	164	329	47	67	115	90	61	315	160
				n	22	26	25	22	19	24	23	20	23	20
				Avg	10	2	13	2	4	3	2	2	5	2

Devon - East Pine Tree Draw (WY0040436) Water Quality and Discharge Statistics

Parameter	Unit	Permit Limit1	Anticipated Water Quality[2]	Statistic	001	002	004	005	006	007	008	010	011[3]	012[3]
Sulfates	mg/L		2	Min	1	1	1	1	1	1	1	1	1	1
				Max	53	5	39	5	13	9	5	5	20	5
				StDev	16	2	13	1	4	2	1	1	7	2
				n	11	10	19	10	14	14	9	8	9	8
Total Petroleum Hydrocarbons	mg/L		1.7	Avg	1.0	1.0	0.7	1.0	1.0	0.7	1.0	0.5	1.0	1.0
				Min	1.0	1.0	0.0	1.0	1.0	0.0	1.0	0.0	0.9	1.0
				Max	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
				StDev	0.0	0.0	0.6	0.0	0.0	0.6	0.0	0.7	0.1	0.0
				n	2	2	3	2	2	3	2	2	2	2
Total Radium 226	pCi/L		<0.2±0.2	Avg	0.5	0.3	0.5	0.3	0.5	0.3	0.3	0.3	0.8	0.6
				Min	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.5	0.4
				Max	0.6	0.5	1.1	0.4	0.9	0.6	0.5	0.5	1.0	0.8
				StDev	0.2	0.1	0.3	0.1	0.3	0.1	0.1	0.1	0.2	0.2
				n	3	5	6	5	4	6	4	5	4	4

[1] - Permit limits established in Devon's East Pine Tree Unit permit (WY0040436), effective August 30, 2007.
[2] - Anticipated water quality reported in initial WYPDES permit application.
[3] - Outfalls most likely to contribute to the 72 Sand Aquifer

Devon - East Pine Tree Draw (WY0040436) Water Quality and Discharge Statistics

Parameter	Unit	Permit Limit[1]	Anticipated Water Quality[2]	Statistic	013	017	018	019	020[3]	021[3]	022[3]	023	024	025	026	027	030
Alkalinity	mg/L			Avg	No Discharge	997	No Discharge	602	702	498	434	No Discharge	1,101	796	302	407	617
				Min		875		567	668	443	396		855	718	249	363	577
				Max		1,070		661	737	519	474		1,310	830	408	469	653
				StDev		59		28	26	24	21		117	34	48	48	26
				n		14		14	14	9	12		11	15	14	6	20
Arsenic	ug/L	**2.4**	0.59	Avg	No Discharge	5.6	No Discharge	0.5	2.1	2.0	0.6	No Discharge	2	0.6	1.6	1.1	1.8
				Min		1.0		0.0	2.0	-	0.0		1	0.4	0.9	-	0.0
				Max		11.9		1.0	2.2	-	1.0		3	1.0	3.0	-	5.0
				StDev		5.6		0.5	0.1	-	0.6		1	0.3	1.2	-	1.8
				n		3		3	3	1	3		3	3	3	1	6
Barium	ug/L	**1,800**	700	Avg	No Discharge	1,433	No Discharge	577	925	600	421	No Discharge	2,003	1,153	296	360	980
				Min		900		531	874	-	400		1,400	1,100	170	-	700
				Max		1,700		600	1,000	-	464		2,410	1,200	500	-	1,200
				StDev		462		40	67	-	37		533	50	178	-	172
				n		3		3	3	1	3		3	3	3	1	6
Bicarbonate	mg/L			Avg	No Discharge	1,211	No Discharge	723	828	605	517	No Discharge	1,335	960	365	496	741
				Min		1,070		691	802	540	483		955	876	304	442	648
				Max		1,310		768	849	629	578		1,600	1,010	497	572	796
				StDev		70		24	16	28	30		164	42	61	59	39
				n		14		14	12	9	14		11	17	14	6	20
Calcium	mg/L			Avg	No Discharge	88	No Discharge	55	54	36	28	No Discharge	46	68	17	26	59
				Min		71		2	2	34	1		2	55	1	1	53
				Max		110		68	58	40	35		117	75	27	34	69
				StDev		9		27	26	2	15		45	6	9	14	5
				n		18		24	26	12	23		26	17	30	12	19
Chlorides	mg/L	**46**	18	Avg	No Discharge	5	No Discharge	5	5	7	8	No Discharge	5	6	9	Not Analyzed	9
				Min		5		4	5	-	7		3	4	7		7
				Max		7		7	6	-	9		7	7	11		11
				StDev		1		1	1	-	1		2	2	2		1
				n		5		4	3	1	4		3	3	4		20
Dissolved Iron	ug/L	**1000**		Avg	No Discharge	353	No Discharge	467	351	1,060	90	No Discharge	3,765	498	892	905	1,820
				Min		170		40	0	310	0		114	60	100	-	0
				Max		900		1,000	830	1,800	285		9,640	1,070	2,890	-	8,900
				StDev		365		496	405	745	131		5,138	450	1,336	-	3,958
				n		4		4	4	3	4		3	4	4	1	5
Dissolved Cadmium	ug/L		<0.1	Avg	No Discharge	Not Analyzed	No Discharge	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	No Discharge	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	0.35
				Min													0.1
				Max													0.6
				StDev													0.35355339
				n													2
Dissolved Manganese	ug/L			Avg	No Discharge	77	No Discharge	48	70	61	30	No Discharge	102	88	119	74	57
				Min		73		45	60	50	25		51	87	52	-	17
				Max		80		50	79	71	35		184	90	180	-	86
				StDev		5		4	13	15	7		72	2	64	-	29
				n		2		2	2	2	2		3	3	3	1	4
				Avg	No	0.0414	No	0.0183	0.0086	0.0041	0.0066	No	0.016	0.0130	0.0057	0.0032	0.0175
				Min		0.0081		0.0021	0.0000	0.0000	0.0021		0.000	0.0021	0.0032	0.0000	0.0001

Devon - East Pine Tree Draw (WY0040436) Water Quality and Discharge Statistics

Parameter	Unit	Permit Limit1	Anticipated Water Quality2	Statistic	013	017	018	019	020[3]	021[3]	022[3]	023	024	025	026	027	030
Flow - MAX	MGD	0.68		Max	No Discharge	0.0701	No Discharge	0.0374	0.0155	0.0079	0.0440	No Discharge	0.061	0.0244	0.0108	0.0078	0.0894
				StDev		0.0174		0.0086	0.0060	0.0021	0.0070		0.019	0.0038	0.0017	0.0023	0.0183
				n		41		32	31	26	32		30	34	34	21	59
Flow - AVG	MGD			Avg	No Discharge	0.0291	No Discharge	0.0158	0.0076	0.0021	0.0044	No Discharge	0.011	0.0108	0.0046	0.0021	0.0139
				Min		0.0031		0.0011	0.0000	0.0000	0.0016		0.000	0.0011	0.0018	0.0000	0.0000
				Max		0.0570		0.0321	0.0155	0.0060	0.0072		0.063	0.0151	0.0092	0.0063	0.0689
				StDev		0.0128		0.0087	0.0063	0.0013	0.0014		0.017	0.0026	0.0015	0.0017	0.0139
				n		41		32	31	26	32		30	34	34	21	59
				Sum		1.1917		0.5064	0.2366	0.0554	0.1393		0.335	0.3667	0.1547	0.0435	0.8211
Cumulative Average Discharge	mgal				No Discharge	1,488	No Discharge	493	217	44	136	No Discharge	276	379	160	26	1,472
	ac-ft					4,568		1,514	665	135	416		846	1,164	491	81	4,518
Fluorides	mg/L			Avg	No Discharge	Not Analyzed	No Discharge	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	No Discharge	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	0.7
				Min													0.5
				Max													0.7
				StDev													0.1
				n													18
Magnesium	mg/L			Avg	No Discharge	32	No Discharge	16	14	8	6	No Discharge	17	16	4	5	19
				Min		24		1	12	7	5		2	15	0	0	17
				Max		38		23	16	9	8		39	18	7	6	23
				StDev		4		8	1	1	1		15	1	2	2	2
				n		18		24	14	12	12		26	17	30	12	19
pH	SU	6.5 - 9.0	7.9	Avg	No Discharge	7.62	No Discharge	7.82	7.62	7.18	7.72	No Discharge	7	7.24	7.90	7.47	7.91
				Min		7.49		7.03	6.94	6.78	7.40		7	6.86	7.72	7.40	7.27
				Max		7.89		8.28	8.12	8.03	8.27		8	7.84	8.20	7.53	8.17
				StDev		0.11		0.47	0.62	0.52	0.48		0	0.38	0.21	0.09	0.28
				n		9		6	5	5	3		6	5	4	2	11
Potassium	mg/L			Avg	No Discharge	Not Analyzed	No Discharge	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	No Discharge	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	9
				Min													8
				Max													10
				StDev													1
				n													18
Sodium	mg/L			Avg	No Discharge	298	No Discharge	209	232	180	160	No Discharge	179	255	117	153	178
				Min		257		8	223	164	144		12	230	4	133	165
				Max		338		230	251	196	172		388	283	151	174	190
				StDev		23		102	9	8	8		169	13	58	18	7
				n		17		23	13	11	12		26	16	29	6	19
Sodium Adsorption Ratio	Unitless	10		Avg	No Discharge	7.0	No Discharge	6.4	7.2	7.1	6.9	No Discharge	8.1	7.2	6.7	7.2	5.1
				Min		6.3		6.1	6.7	6.6	6.5		7.0	6.9	5.8	7.0	4.9
				Max		7.7		6.7	7.6	7.6	7.3		9.6	7.7	7.8	7.5	5.4
				StDev		0.5		0.2	0.3	0.3	0.2		0.8	0.2	0.4	0.2	0.2
				n		18		13	14	12	12		13	17	16	6	19
Specific Conductance	umhos/cm	2,000	1,130	Avg	No Discharge	1,684	No Discharge	1,145	1,186	912	798	No Discharge	1,819	1,316	585	735	1,076
				Min		1,474		1,076	1,024	874	741		1,470	415	483	664	986
				Max		1,823		1,270	1,260	936	863		2,080	1,454	743	825	1,160
				StDev		102		54	55	19	36		176	242	79	77	52
				n		18		13	14	12	12		13	17	16	6	19
				Avg		1		40	1	1	8		1	16	9		2

Devon - East Pine Tree Draw (WY0040436) Water Quality and Discharge Statistics

Parameter	Unit	Permit Limit1	Anticipated Water Quality2	Statistic	013	017	018	019	020[3]	021[3]	022[3]	023	024	025	026	027	030
Sulfates	mg/L		2	Min	No Discharge	-	No Discharge	38	-	-	7	No Discharge	1	1	1	Not Analyzed	1
				Max		-		42	-	-	9		1	40	16		5
				StDev		-		3	-	-	1.768		0	21	11		2
				n		1		2	1	1	2		3	3	2		5
Total Petroleum Hydrocarbons	mg/L		1.7	Avg	No Discharge	Not Analyzed	No Discharge	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	No Discharge	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	1.0
				Min													–
				Max													–
				StDev													–
				n													1
Total Radium 226	pCi/L		<0.2±0.2	Avg	No Discharge	Not Analyzed	No Discharge	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	No Discharge	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	0.5
				Min													0.2
				Max													0.7
				StDev													0.2
				n													4

1 - Permit limits established in Devon's East Pine Tree Unit permit (WY0040436), effective August 30, 2007.
2 - Anticipated water quality reported in initial WYPDES permit application.
3 - Outfalls most likely to contribute to the 72 Sand Aquifer

BBC - Palm Tree Project (WY0051217) Water Quality and Discharge Statistics

PARAMETER	UNIT	STATISTIC	PERMIT LIMIT[1]	Anticipated Water Quality	OUTFALL 018	OUTFALL 020	OUTFALL 021
Bicarbonate	mg/L	Avg		1070	542	744	674
		Min			327	549	529
		Max			799	944	770
		StDev			119	110	68
		n			16	17	20
Chlorides	mg/L	Avg	46	18	9	8	9
		Min			8	7	8
		Max			11	10	11
		StDev			2	2	1
		n			4	4	4
Dissolved Calcium	mg/L	Avg		74	27	45	45
		Min			2	15	20
		Max			53	74	58
		StDev			11	14	10
		n			16	17	20
Dissolved Iron[2]	ug/L	Avg	1000	ND	1810	1514	2020
		Min			ND	ND	ND
		Max			2700	3380	2020
		StDev			1259	1665	N/A
		n			4	4	4
Dissolved Magnesium	mg/L	Avg		16	7	10	10
		Min			3	8	8
		Max			12	14	14
		StDev			2	2	1
		n			16	17	20
Dissolved Manganese	ug/L	Avg		58	63	119	66
		Min			23	97	45
		Max			90	150	90
		StDev			30	23	19
		n			4	4	4
Dissolved Sodium	mg/L	Avg		322	177	206	181
		Min			133	181	163
		Max			214	221	206
		StDev			23	9	11
		n			16	17	20
pH	SU	Avg	6.5-9.0	7.73	8.03	8.03	7.94
		Min			7.18	7.24	7.31
		Max			8.52	9.03	8.23
		StDev			0.58	0.72	0.34
		n			8	8	8
Sodium Adsorption Ratio	Calculated	Avg	10	8.9	7.9	7.4	6.4
		Min			6.4	6.1	5.4
		Max			10.0	10.9	8.4
		StDev			1.1	1.1	0.7
		n			16	17	20

BBC - Palm Tree Project (WY0051217) Water Quality and Discharge Statistics

PARAMETER	UNIT	STATISTIC	PERMIT LIMIT[1]	Anticipated Water Quality	OUTFALL 018	OUTFALL 020	OUTFALL 021
Specific Conductance	micromhos/cm	Avg	2,000	1,560	880	1,052	967
		Min			629	870	839
		Max			1,340	1,220	1,040
		StDev			162	85	54
		n			16	17	20
Sulfates	mg/L	Avg		ND	18	1	ND
		Min			ND	ND	
		Max			32	1	
		StDev			21	0	
		n			4	4	4
Total Alkalinity	mg/L as CaCO3	Avg		880	449	615	555
		Min			270	482	457
		Max			655	773	645
		StDev			96	83	53
		n			16	17	20
Total Flow (MGD) - MAX	MGD	Avg	5.3		0.0403	0.0079	0.0083
		Min			0.0001	0.0001	0.0000
		Max			0.9680	0.0589	0.0458
		StDev			0.1648	0.0137	0.0099
		n			34	37	40
		Sum			1.3693	0.2909	0.3324
Total Flow (MGD) - AVG	MGD	Avg			0.0147	0.0079	0.0083
		Min			0.0001	0.0001	0.0016
		Max			0.0968	0.0589	0.0458
		StDev			0.0226	0.0137	0.0099
		n			34	37	40
		Sum			0.4981	0.2909	0.3324
Cumulative Average Discharge	mgal				516	327	405
	ac-ft				1,582	1,004	1,242
Total Arsenic	ug/L	Avg	3		0.8	1.0	1.6
		Min			0.5	ND	ND
		Max			1.0	1.6	1.7
		StDev			0.2	0.5	0.1
		n			4	4	4
Total Barium	ug/L	Avg	1,800	1,110	608	713	832
		Min			414	ND	630
		Max			900	847	1,000
		StDev			236	125	158
		n			4	4	4
Total Petroleum Hydrocarbons	mg/L	Avg		ND	ND	ND	ND
		Min					
		Max					
		StDev					
		n			4	4	4

BBC - Palm Tree Project (WY0051217) Water Quality and Discharge Statistics

PARAMETER	UNIT	STATISTIC	PERMIT LIMIT[1]	Anticipated Water Quality	OUTFALL 018	OUTFALL 020	OUTFALL 021
Total Radium 226	pCi/L	Avg		ND	0.36	0.47	0.23
		Min			0.15	ND	ND
		Max			0.6	1.00	0.27
		StDev			0.22	0.46	0.06
		n			4	4	4

[1] - Permit limits established in BBC's Palm Tree Project permit (WY0051217), effective February 4, 2008.

[2] - Anticipated water quality reported in initial WYPDES permit application.

BBC - BBC Pine Tree Area (WY0055131) Water Quality and Discharge Statistics

PARAMETER	UNIT	PERMIT LIMIT[1]	Anticipated Water Quality	STATISTIC	WY0055131 OUTFALL				
					004	005	006	007	008
Alkalinity	mg/L		735	avg	780	1,059	922	No Discharge	No Discharge
				min	658	668	401		
				max	926	1,420	1,410		
				stdev	123	341	472		
				n	9	7	6		
Arsenic	ug/L	**3**	0.8	avg	0.7	1.7	1.6	No Discharge	No Discharge
				min	0.1	0.8	ND		
				max	1.4	2.2	1.8		
				stdev	0.7	0.8	0.3		
				n	3	3	4		
Bicarbonate	mg/L		897	avg	952	1,293	1,126	No Discharge	No Discharge
				min	803	815	489		
				max	1,130	1,730	1,730		
				stdev	150	417	577		
				n	9	7	6		
Calcium	mg/L		59	avg	74	82	73	No Discharge	No Discharge
				min	40	21	20		
				max	95	134	146		
				stdev	20	42	45		
				n	9	12	11		
Chlorides	mg/L	**46**	7	avg	10	7	7	No Discharge	No Discharge
				min	9	4	5		
				max	12	8	8		
				stdev	1	1	1		
				n	9	7	6		
Dissolved Cadmium	ug/L		ND	avg	0.1	ND	Not Analyzed	No Discharge	No Discharge
				min	ND	-			
				max	0.1	-			
				stdev	-	-			
				n	3	2			
Dissolved Iron	ug/L	**1,000**	432	avg	160	1,257	570	No Discharge	No Discharge
				min	ND	379	62		
				max	170	2,960	1,450		
				stdev	14	1,475	765		
				n	3	3	3		

BBC - BBC Pine Tree Area (WY0055131) Water Quality and Discharge Statistics

PARAMETER	UNIT	PERMIT LIMIT[1]	Anticipated Water Quality	STATISTIC	WY0055131 OUTFALL				
					004	005	006	007	008
Dissolved Manganese	ug/L		62	avg	97	105	85	No Discharge	No Discharge
				min	54	62	83		
				max	181	147	86		
				stdev	73	60	2		
				n	3	2	2		
Total Flow (MGD) - MAX	MGD	1.02		avg	0.0042	0.0261	0.0146	No Discharge	No Discharge
				min	0.0000	0.0000	0.0000		
				max	0.0362	0.1328	0.1194		
				stdev	0.0053	0.0331	0.0221		
				n	45	32	33		
Total Flow (MGD) - AVG	MGD			avg	0.0949	0.0197	0.0124	No Discharge	No Discharge
				min	0.0000	0.0000	0.0000		
				max	0.6000	0.0771	0.1543		
				stdev	0.2089	0.0246	0.0262		
				n	54	32	33		
				sum	5.1262	0.6307	0.4086		
Cumulative Average Discharge	mgal				6,700	518	348	No Discharge	No Discharge
	ac-ft				20,563	1,589	1,068		
Fluorides	mg/L			avg	1	1	1	No Discharge	No Discharge
				min	1	1	1		
				max	1	1	1		
				stdev	0	0	0		
				n	9	6	5		
Magnesium	mg/L		21	avg	26	33	34	No Discharge	No Discharge
				min	18	9	7		
				max	36	54	74		
				stdev	8	17	23		
				n	9	12	11		

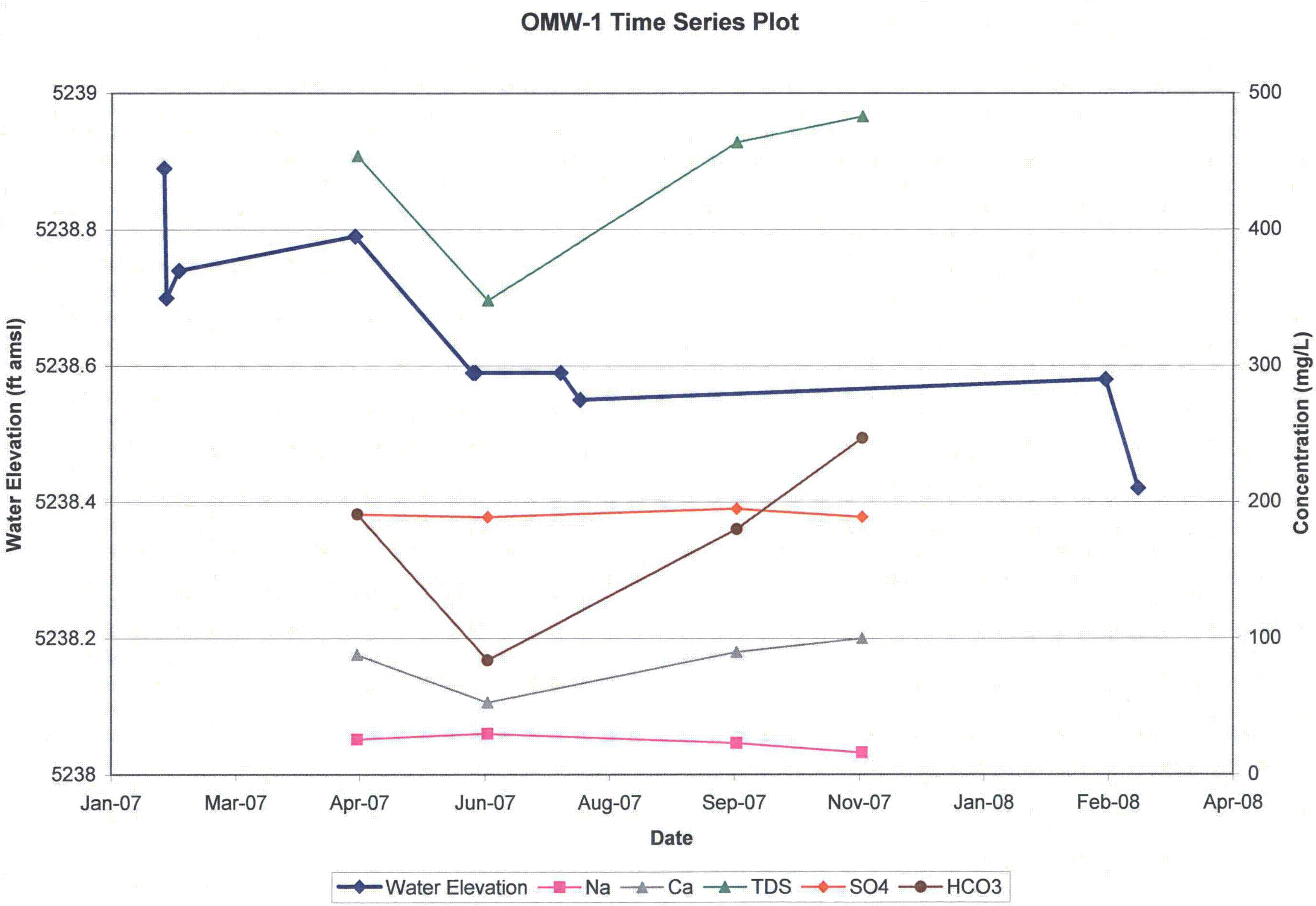
BBC - BBC Pine Tree Area (WY0055131) Water Quality and Discharge Statistics

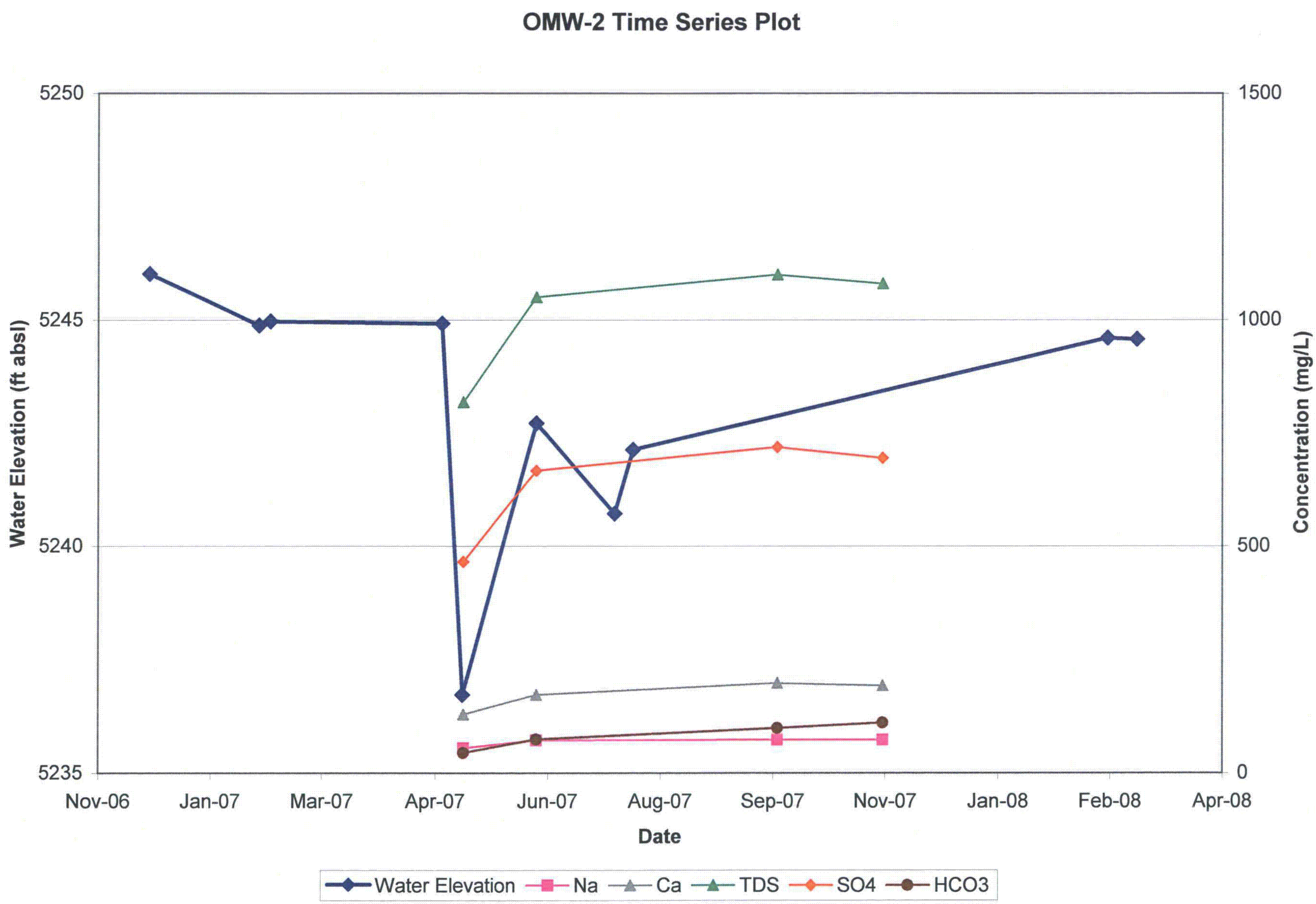
PARAMETER	UNIT	PERMIT LIMIT[1]	Anticipated Water Quality	STATISTIC	WY0055131 OUTFALL				
					004	005	006	007	008
pH	SU	**6.5-9.0**	7.39	avg	7.48	7.31	7.25	No Discharge	No Discharge
				min	7.19	7.03	6.96		
				max	7.79	7.73	7.73		
				stdev	0.27	0.27	0.28		
				n	5	5	6		
Potassium	mg/L			avg	9	12	12	No Discharge	No Discharge
				min	7	7	6		
				max	11	20	18		
				stdev	1	5	5		
				n	9	6	5		
Sodium	mg/L		216	avg	222	305	197	No Discharge	No Discharge
				min	201	191	7		
				max	248	422	344		
				stdev	17	79	89		
				n	9	12	11		
Sodium Adsorption Ratio	Calculated	**10**	6	avg	6	8	6	No Discharge	No Discharge
				min	5	7	5		
				max	7	9	7		
				stdev	0	1	1		
				n	9	12	10		
Specific Conductance	micromhos/cm	**2,000**	1,279	avg	1,350	1,686	1,415	No Discharge	No Discharge
				min	1,150	979	719		
				max	1,544	2,270	2,280		
				stdev	174	530	611		
				n	9	12	11		
Sulfates	mg/L		ND	avg	3	3	8	No Discharge	No Discharge
				min	1	ND	ND		
				max	6	3	19		
				stdev	2	0	8		
				n	5	6	5		

BBC - BBC Pine Tree Area (WY0055131) Water Quality and Discharge Statistics

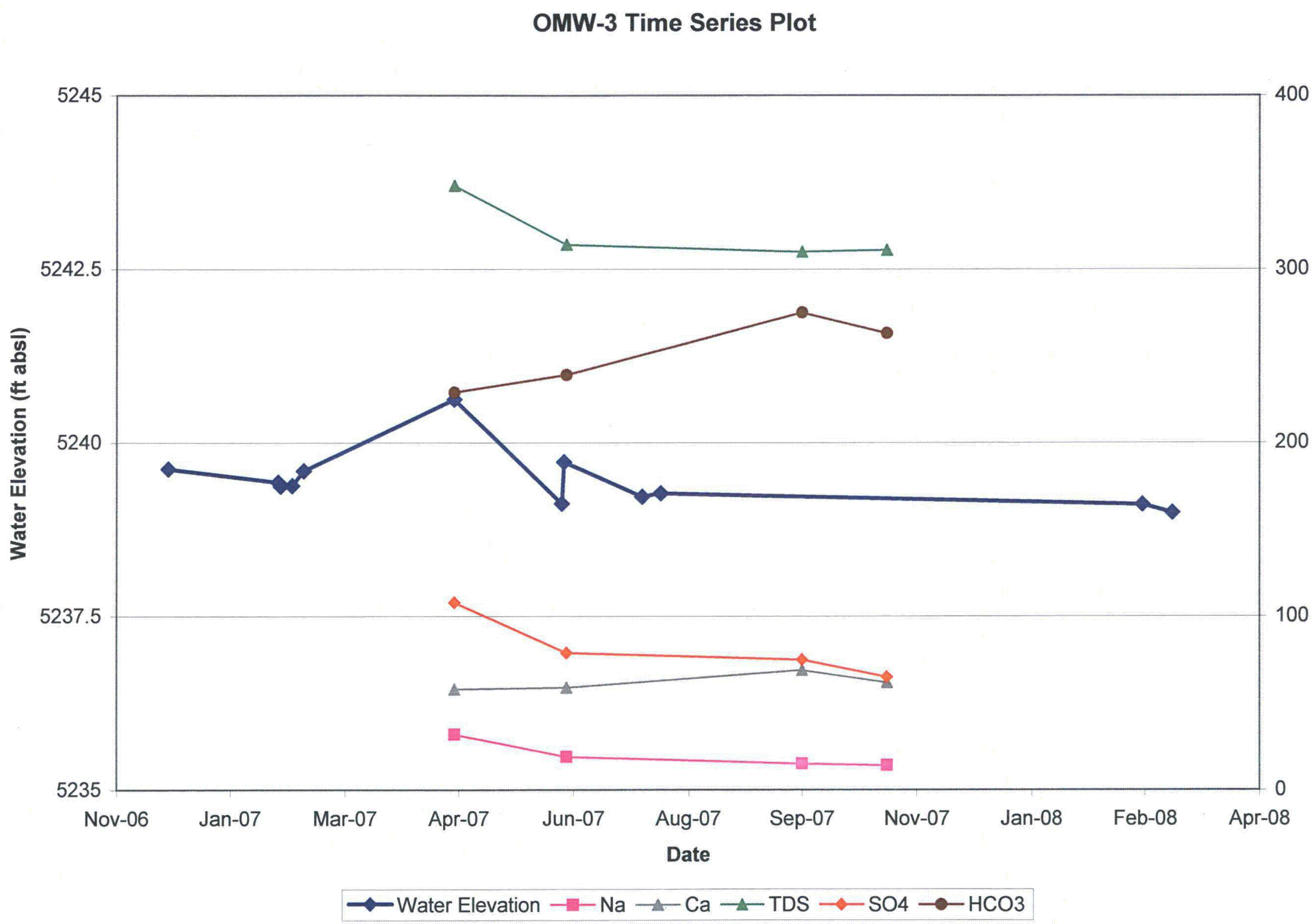
PARAMETER	UNIT	PERMIT LIMIT[1]	Anticipated Water Quality	STATISTIC	WY0055131 OUTFALL				
					004	005	006	007	008
Total Barium	ug/L	**1,800**	920	avg	1,050	2,023	1,157	No Discharge	No Discharge
				min	690	920	371		
				max	1,650	2,620	1,600		
				stdev	523	957	683		
				n	3	3	3		
Total Petroleum Hydrocarbons	mg/L		ND	avg	1	ND	ND	No Discharge	No Discharge
				min	ND	-	-		
				max	1	-	-		
				stdev	-	-	-		
				n	3	2	2		
Total Radium 226	pCi/L		0.4	avg	0.6	1.1	0.4	No Discharge	No Discharge
				min	0.2	0.4	0.3		
				max	1.2	1.7	0.5		
				stdev	0.5	0.9	0.1		
				n	3	2	2		

[1] - Permit limits established in BBC Pine Tree Area permit (WT0055131), effective October 4, 2007.
[2] - Anticipated water quality reported in initial WYPDES permit application.

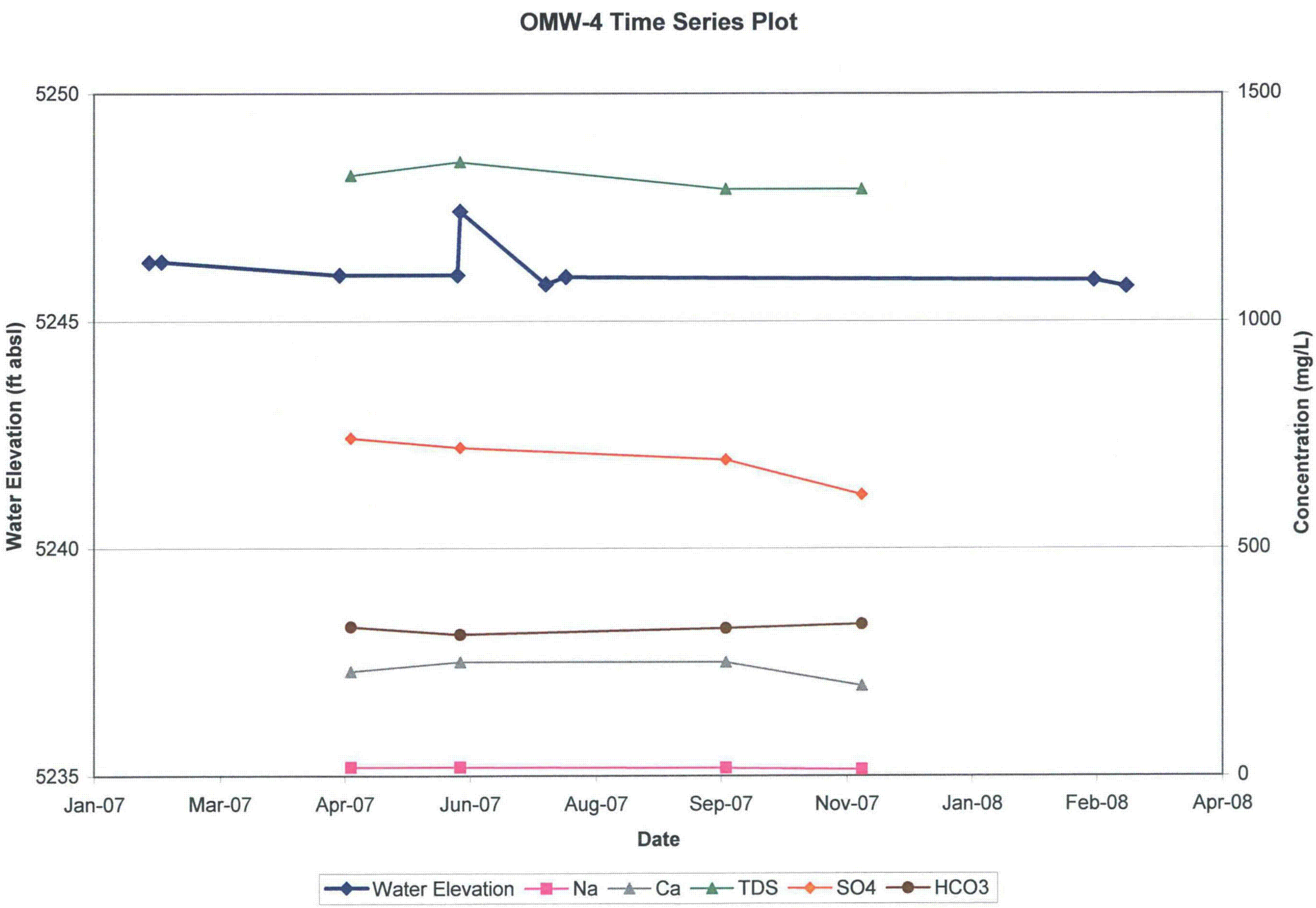

OMW-1 Time Series Plot
Water Elevation (ft amsl)
Concentration (mg/L)
5239
5238.8
5238.6
5238.4
5238.2
5238
500
400
300
200
100
0
Jan-07
Mar-07
Apr-07
Jun-07
Aug-07
Sep-07
Nov-07
Jan-08
Feb-08
Apr-08
Date
Water Elevation
Na
Ca
TDS
SO4
HCO3



OMW-2 Time Series Plot
5250
5245
5240
5235
Water Elevation (ft absl)
1500
1000
500
0
Concentration (mg/L)
Nov-06
Jan-07
Mar-07
Apr-07
Jun-07
Aug-07
Sep-07
Nov-07
Jan-08
Feb-08
Apr-08
Date
Water Elevation
Na
Ca
TDS
SO4
HCO3



OMW-3 Time Series Plot
5245
5242.5
5240
5237.5
5235
Water Elevation (ft absl)
400
300
200
100
0
Concentration (mg/L)
Nov-06
Jan-07
Mar-07
Apr-07
Jun-07
Aug-07
Sep-07
Nov-07
Jan-08
Feb-08
Apr-08
Date
Water Elevation
Na
Ca
TDS
SO4
HCO3


OMW-4 Time Series Plot
5250
5245
5240
5235
Water Elevation (ft absl)
1500
1000
500
0
Concentration (mg/L)
Jan-07
Mar-07
Apr-07
Jun-07
Aug-07
Sep-07
Nov-07
Jan-08
Feb-08
Apr-08
Date
Water Elevation
Na
Ca
TDS
SO4
HCO3

Hydrology Open Issue No. 7
Proposed casing materials and joints are not justified
May 11 2009 Teleconference

Open Issue discussion:

For wellfield infrastructure, EMC stated that wells would be completed with schedule 40 PVC well casing using either glue and screw or mechanical threaded joints. NRC staff notes that the use of Schedule 40 PVC and glue and screw joints has led to many failures in currently operating ISL facilities. EMC has not justified the use of the casing materials and joints proposed in light of past industry experience.

Answer:

All cased wells that Uranium One has installed at the Moore Ranch Project have been constructed with SDR-17 casing. All wells used for future construction on the project will be constructed with SDR-17 casing unless otherwise approved by the WDEQ and NRC. The SDR-17 casing involves a spline-lock method of securing the casing together rather than the use of tapping screws and PVC cement. An "O-Ring" seals the joints together to create a watertight seal.

Proposed Revisions to License Application

3.1.2.1 Well Materials of Construction

The well casing material will be rigid polyvinyl chloride (PVC) ~~with schedule 40 wall thickness and~~ Standard Dimension Ratio 17 (SDR-17) with a nominal 5-inch outside diameter. However, if a larger pump size is necessary, larger diameter casing may be utilized. The table below shows the range of casing sizes that could be used at Moore Ranch, and the corresponding drill hole size to ensure adequate annular sealing. Each joint of the PVC casing will normally have a length of approximately 20 feet. Each joint will ~~be connected either with glue and self tapping screws~~ joined mechanically (with pipe threads or a water tight o-ring seal with a high strength nylon spline).

Casing	I.D.	O.D.	Bit size
4.5"	4.454	4.950	7-7/8
5.0"	5.047	5.563	8-3/4
6.0"	6.065	6.625	9-7/8

Hydrology Open Issue No. 8
Evidence is not provided that extraction rates to recover an excursion will not result in excessive dewatering
May 11 2009 Teleconference

Open Issue discussion:

The groundwater flow model simulations provide evidence that EMC can maintain a cone of depression for expected production and restoration operations in the unconfined "70 sand" aquifer. However, substantial dewatering can occur at extraction wells if rates exceed 20 gpm. Dewatering of wells in the unconfined aquifer will limit the flexibility in the extraction rates which can be used at Moore Ranch. These limits may pose a problem if an excursion of lixiviant from a wellfield occurs. Correcting an excursion typically involves a strategy of ceasing injection and increasing pumping rates near the excursion. In the application, EMC stated that an excursion could be reversed within a relatively short period of time, assuming the required extraction rates can be maintained. EMC also stated that additional simulations would be performed using the groundwater model to further refine methods to recover an excursion; however, it did not simulate this scenario with the groundwater flow model to demonstrate that excursion capture would not lead to excessive dewatering.

Answer: A numerical groundwater flow model was previously submitted to the NRC to address issues related to hydraulic stresses on the production zone aquifer during typical production and restoration operations (Numerical Modeling of Groundwater Conditions Related to Insitu Recovery at the Moore Ranch Uranium Project, Wyoming, Petrotek 2008). That same numerical model was used to simulate an excursion recovery scenario and also to demonstrate that a 500 foot well spacing for the monitor ring is adequate for detection of an excursion. The model was used to simulate excursions from Wellfield 2. Wellfield 2 was selected as the location for simulated excursions because this is where unconfined aquifer conditions are prevalent and the hydraulic head is limited. The excursion simulation shows that the excursions would intercept and be detected by a monitor well in the monitor ring at 500 feet. The excursion recovery simulation indicated that hydraulic control of the excursion could be achieved out to the monitor ring within 10 to 30 days. The excursion recovery simulation indicates that excessive dewatering of the 70 Sand will not occur using pumping rates that can result in successful recovery of an excursion. The simulation is described in revised Addendum 5.7.1

Proposed Revisions to License Application

Insert as last paragraph under TR Section 5.7.8.2

A numerical model has been developed to further demonstrate that an excursion could be recovered under hydrologic conditions present at Moore Ranch. The numerical model is used simulate the occurrence and recovery of an excursion using pumping rates that could be achieved and maintained at the site. The model results indicate that an excursion identified at the proposed monitor ring distance of 500 feet from the wellfield could be hydraulically controlled within 10 to 30 days. The model results also indicate that a 500-foot spacing between monitor ring wells should be adequate for detection of an excursion. Details of the model simulation are provided in Addendum 5.7.1

Addendum 5.7.1 will be replaced with the following Technical Memorandum "Numerical Assessment of Monitor Well Spacing and Excursion Recovery, Moore Ranch ISR Uranium Project, Wyoming" (Petrotek 2009)

Technical Memorandum

To: Energy Metals Corporation

From: Petrotek Engineering Corporation

Date: 10/12/09

Subject: Numerical Assessment of Monitor Well Spacing and Excursion Recovery, Moore Ranch ISR Uranium Project, Wyoming

Introduction

Energy Metals Corporation US (EMC) plans to develop and extract uranium from in-situ recovery (ISR) wellfields within the Wasatch Formation at the Moore Ranch Project in Campbell County, Wyoming. The target orebodies are located within the 70 Sand. The 70 Sand aquifer is unconfined across the southern portion of the Permit Area. The limited hydraulic head within the 70 Sand has raised concerns regarding the proposed monitor well ring spacing and the ability to hydraulically recover an excursion without dewatering the production zone aquifer. A numerical model has been developed to simulate recovery of a potential excursion. The model results indicate that an excursion identified at the proposed monitor ring distance of 500 feet from the wellfield could be hydraulically controlled within 10 to 30 days. The model results also indicate that a 500-foot spacing between monitor ring wells should be adequate for detection of an excursion. Additional discussion is presented below.

Numerical Modeling of Excursion and Excursion Recovery

The model used to assess monitor ring spacing and excursion recovery was previously described in the report "Numerical Modeling of Groundwater Conditions Related to Insitu Recovery at the Moore Ranch Uranium Project, Wyoming" (PEC 2008). Only the changes made to that model to simulate an excursion during ISR production are described in this technical memorandum. Because unconfined conditions are more prevalent within proposed Wellfield 2, the modeling effort was focused on this area. Figure 1 shows the configuration of well patterns and placement of the monitor well ring as simulated in the model. The monitor well ring is located approximately 500 feet from the perimeter of the wellfield and spacing between individual monitor wells is also 500 feet. The model domain extends several miles in each direction from Wellfield 2. The program used to perform the numerical groundwater flow modeling was MODFLOW SURFACT, Version 3.0 (HydroGeologic 2006).

The original model simulated the full production and restoration cycle for the Moore Ranch Project (Petrotek. 2008). For this assessment, an excursion during production at Wellfield 2 is simulated followed by an excursion recovery simulation.

Excursion Simulation

The excursion was simulated by turning off an extraction well in two well patterns located along the northern and north central edges of the wellfield. Each of those extraction wells had previously been simulated as producing at a rate of 20 gallons per minute (gpm) or 3,850 ft^3/d. Figure 2 shows the location of the well patterns where the extraction well was turned off, identified as WP1 and WP2.No change was made to the injection well rates or locations in or around those well patterns for this simulation. All other extraction and injection wells were simulated at the same rates presented in the first production phase reported in the "Numerical Modeling of Groundwater Conditions Related to Insitu Recovery at the Moore Ranch Uranium Project, Wyoming" (PEC 2008).

Results of the excursion are simulated using particle tracking. MODPATH, Version 3.0 (Pollack 1994) was the program used to simulate groundwater flowpaths with particle tracking. Natural groundwater flow (uninfluenced by mining) is toward the north. A line of particles was placed along the northward edges of the two well patterns. As shown on the figure, particles (representing the flowpath of groundwater) travel away from the wellfield and toward the monitor well ring. This excursion simulates the loss of lixiviant during the production phase of ISR. The simulation shows that some particles from both well patterns that are "out of balance" will reach (and be detected by) monitor wells in the monitor ring. The particle tracking clearly indicates that a 500 foot well spacing between monitor ring wells is adequate for detection of an excursion. Figure 3 indicates the potentiometric surface during the excursion simulation.

Figures 4a and 4b show a velocity vector analysis of the flow systems in the vicinity of the WP1 and WP2 sites, respectively, at the time the excursion is occurring. Vector analysis simply provides a means of visualizing the groundwater flow velocity and direction at any point within the flowfield. The velocity vector field is calculated by the model. The arrows on the figures point in the direction of groundwater flow. Groundwater is clearly moving away from the two "out of balance" well patterns and toward the monitor well ring.

Excursion Recovery Simulation

A second simulation was run to evaluate if the excursion previously simulated could be hydraulically controlled by adjusting operating rates within the wellfield. For the excursion recovery simulation, the following adjustments were made.

For the WP1 well pattern, the extraction well was turned on at a rate of 40 gpm (7,700 ft^3/d). The three most northern injection wells in the well pattern were turned off, resulting in a loss of approximately 18.2 gpm (3,505 $ft/^3/d$) of injection.

For the WP2 well pattern, the extraction well was turned on at a rate of 30 gpm (5725 ft^3/d). Additionally, the rate for each extraction well in the three immediately adjacent well patterns was increased from 20 (3,850 ft^3/d) to 30 gpm (5725 ft^3/d). Five injection wells located along the perimeter of the well pattern and adjacent areas were turned off, reducing infiltration by a total of 38 gpm (7,315 ft3/d).

Ten days after the start of excursion recovery, the simulated potentiometric surface shows the development of a significant cone of depression around both the WP1 and WP2 areas (Figure 5). Velocity vector analysis indicates that groundwater capture extends almost to the monitor well ring from WP1 (Figure 6a) and beyond the monitor ring from WP2 after ten days (Figure 6b). After thirty days, the potentiometric surface shows an expansion of the cone of depression around both sites (Figure 7). Hydraulic capture is clearly demonstrated for both areas with the velocity vector analysis (Figure 8a and 8b).

A series of hydrographs were developed from the model simulations that demonstrate that hydraulic capture can be achieved without fully dewatering the 70 Sand aquifer. Figure 9 shows hydrographs for the extraction well in well pattern WP1 and for monitor ring wells MW1, MW2 and MW3 that are located north of WP1. Based on the particle tracking, these are the monitor wells that would most likely detect an excursion from WP1. The hydrograph illustrates a couple of important points. First, although there is a significant decrease in water level in the extraction well (approximately 30 feet after six months of recovery operations) there is still nearly 50 feet of saturated thickness remaining in the well. The increased pumping rates simulated to recovery the excursion did not result in total dewatering of the 70 Sand aquifer. Second, there is substantial drawdown at the monitor ring well, located 500 feet away. This drawdown indicates that hydraulic control can be achieved at rates that are sustainable within the 70 Sand aquifer.

Figure 10 shows hydrographs for the extraction well in well pattern WP2 and monitor wells MW23 and MW24. Based on the particle tracking, these are the monitor wells that would most likely detect an excursion from WP2. Similar to the WP1 response, the monitor wells show a substantial drawdown fairly rapidly, indicating hydraulic capture at the simulated rates. For this area, the drawdown in the extraction well may eventually result in localized dewatering of the 70 Sand, if the recovery operation were continued at the simulated rates for an extended period of time. However, as shown on the previous figures, the hydraulic capture occurred more quickly at WP2 than at WP1, partly because a higher extraction rate was simulated. Extraction rates could be adjusted downward and still result in hydraulic capture within less than 30 days. Alternatively, the simulated rates could be employed initially for a short period of time to rapidly achieve hydraulic capture, followed by a gradual decrease in rates that would still maintain capture. The increased extraction rate required for hydraulic capture could also be spread over a greater number of wells in order to reduce the possibility of dewatering at any specific extraction wells. Another option would be to establish initial hydraulic control from wells within the wellfield, followed by installation of excursion recovery wells between the wellfield and monitor well ring for continued recovery operation.

Summary

Numerical modeling was performed to assess recovery of an excursion and monitor well spacing in an area where the production zone aquifer is unconfined and has limited hydraulic head. The modeling was focused on Wellfield 2 where unconfined conditions are prevalent. The model development was based on site specific aquifer properties and conditions as described in the report "Numerical Modeling of Groundwater Conditions Related to Insitu Recovery at the Moore Ranch Uranium Project, Wyoming" (PEC 2008)

Model simulations indicate that the proposed monitor well ring spacing of 500 feet from the wellfield and 500 feet between monitor wells is adequate for detection of an excursion. Results of the modeling also indicate that an excursion detected at the monitor well ring can be hydraulically controlled within 10 to 30 days of recovery startup. Further, the rates required to achieve hydraulic control within that time frame will not fully dewater that 70 Sand aquifer.

Long-term operation of recovery operations (if necessary) might require assessment of alternatives such as lower extraction rates, spreading the additional extraction over a larger number of wells, or even installation of excursion recovery wells between the wellfield and monitor well ring. Although the hydraulic head in the 70 Sand aquifer is limited, the aquifer appears to have adequate yield to allow for a wide range of options for hydraulic control of potential excursions.

Technical Memorandum

To: Donna Wichers, Mike Griffin, Jon Winter, Uranium One

From: Errol Lawrence, Petrotek Engineering Corporation

Date: 10/12/09

Subject: Numerical Assessment of Monitor Well Spacing and Excursion Recovery, Moore Ranch ISR Uranium Project, Wyoming

Introduction

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Numerical Modeling of Excursion and Excursion Recovery

The model used to assess monitor ring spacing and excursion recovery was previously described in the report "Numerical Modeling of Groundwater Conditions Related to Insitu Recovery at the Moore Ranch Uranium Project, Wyoming" (PEC 2008). Only the changes made to that model to simulate an excursion during ISR production are described in this technical memorandum. Because unconfined conditions are more prevalent within proposed Wellfield 2, the modeling effort was focused on this area. Figure 1 shows the configuration of well patterns and placement of the monitor well ring as simulated in the model. The monitor well ring is located approximately 500 feet from the perimeter of the wellfield and spacing between individual monitor wells is also 500 feet. The model domain extends several miles in each direction from Wellfield 2. The program used to perform the numerical groundwater flow modeling was MODFLOW SURFACT, Version 3.0 (HydroGeologic 2006).

The original model simulated the full production and restoration cycle for the Moore Ranch Project (Petrotek. 2008). For this assessment, an excursion during production at Wellfield 2 is simulated followed by an excursion recovery simulation.

Excursion Simulation

The excursion was simulated by turning off an extraction well in two well patterns located along the northern and north central edges of the wellfield. Each of those extraction wells had previously been simulated as producing at a rate of 20 gallons per minute (gpm) or 3,850 ft^3/d. Figure 2 shows the location of the well patterns where the extraction well was turned off, identified as WP1 and WP2.No change was made to the injection well rates or locations in or around those well patterns for this simulation. All other extraction and injection wells were simulated at the same rates presented in the first production phase reported in the "Numerical Modeling of Groundwater Conditions Related to Insitu Recovery at the Moore Ranch Uranium Project, Wyoming" (PEC 2008).

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For the WP2 well pattern, the extraction well was turned on at a rate of 30 gpm (5725 ft^3/d). Additionally, the rate for each extraction well in the three immediately adjacent well patterns was increased from 20 (3,850 ft^3/d) to 30 gpm (5725 ft^3/d). Five injection wells located along the perimeter of the well pattern and adjacent areas were turned off, reducing infiltration by a total of 38 gpm (7,315 ft3/d).

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Figure 10 shows hydrographs for the extraction well in well pattern WP2 and monitor wells MW23 and MW24. Based on the particle tracking, these are the monitor wells that would most likely detect an excursion from WP2. Similar to the WP1 response, the monitor wells show a substantial drawdown fairly rapidly, indicating hydraulic capture at the simulated rates. For this area, the drawdown in the extraction well may eventually result in localized dewatering of the 70 Sand, if the recovery operation were continued at the simulated rates for an extended period of time. However, as shown on the previous figures, the hydraulic capture occurred more quickly at WP2 than at WP1, partly because a higher extraction rate was simulated. Extraction rates could be adjusted downward and still result in hydraulic capture within less than 30 days. Alternatively, the simulated rates could be employed initially for a short period of time to rapidly achieve hydraulic capture, followed by a gradual decrease in rates that would still maintain capture. The increased extraction rate required for hydraulic capture could also be spread over a greater number of wells in order to reduce the possibility of dewatering at any specific extraction wells. Another option would be to establish initial hydraulic control from wells within the wellfield, followed by installation of excursion recovery wells between the wellfield and monitor well ring for continued recovery operation.

Summary

Numerical modeling was performed to assess recovery of an excursion and monitor well spacing in an area where the production zone aquifer is unconfined and has limited hydraulic head. The modeling was focused on Wellfield 2 where unconfined conditions are prevalent. The model development was based on site specific aquifer properties and conditions as described in the report "Numerical Modeling of Groundwater Conditions Related to Insitu Recovery at the Moore Ranch Uranium Project, Wyoming" (PEC 2008)

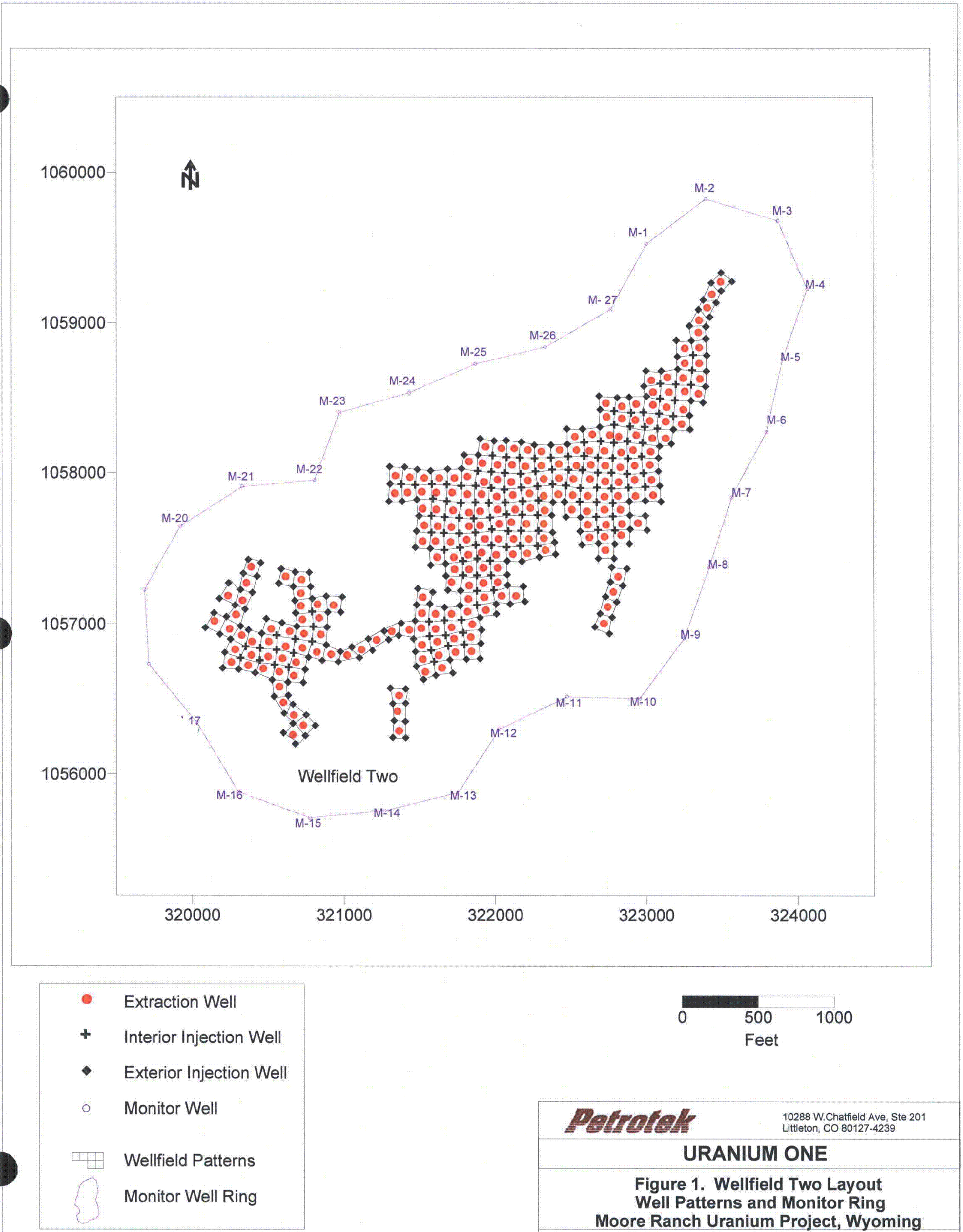
Model simulations indicate that the proposed monitor well ring spacing of 500 feet from the wellfield and 500 feet between monitor wells is adequate for detection of an excursion. Results of the modeling also indicate that an excursion detected at the monitor well ring can be hydraulically controlled within 10 to 30 days of recovery startup. Further, the rates required to achieve hydraulic control within that time frame will not fully dewater that 70 Sand aquifer.

Long-term operation of recovery operations (if necessary) might require assessment of alternatives such as lower extraction rates, spreading the additional extraction over a larger number of wells, or even installation of excursion recovery wells between the wellfield and monitor well ring. Although the hydraulic head in the 70 Sand aquifer is limited, the aquifer appears to have adequate yield to allow for a wide range of options for hydraulic control of potential excursions.

Insert as last paragraph under TR Section 5.7.8.2

A numerical model has been developed to further demonstrate that an excursion could be recovered under hydrologic conditions present at Moore Ranch. The numerical model is used simulate the occurrence and recovery of an excursion using pumping rates that could be achieved and maintained at the site. The model results indicate that an excursion identified at the proposed monitor ring distance of 500 feet from the wellfield could be hydraulically controlled within 10 to 30 days. The model results also indicate that a 500-foot spacing between monitor ring wells should be adequate for detection of an excursion. Details of the model simulation are provided in Addendum 5.7.1

REPLACE EXISTING Addendum 5.7.1



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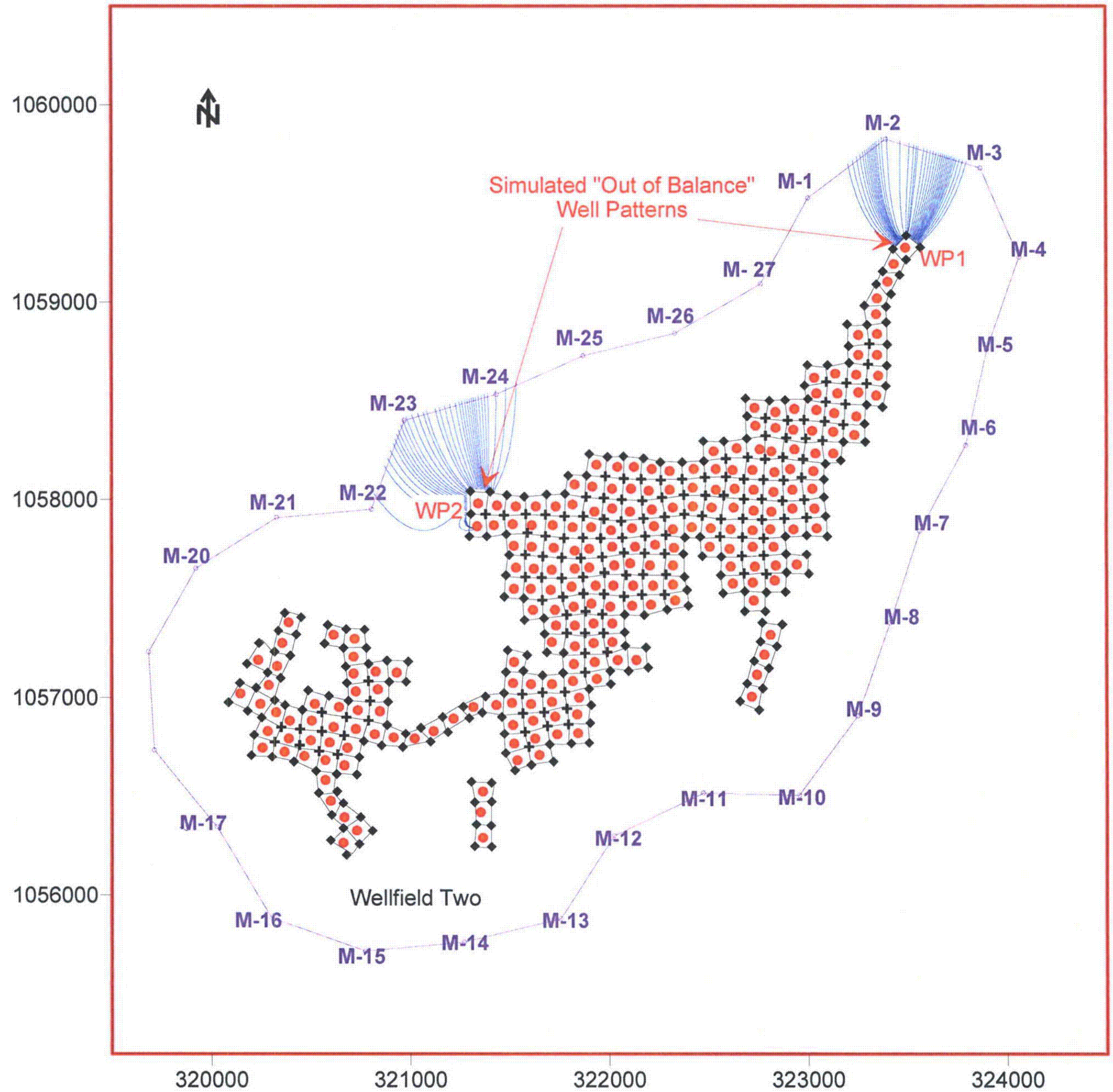
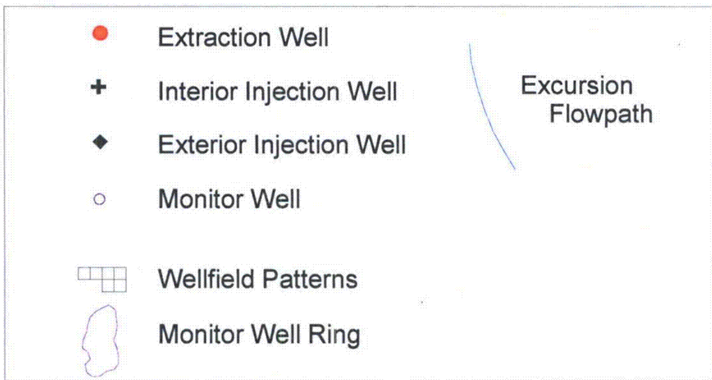
URANIUM ONE

Figure 1. Wellfield Two Layout
Well Patterns and Monitor Ring
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig1MRExcursion.srf Date: 10/10/09





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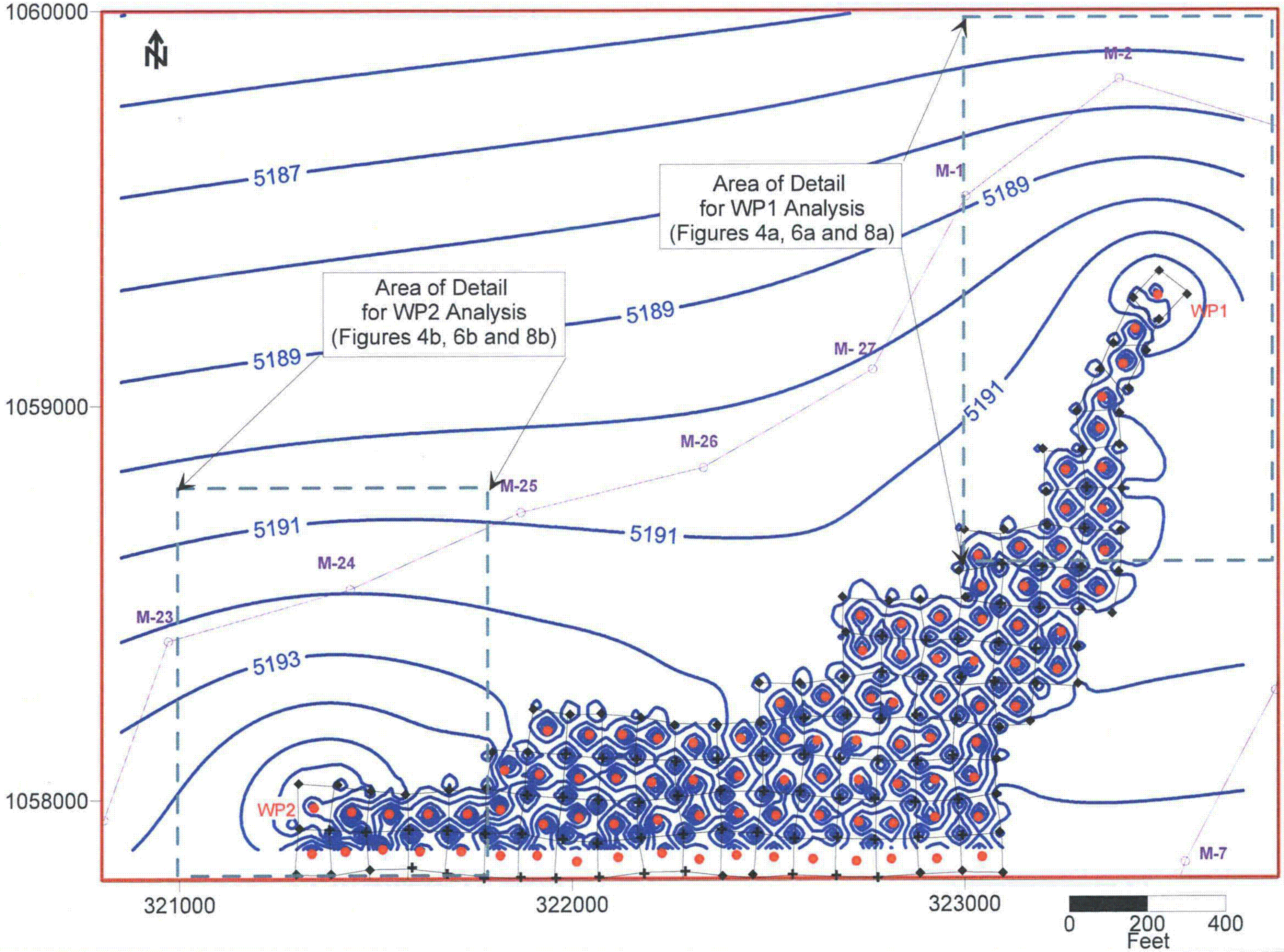
URANIUM ONE

Figure 2. Simulated Excursion Flowpaths
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig2MRExcursion.srf Date: 10/10/09



Extraction Well
Interior Injection Well
Exterior Injection Well
Monitor Well
Wellfield Patterns
Monitor Well Ring
Potentiometric Surface (ft amsl)
Contour Interval = 1 foot

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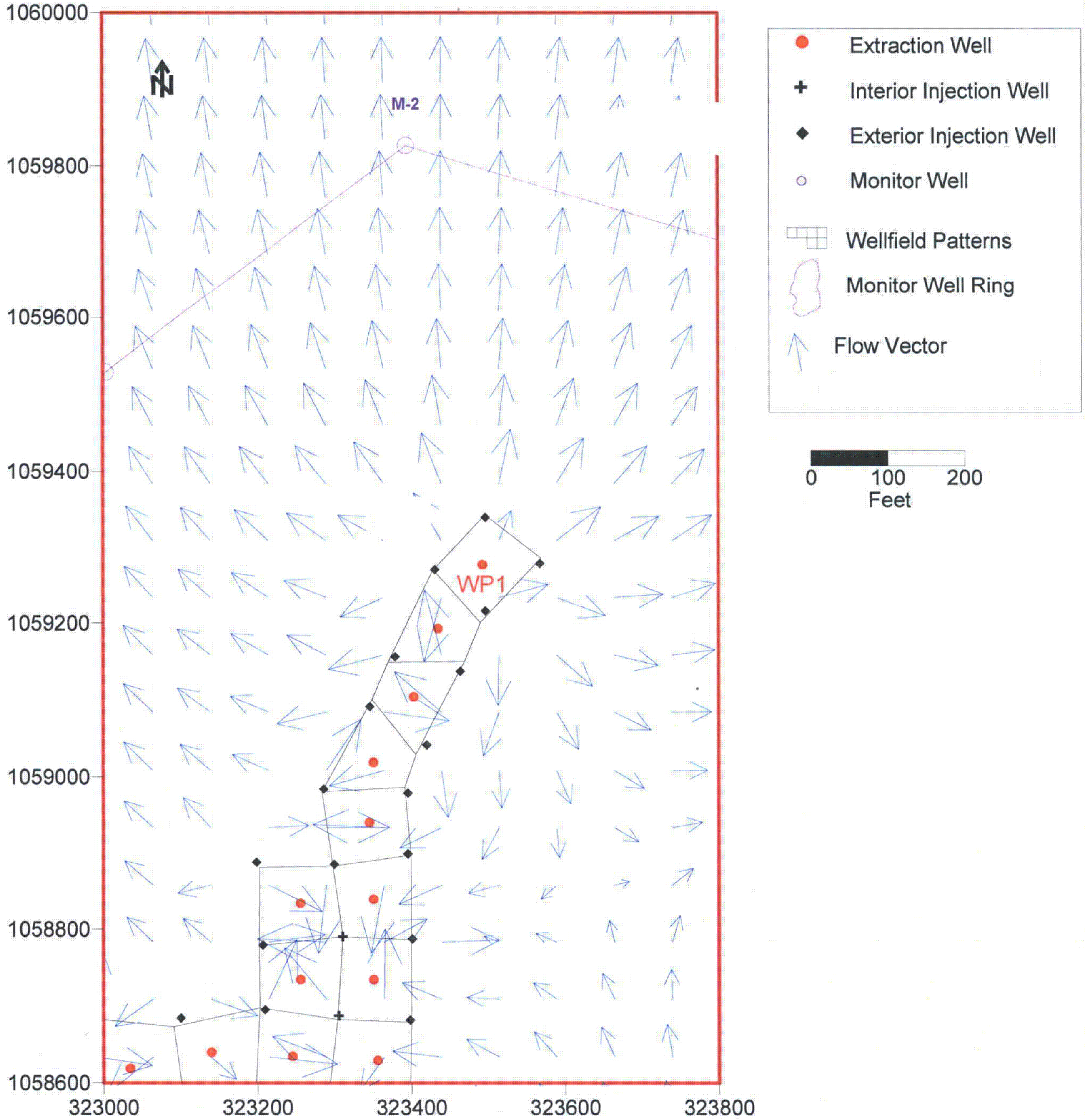
Figure 3. Simulated Potentiometric Surface In the 70 Sand During Excursion Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig3MRExcursion.srf Date: 10/10/09



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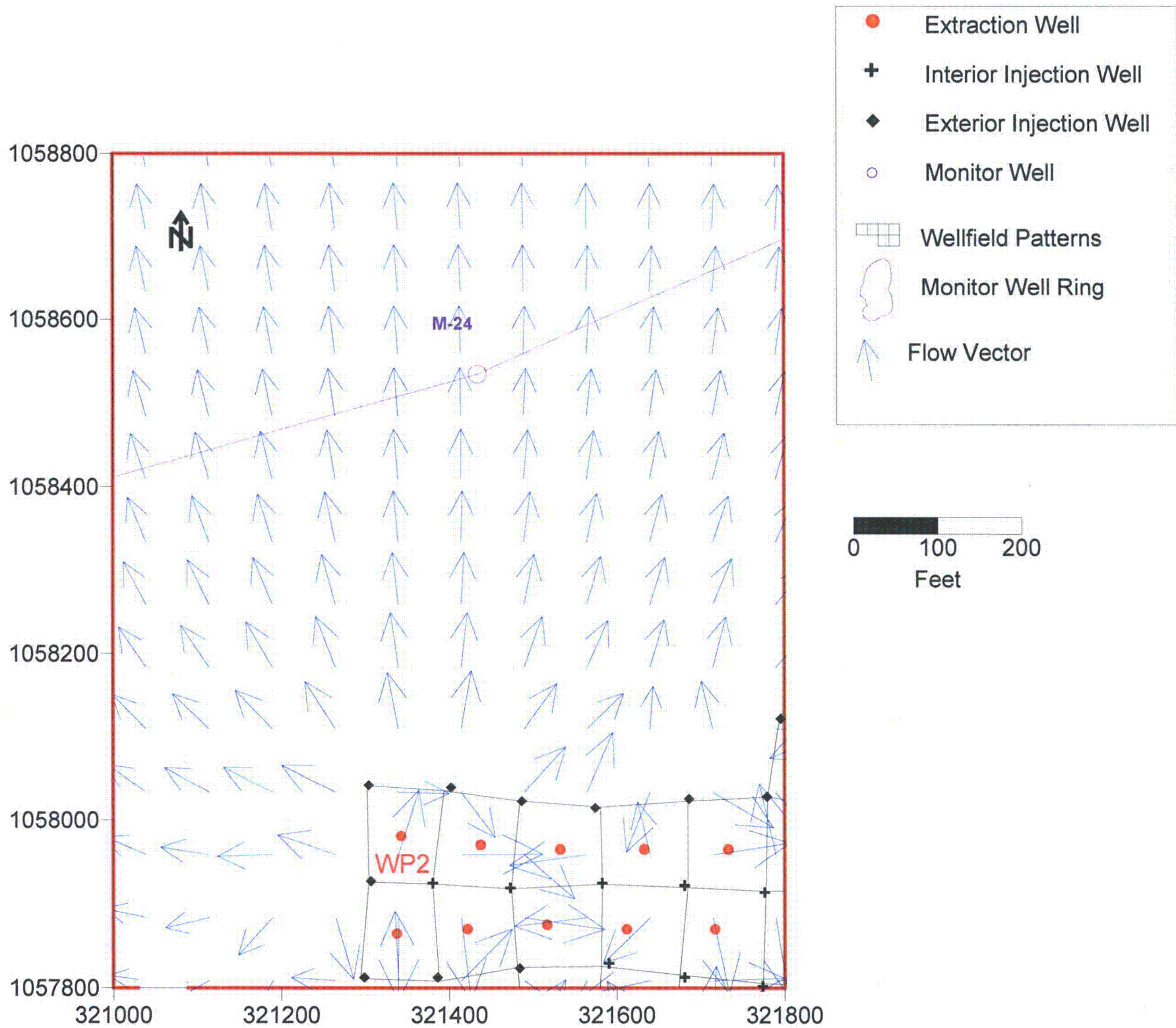
URANIUM ONE

Figure 4a. Vector Analysis-Well Pattern 1 (WP1) During Simulated Excursion Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig4aMRExcursion.srf Date: 10/10/09



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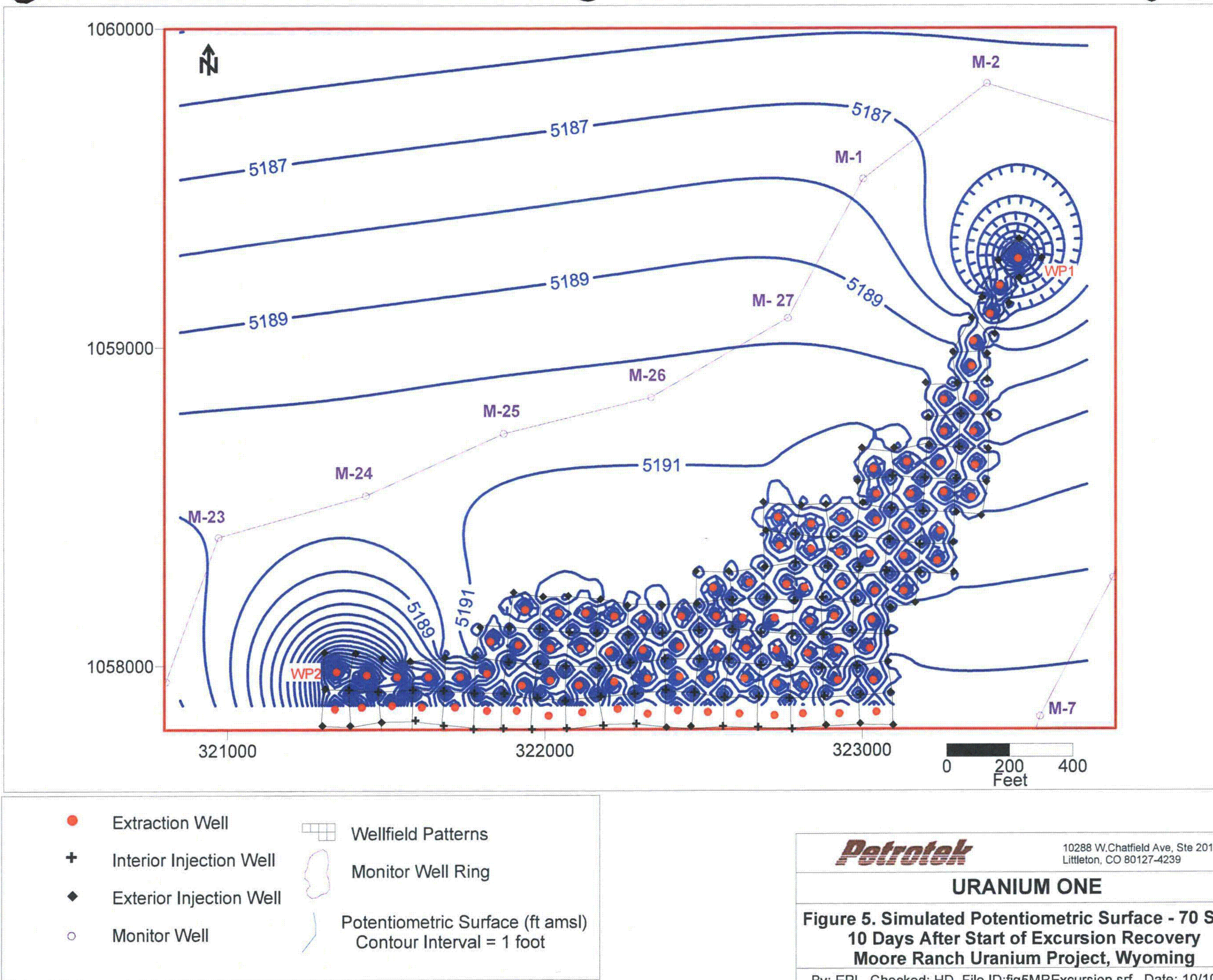
URANIUM ONE

Figure 4b. Vector Analysis - Well Pattern 2 (WP2) During Simulated Excursion Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig4bMRExcursion.srf Date: 10/10/09



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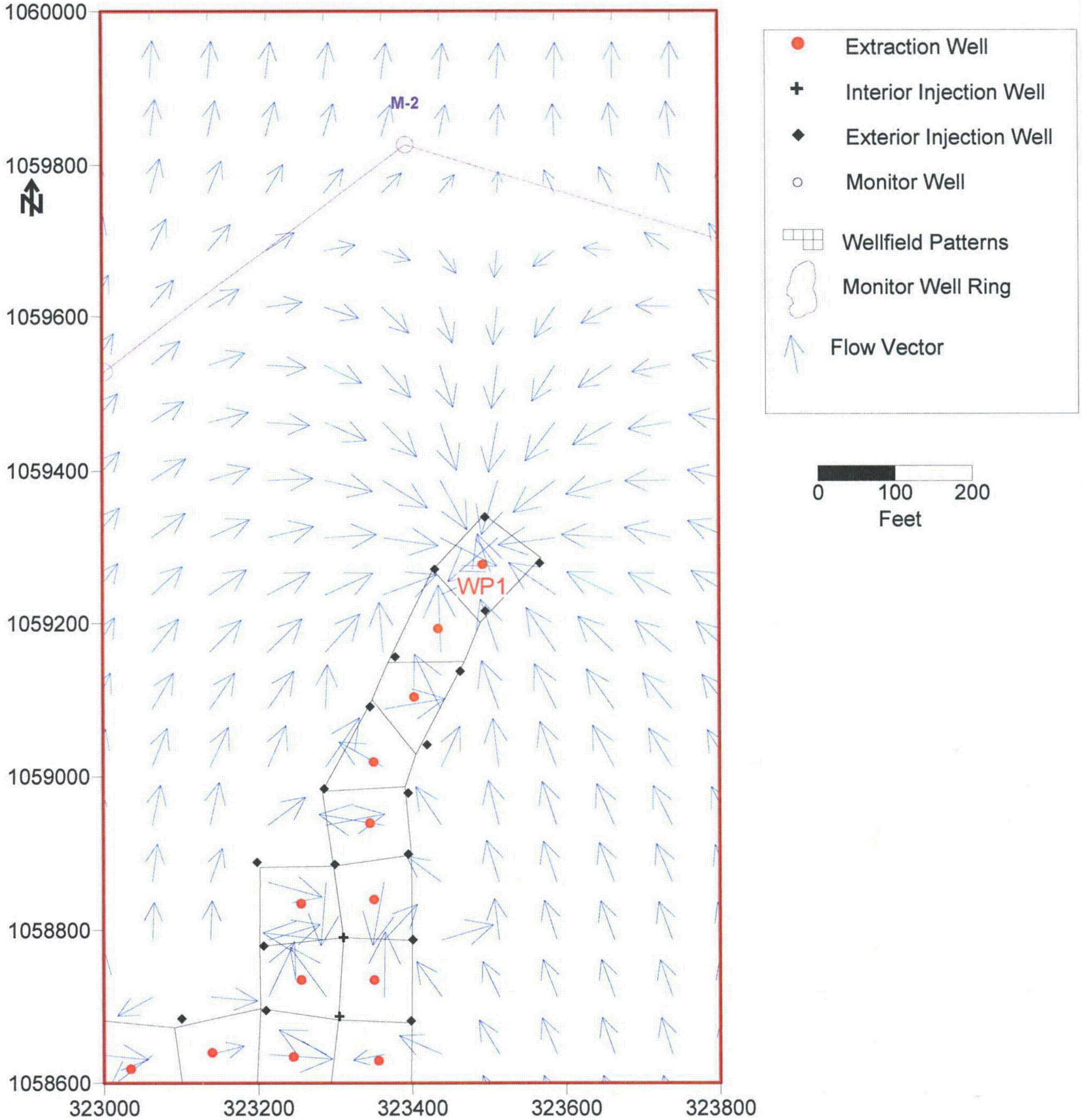
URANIUM ONE

Figure 5. Simulated Potentiometric Surface - 70 Sand
10 Days After Start of Excursion Recovery
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig5MRExcursion.srf Date: 10/10/09



Excursion Recovery Simulation

Extraction Well in WP1 at 40 gpm
3 Injection Wells turned off (reduction of 18 gpm)
Net increase in pumping rate of 38 gpm
Other Wells at typical Production Rates

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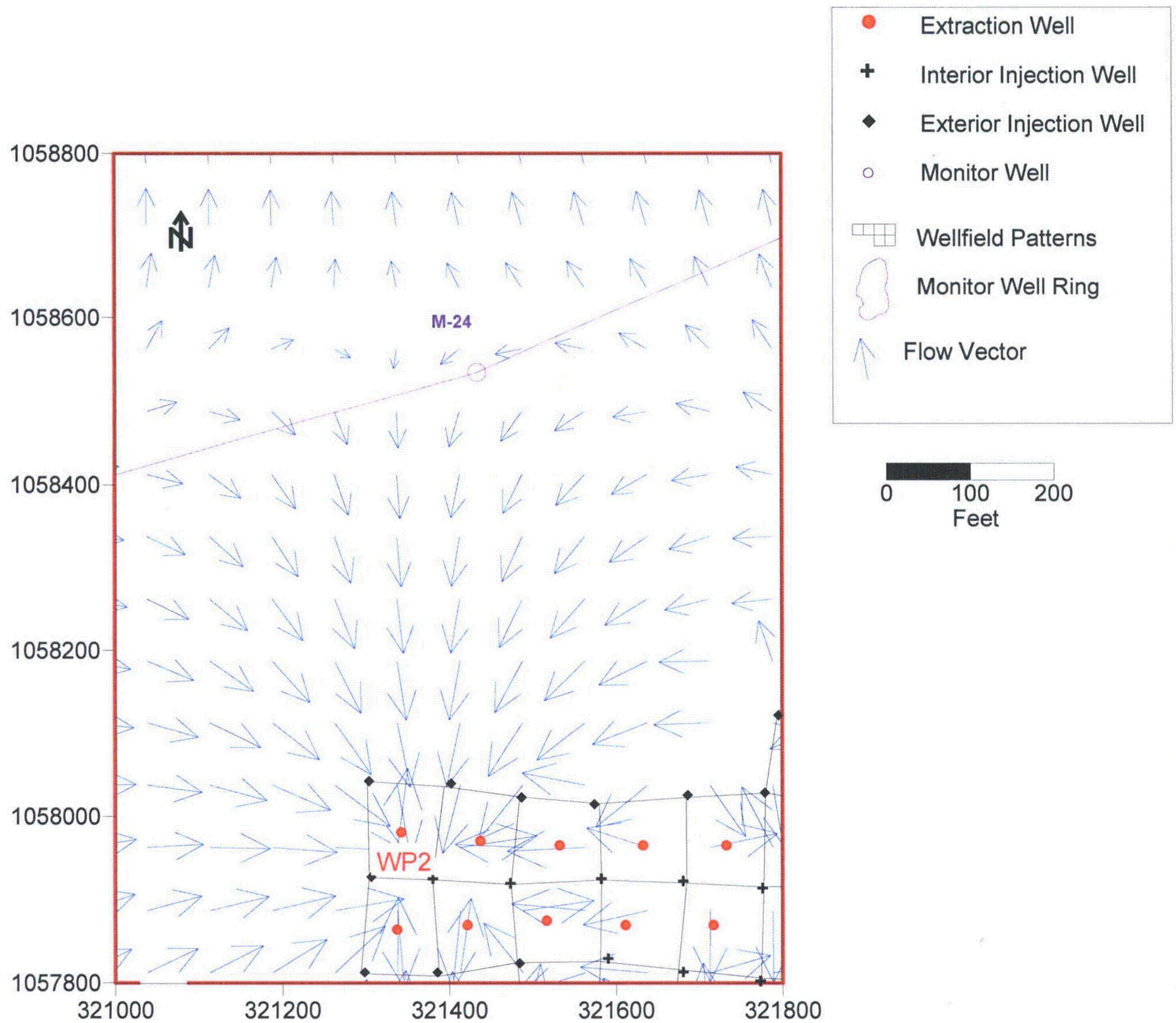
URANIUM ONE

Figure 6a. Vector Analysis - Well Pattern 1 (WP1)
10 Days After Start of Excursion Recovery
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig6aMRExcursion.srf Date: 10/10/09



Excursion Recovery Simulation

Extraction Well in WP2 and in 3 surrounding Well Patterns operating at 30 gpm each
5 Injection Wells turned off (reduction of 38 gpm)
Net increase in pumping rate of 78 gpm
Other Wells at typical Production Rates

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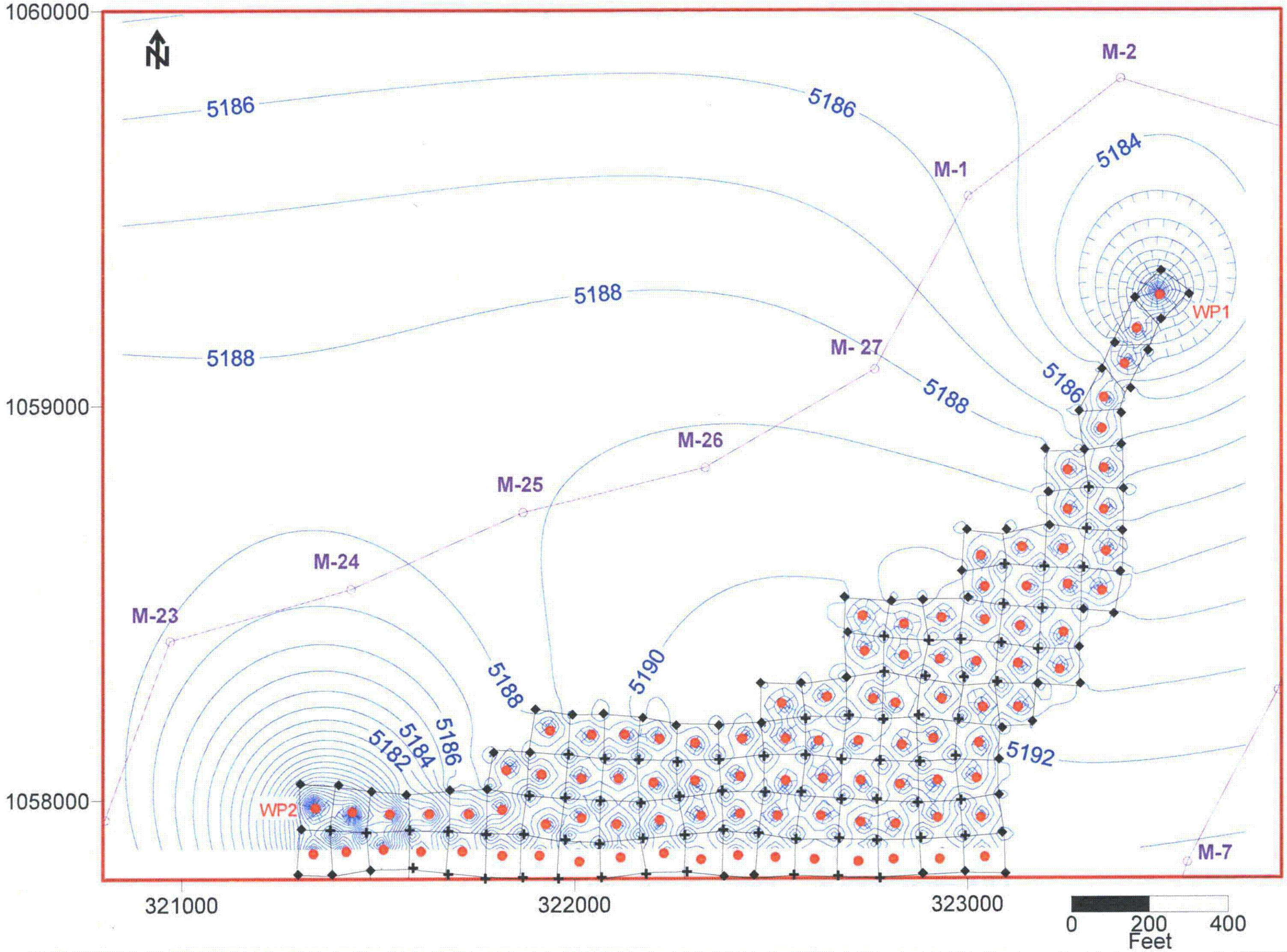
URANIUM ONE

Figure 6b. Vector Analysis - Well Pattern 2 (WP2) 10 Days After Start of Excursion Recovery Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig6bMRExcursion.srf Date: 10/10/09



Extraction Well
Interior Injection Well
Exterior Injection Well
Monitor Well
Wellfield Patterns
Monitor Well Ring
Potentiometric Surface (ft amsl)
Contour Interval = 1 foot

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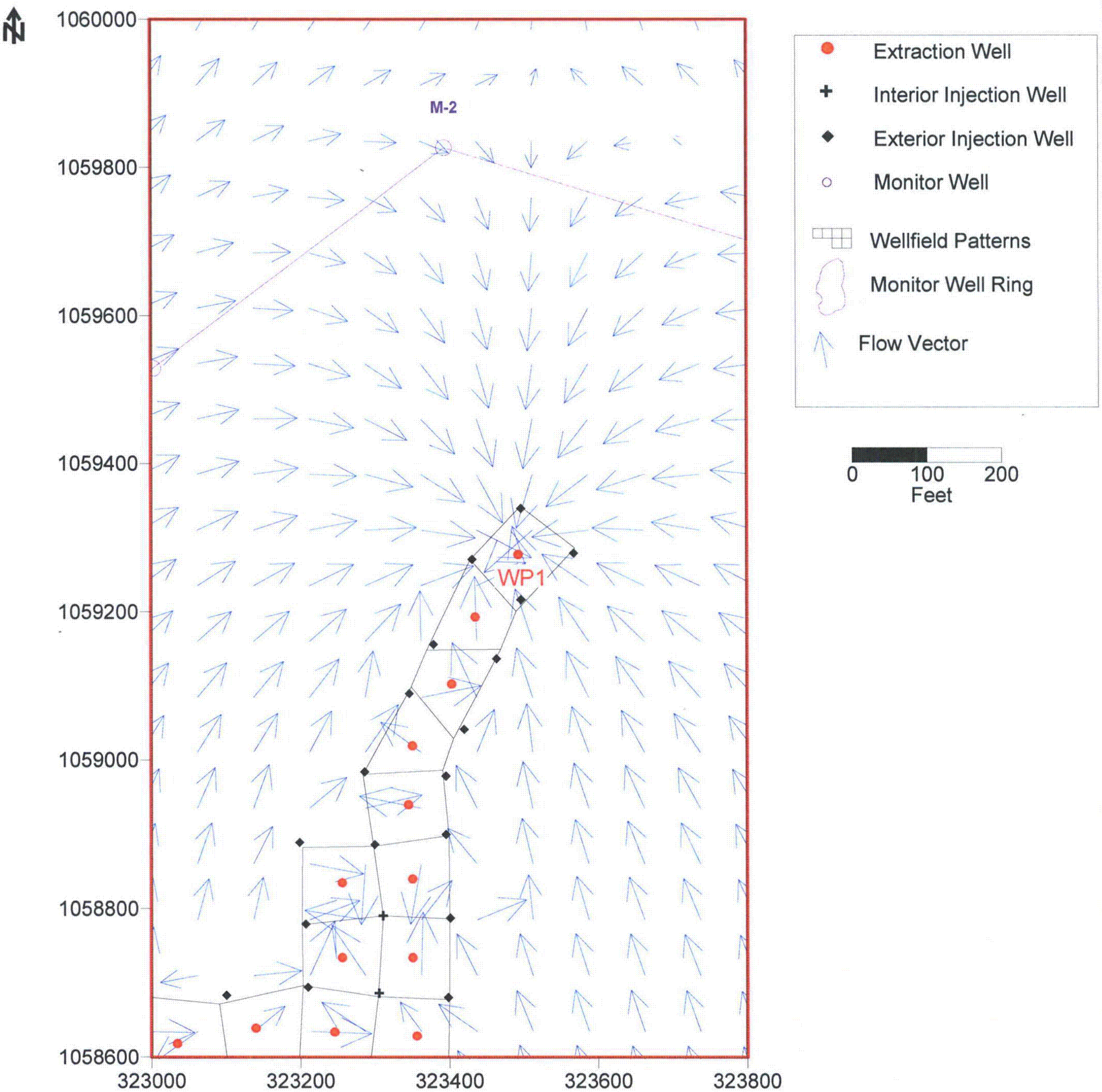
URANIUM ONE

Figure 7. Simulated Potentiometric Surface - 70 Sand 30 Days After Start of Excursion Recovery Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig7MRExcursion.srf Date: 10/10/09



Excursion Recovery Simulation

Extraction Well in WP1 at 40 gpm
3 Injection Wells turned off (reduction of 18 gpm)
Net increase in pumping rate of 38 gpm
Other Wells at typical Production Rates

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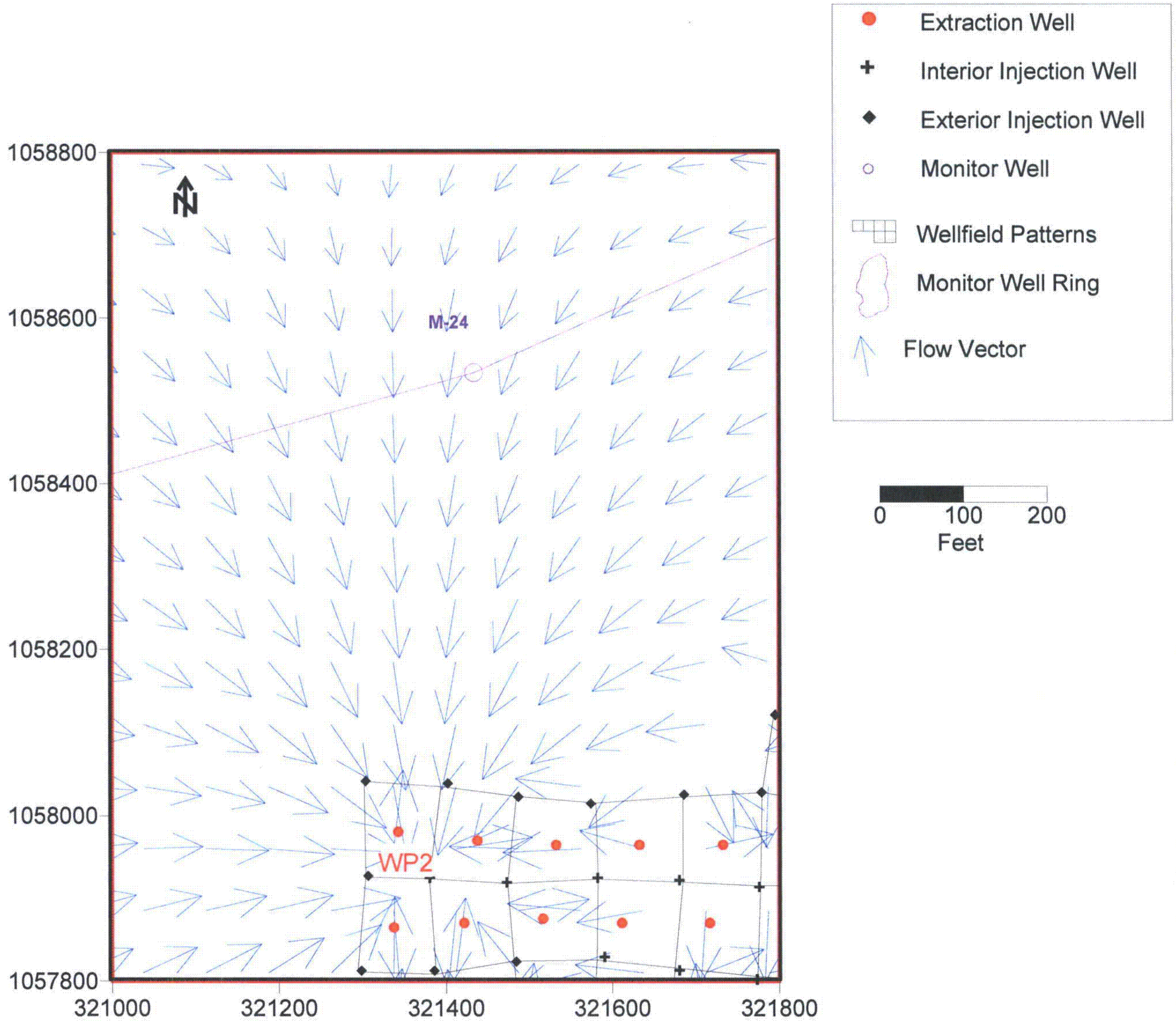
URANIUM ONE

Figure 8a. Vector Analysis-Well Pattern 1 (WP1)
30 Days After Start of Excursion Recovery
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig8aMRExcursion.srf Date: 10/10/09



Excursion Recovery Simulation

Extraction Well in WP2 and in 3 surrounding Well Patterns operating at 30 gpm each
5 Injection Wells turned off (reduction of 38 gpm)
Net increase in pumping rate of 78 gpm
Other Wells at typical Production Rates

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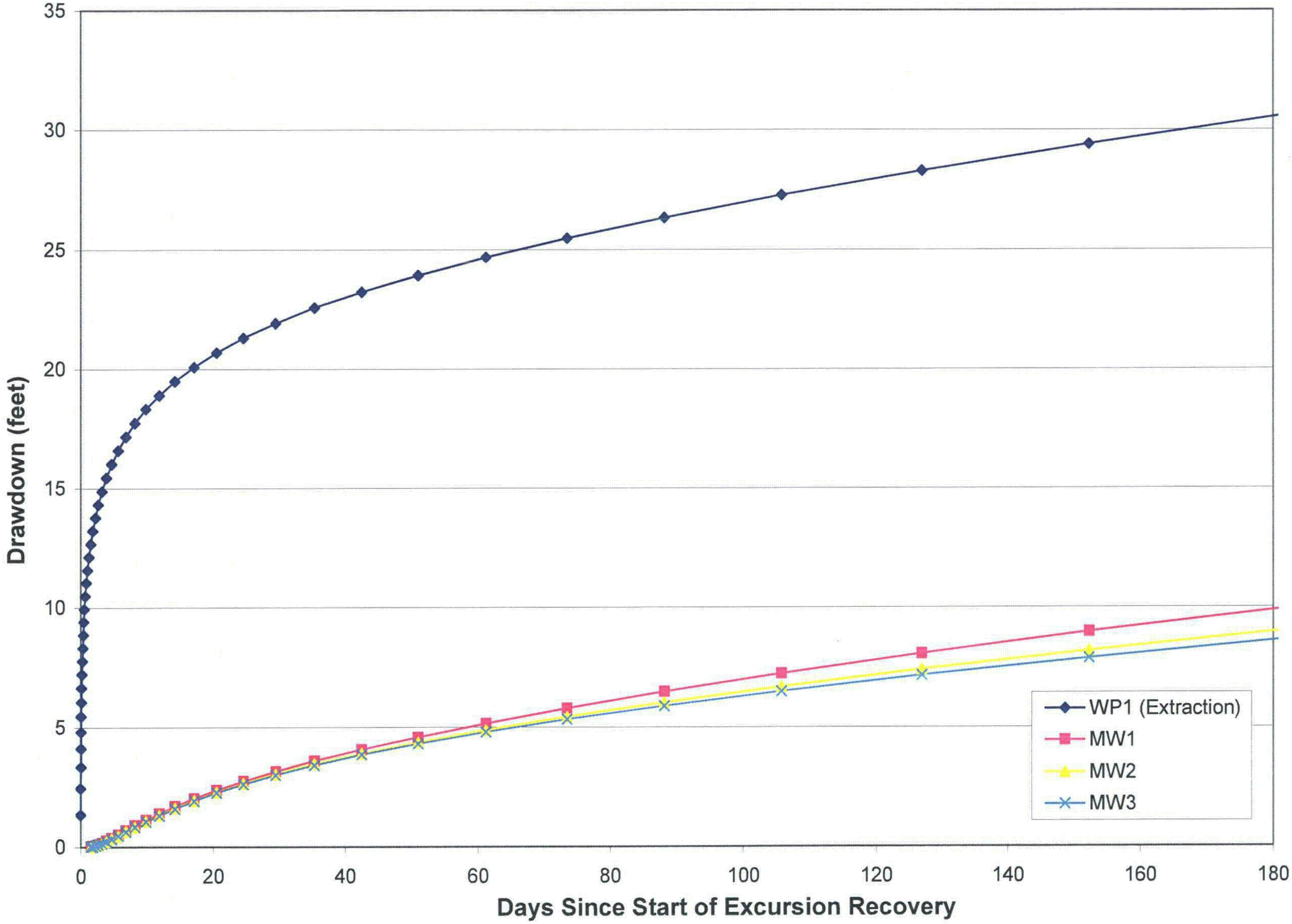
URANIUM ONE

Figure 8b. Vector Analysis-Well Pattern 2 (WP2)
30 Days After Start of Excursion Recovery
Moore Ranch Uranium Project, Wyoming

By: EPL Checked: HD File ID:fig8bMRExcursion.srf Date: 10/10/09



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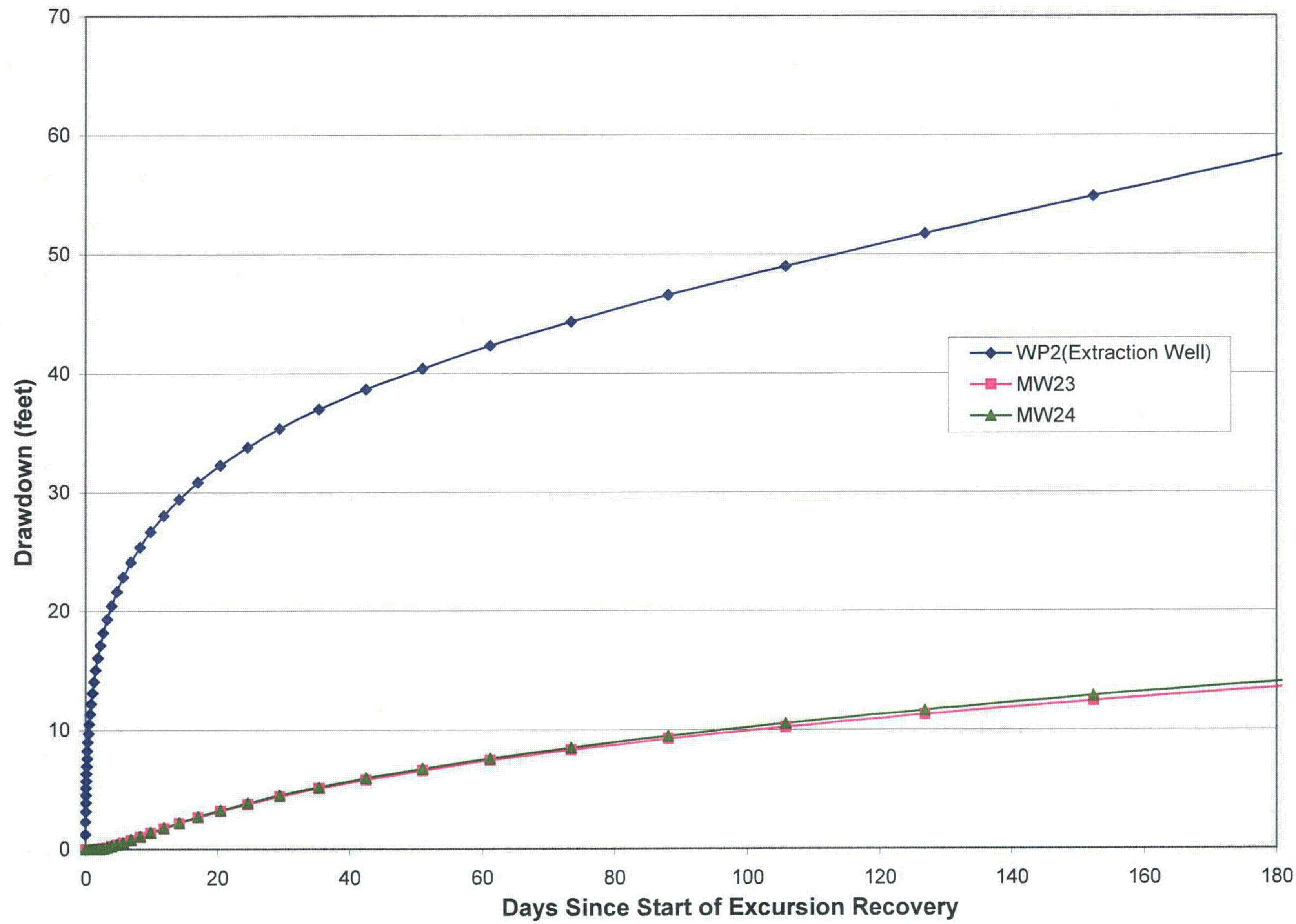
URANIUM ONE

Figure 9. Simulated Drawdown During Excursion Recovery
Well Pattern 1 Extraction Well and Monitor Ring Wells MW1, MW2 and MW3
Moore Ranch Uranium Project, Wyoming

By: EPL	Checked: HD	File ID:fig9excursion.srf	Date: 10/10/09



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URANIUM ONE

Figure 10. Simulated Drawdown During Excursion Recovery Well Pattern 2 Extraction Well and Monitor Ring Wells MW23 and MW24 Moore Ranch Uranium Project, Wyoming

By: EPL | Checked: HD | File ID:fig110recovery.srf | Date: 10/08/09

Hydrology Open Issue No. 9
The behavior of the 70 sand during operation has not been adequately assessed in the area where it coalesces with the 68 sand
May 11 2009 Teleconference

Open Issue discussion:

The groundwater flow model simulations conducted by EMC use a single layer model to represent the "70 sand." NRC staff notes this assumption is appropriate for the smaller five spot groundwater flow model which covered areas of the wellfields where the "70 sand" and "68 sand" do not coalesce. However, in the northeastern and central portion of Wellfield 2, the "70 sand" coalesces with the "68 sand." For these areas the single layer model might not be adequate and it may be necessary to create a multi-layer aquifer model to determine how the drawdown is propagated across the ore zone to the monitoring well ring as the thickness of the aquifer is the combined thickness of the 68 and 70 sands. In this scenario, the drawdown may be less and the cone of depression may not reach to the monitoring well ring.

Answer: A pump test was conducted in the 68 Sand near the area where confinement is absent to assess aquifer properties of that hydrostratigraphic unit. Results of the pump test indicate that the transmissivity of the 68 Sand is two to three orders of magnitude lower than the transmissivity of the overlying 70 Sand. The large difference in transmissivity (and hydraulic conductivity) implies that groundwater flow patterns within the 70 Sand during ISR operations will be dominated by horizontal flow, with minimal exchange between the 68 and 70 Sands. Numerical modeling was performed to simulate hydraulic stresses and responses that will occur during ISR operations in the area where the confining unit is absent. The numerical modeling confirms that minimal flow will occur into or out of the 68 Sand during ISR production and restoration operations. Net flow between the two sands in a simulation of a small scale wellfield (9 recovery wells, 16 injection wells, with recovery of 180 gpm and injection of 178.2 gpm) with no confining unit, was less than 0.1 ft^3/d (5.2 E-04 gpm). Based on the pump test results and numerical model simulations, impacts to the 70 Sand where the 68 and 70 Sands coalesce are anticipated to be minimal during ISR production and restoration operations at the rates projected in the WDEQ Permit to Mine Application and the NRC License Application. Additional discussion and results of the modeling are presented in the Technical Memorandum Evaluation of Potential Impacts to the 68 Sand from ISR Production in Wellfield 2, Moore Ranch Uranium Project, Wyoming (Petrotek, October 2009). Input and output model files are also provided for review.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

The License Application Technical Report will be revised to incorporate the Technical Memorandum. *Evaluation of Potential Impacts to the 68 Sand from ISR Production in Wellfield 2, Moore Ranch Uranium Project, Wyoming (Petrotek, October 2009)* as Appendix B6. This Technical Memorandum is presented in Hydrology Open Issue No.4.

Hydrology Open Issue No. 10
The description and use of downhole gas spargers at Moore Ranch is not provided
May 11 2009 Teleconference

Open Issue discussion:

In the discussion of how oxygen dissolution was controlled in another unconfined ISR operation, it was stated that downhole gas spargers were used. If they are to be used at Moore Ranch, their physical and functional description must be included in the application.

Answer: There is no plan to utilize downhole gas spargers at Moore Ranch.

Proposed Revisions to License Application

There are no changes proposed to the license application in response to this Open Issue.

Hydrology Open Issue No. 11
The impact of operations on the 68 sand where it coalesces with the 70 sand is not provided
May 11 2009 Teleconference

Open Issue discussion:

The field testing and groundwater flow simulation results presented by EMC assess the behavior of the "70 sand" unconfined aquifer. However, it is unknown how the "68 sand" will be impacted by operations in the area where the "70 sand" and the "68 sand" coalesce as EMC did not include this layer in the simulations.

Answer: A pump test was conducted in the 68 Sand near the area where confinement is absent to assess aquifer properties of that hydrostratigraphic unit. Results of the pump test indicate that the transmissivity of the 68 Sand is two to three orders of magnitude lower than the transmissivity of the overlying 70 Sand. The large difference in transmissivity (and hydraulic conductivity) implies that groundwater flow patterns within the 70 Sand during ISR operations will be dominated by horizontal flow, with minimal exchange between the 68 and 70 Sands. Numerical modeling was performed to simulate hydraulic stresses and responses that will occur during ISR operations in the area where the confining unit is absent. The numerical modeling confirms that minimal flow will occur into or out of the 68 Sand during ISR production and restoration operations. Additional discussion is presented in the Technical Memorandum. Evaluation of Potential Impacts to the 68 Sand from ISR Production in Wellfield 2, Moore Ranch Uranium Project, Wyoming (Petrotek, October 2009). Input and output model files are also provided for review.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

The License Application Technical Report will be revised to incorporate the Technical Memorandum. *Evaluation of Potential Impacts to the 68 Sand from ISR Production in Wellfield 2, Moore Ranch Uranium Project, Wyoming (Petrotek, October 2009)* as Appendix B6. This Technical Memorandum is presented in Hydrology Open Issue No.4

Hydrology Open Issue No. 12
The location of monitoring wells in the 60 sand where it is the underlying aquifer is not provided
May 11 2009 Teleconference

Open Issue discussion:

Monitoring wells will be established in the "72 sand" overlying aquifer and "68 sand" underlying aquifer on four-acre spacing for the proposed wellfields to detect vertical excursions. In the areas where the "68 sand" and the "70 sand" coalesce in Wellfield 2, EMC stated that it would treat them as one aquifer. It would, therefore, install additional monitoring wells in the "68 sand" to provide additional monitoring capabilities to detect any impacts outside of the area where the two sands coalesce. EMC also stated it would install monitoring wells in the underlying "60 sand" in the region where the 68 and 70 sand coalesce in Wellfield 2 at a spacing of one every four acres. EMC indicated the location of these underlying wells will be determined during wellfield planning and submitted to WDEQ in the wellfield hydrologic data package. Without reviewing the number and location of these wells, NRC staff cannot be assured that they will provide adequate monitoring of this region of Wellfield 2.

Answer: The 60 Sand is the underlying aquifer in the areas where the confining unit between the 68 and 70 sand is absent. An isopach map of the confining unit between the 68 and 70 Sands is shown on Figures 2.6-17 and 2.6-18. The area where the sands coalesce is indicated where the confining unit is absent (area inside the zero contour line). In the portions of Wellfield 2 where the 70 and 68 sands coalesce, the 60 Sand will be considered the underlying aquifer. Monitor wells will be placed in the underlying 60 Sand in the areas where the 70 and 68 sand coalesce at a spacing of 1 well per 4 acres. The number and location of these underlying wells will be determined during final wellfield planning.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

Under Section 2.6.2 Site Geology, next to last paragraph in the section

Figure 2.6-16 is an isopach map of the production 70 sand. In the vicinity of monitor well UMW-2 the sand thickens and coalesces with the underlying 68 sand. Isopach maps of the underlying shale (Figures 2.6-17 and 2.6-18) illustrate the disappearance of this shale in a small area around UMW-2 and a larger area just to the northeast of UMW-2 (see also cross sections C-C' and G-G').

Under Section 5.7.8.2 Groundwater Monitoring

Monitor wells will be installed within the overlying aquifer (72-Sand) and underlying aquifer (68-sand) at a density of one well per every four acres of pattern area. These wells will be used to obtain baseline water quality data to be used in the development of UCL's for these zones. In the areas of Wellfield 2 where a confining unit exists between the 70 and 68 sands, monitor wells will be placed in the 68 sand at the spacing described in this section (1 per 4 acres). Additional monitor wells may be placed around the area where the two sands coalesce to provide increased monitoring of any potential impacts to areas of the 68 sand outside of the coalescing area. Monitor wells will be placed in the underlying 60 sand in the areas where the 70 and 68 sand coalesce at a spacing of 1 well per 4 acres. The final number and location of these underlying wells will be determined during final wellfield planning and submitted to the WDEQ-LQD in the Wellfield Package.

Figure 2.6-17

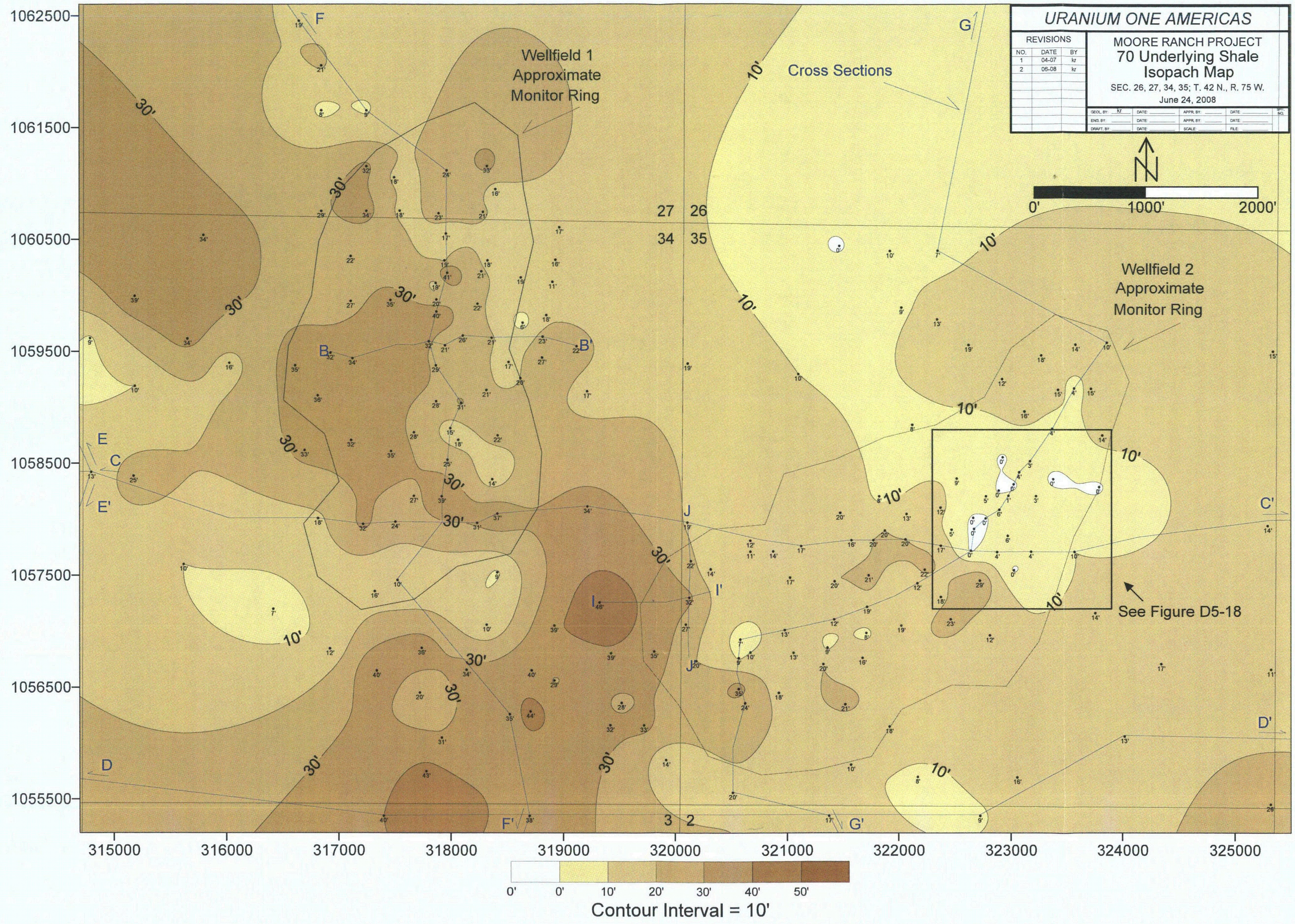
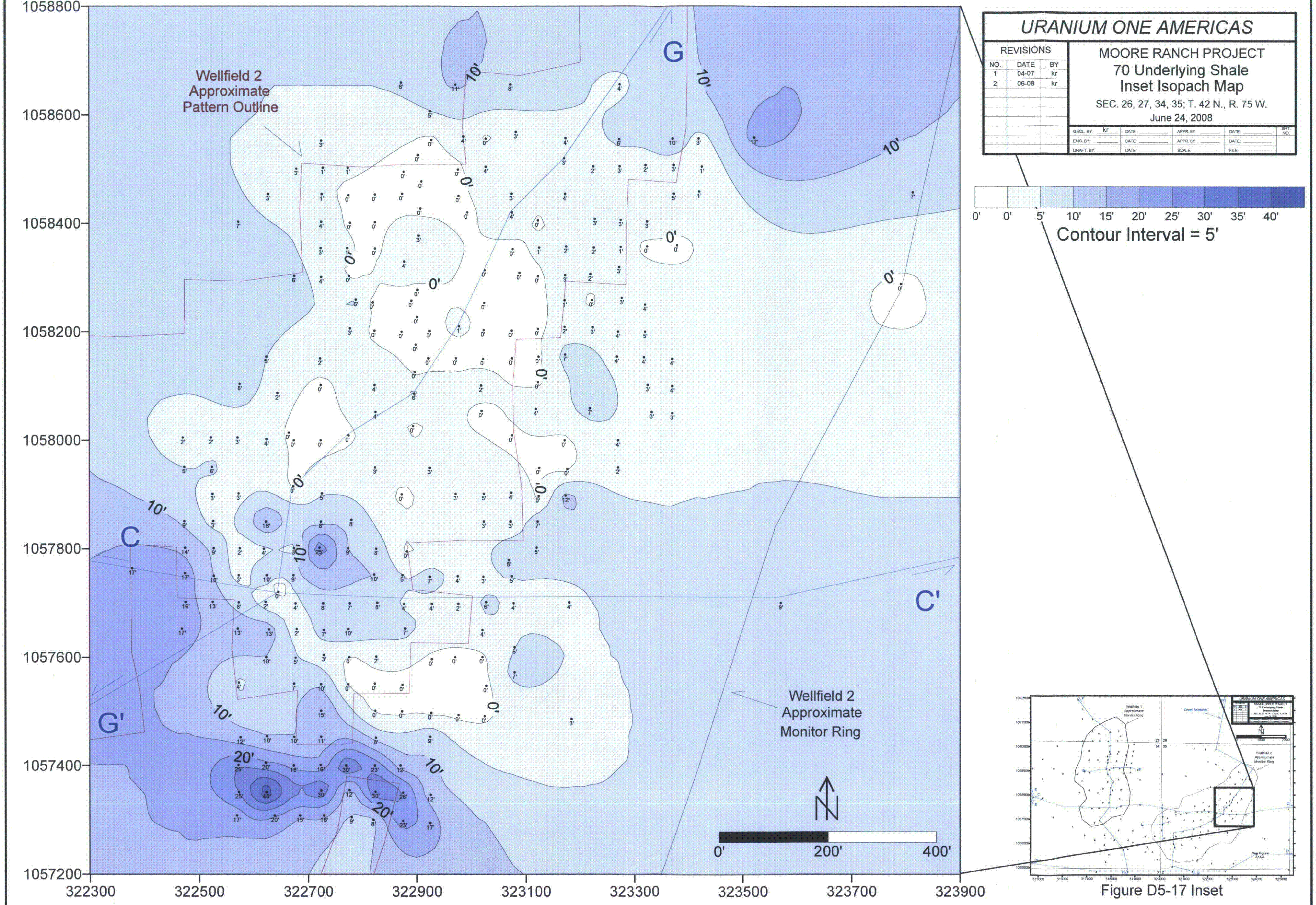

URANIUM ONE AMERICAS
REVISIONS
NO. DATE BY
1 04-07 kr
2 06-08 kr
MOORE RANCH PROJECT
70 Underlying Shale Isopach Map
SEC. 26, 27, 34, 35; T. 42 N., R. 75 W.
June 24, 2008
N
0' 1000' 2000'
Wellfield 1 Approximate Monitor Ring
Wellfield 2 Approximate Monitor Ring
Cross Sections
See Figure D5-18
27 26
34 35
3 2
1062500
1061500
1060500
1059500
1058500
1057500
1056500
1055500
315000
316000
317000
318000
319000
320000
321000
322000
323000
324000
325000
0' 0' 10' 20' 30' 40' 50'
Contour Interval = 10'

Figure 2.6-18



URANIUM ONE AMERICAS
REVISIONS
NO. | DATE | BY
1 | 04-07 | kr
2 | 06-08 | kr
MOORE RANCH PROJECT
70 Underlying Shale
Inset Isopach Map
SEC. 26, 27, 34, 35; T. 42 N., R. 75 W.
June 24, 2008
Wellfield 2
Approximate
Pattern Outline
Wellfield 2
Approximate
Monitor Ring
G
G'
C
C'
0' 0' 5' 10' 15' 20' 25' 30' 35' 40'
Contour Interval = 5'
0' 200' 400'
1058800
1058600
1058400
1058200
1058000
1057800
1057600
1057400
1057200
322300 322500 322700 322900 323100 323300 323500 323700 323900
Figure D5-17 Inset

Hydrology Open Issue No. 13
The proposed excursion indicators for the overlying 72 sand may not distinguish effects from CBM water
May 11 2009 Teleconference

Open Issue discussion:

EMC has proposed the use of chloride, conductivity and total alkalinity for excursion indicators in the overlying "72 sand." The "72 sand" may have been impacted in the past by CBM produced water discharge and may also be impacted in the future. CBM discharge, as described in the application, contains high values of TDS and bicarbonate which can influence the values of conductivity and alkalinity. EMC stated that, based on its analysis of water quality in the "72 sand" at four monitoring wells across the wellfields, there is currently no apparent impact from CBM produced water and concluded these indicators are appropriate. EMC has not demonstrated that this monitoring is sufficient to make this conclusion for all of the "72 sand." Such a determination may only be made after a thorough baseline evaluation of the water quality of the "72 sand" has been conducted to determine if there are areas of impact, especially near CBM discharge points. EMC may need to propose other excursion indicators in areas which have been impacted to distinguish between CBM produced water effects and future ISL operation spills, leaks or excursions on the "72 sand."

Answer: The currently proposed excursion indicator parameters should be adequate to identify that an impact has occurred to groundwater from either ISR or CBM activities. Once an indication of impacts is observed, additional investigation is triggered to determine the cause of the impact, whether it is from ISR activities, CBM activities or some other source. Once an impact has been identified, additional indicator parameters will be evaluated including, but not limited to, dissolved uranium.

Baseline uranium levels within the permit area in the production, overlying and underlying aquifers are variable but generally less than 1 mg/L. More importantly, uranium levels within the 72 sand tend to be very low, generally less than 0.01 mg/l. Average post mining uranium concentration at Irigaray (closest analog) was greater than 7 mg/l. Although CBM water quality does not typically include uranium as an analyte, it is unlikely that levels would approach ISR mining influenced waters. Once an impact is indicated based on changes to the indicator parameters, additional sampling for dissolved uranium could provide further identification as to the source of the change.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

Insert the following in the TR Section 5.7.8.2

- Operational Upper Control Limits and Excursion Monitoring

After baseline water quality is established for the monitor wells for a particular production unit, upper control limits (UCLs) are set for chemical constituents which would be indicative of a migration of lixiviant from the well field. The constituents chosen for indicators of lixiviant migration and for which UCLs will be set are chloride, conductivity, and total alkalinity. Chloride was chosen due to its low natural levels in the native groundwater and because chloride is introduced into the lixiviant from the ion exchange process (uranium is exchanged for chloride on the ion exchange resin). Chloride is also a very mobile constituent in the groundwater and will show up very quickly in the case of a lixiviant migration to a monitor well. Conductivity was chosen because it is an excellent general indicator of overall groundwater quality. Total alkalinity concentrations should be affected during an excursion as bicarbonate is the major constituent added to the lixiviant during mining. Water levels are obtained and recorded prior to each well sampling. However, water levels are not used as an excursion indicator. Upper control limits will be set at the baseline mean concentration plus five standard deviations for each excursion indicator. For chloride with a low baseline mean and little noted variation during baseline sampling, the UCL may be determined by adding 15 mg/l to the baseline mean if that value is greater than the baseline mean plus five standard deviations.

The currently proposed excursion indicator parameters should be adequate to identify that an impact has occurred to groundwater from either ISR or CBM activities. Once an indication of impacts is observed, additional investigation is triggered to determine the cause of the impact, whether it is from ISR activities, CBM activities or some other source. Once an impact has been identified, additional indicator parameters will be evaluated including, but not limited to, dissolved uranium.

Baseline uranium levels within the permit area in the production, overlying and underlying aquifers are variable but generally less than 1 mg/L. More importantly, uranium levels within the 72 sand tend to be very low, generally less than 0.01 mg/l. Average post mining uranium concentration at Irigaray (closest analog) was greater than 7 mg/l. Although CBM water quality does not typically include uranium as an analyte, it is unlikely that levels would approach ISR mining influenced waters. Once an impact is indicated based on changes to the indicator parameters, additional sampling for dissolved uranium could provide further identification as to the source of the change.

Operational monitoring consists of sampling the monitor wells at least twice monthly and at least 10 days apart and analyzing the samples for the excursion indicators chloride, conductivity, and total alkalinity. EMC 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, EMC will document the cause and the duration of any delays.

Hydrology Open Issue No. 14
NRC review of hydrologic data packages
May 11 2009 Teleconference

Open Issue discussion:

The Moore Ranch site contains numerous unique aspects to its operation, many of which will only be resolved during hydrologic testing. NRC staff review of the hydrologic testing is essential to resolve these issues. EMC should, therefore, provide the hydrologic data package for each wellfield to NRC for review and approval.

Answer:

The NRC conference call summary dated May 26, 2009 incorrectly stated that EMC agreed to provide this information. Rather, EMC agreed to address this issue. The purpose of the license application is to provide NRC with adequate information concerning the site-specific conditions and the applicants proposed approach to allow NRC to issue a license for uranium recovery operations. EMC agrees that Moore Ranch contains unique aspects including unconfined conditions in a portion of Wellfield 2. However, these aspects were considered in the original application and in additional hydrologic evaluations provided by EMC in responses to the Technical Report Request for Additional Information (RAI) in 2008. This additional information included hydrologic testing and groundwater modeling to assess the feasibility of operations and groundwater restoration at the Moore Ranch project.

Question 5-12 (e) of the 2008 RAI indicated that the reason for this request was that groundwater protection issues for ISR facilities have a high level of public interest and NRC must retain a role in groundwater protection for new licensees. In the RAI response dated October 27, 2008, EMC replied that this request by NRC staff undercut the purpose of performance based licensing, that NRC has limited staff to review these data packages, and that the Safety and Environmental Review Panel (SERP) process included in the Moore Ranch application ensures that any new wellfield approved at Moore Ranch must fall within the bounding analysis performed by NRC during the licensing process and that SERP deliberations are submitted annually to NRC and are available for review on site. EMC also noted that the wellfield data packages are reviewed and approved by the Wyoming Department of Environmental Quality - Land Quality Division and that staff has been directed by the Commission to rely on State Underground Injection Control (UIC) programs to the extent possible to relieve unnecessary "dual jurisdiction" over wellfields. EMC continues to believe that NRC should not abandon the performance-based licensing approach to wellfield development.

Proposed Revisions to License Application

No changes are proposed to the license application in response to this Open Issue.

Hydrology Open Issue No. 15
The potential for corrective actions for excursions resulting in excessive aquifer dewatering is not resolved
May 11 2009 Teleconference

Open Issue discussion:

Once an excursion is verified, EMC will implement corrective actions. These include an investigation of probable cause, adjusting production/injection rates to produce an inward gradient away from the offending well, pumping individual wells to recovery more lixiviant, or suspending injection in the area adjacent to the well on excursion. EMC stated that an excursion could be reversed within a relatively short period of time. NRC staff is concerned that pumping of the aquifer to capture an excursion could lead to excessive dewatering. EMC stated that additional simulations would be performed using the groundwater flow model to demonstrate recovery of excursions; however, it did not simulate any excursion capture scenarios to support this assertion. EMC could use particle tracking modeling to simulate the movement of an excursion near the monitoring wells and scenarios for capture to address this concern.

Answer:
See comment response Hydrology Open Issue No. 8 and revised Addendum 5.7.1

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this SER question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

See revised Addendum 5.7.1

Hydrology Open Issue No. 16
Revision of the surety if an excursion lasts longer than 60 days is not discussed
May 11 2009 Teleconference

Open Issue discussion:

EMC stated an excursion will be considered corrected when the excursion indicators do not exceed the upper control limits (UCLs) or only one indicator exceeds a UCL by less than 20%. If the concentration of UCLs does not begin to decline after 60 days, EMC will submit a plan and compliance schedule to NRC. EMC did not state that it will update its surety for cleanup of excursions which remain for more than 60 days as discussed in NUREG-1569.

Answer:

The application will be changed to include a commitment to revise the surety if an excursion lasts longer than 60 days.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this Open Issue. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

6.6 FINANCIAL ASSURANCE

EMC will maintain surety instruments in the form of an Irrevocable Letter of Credit to cover the costs of reclamation including the costs of groundwater restoration, the decommissioning, dismantling and disposal of all buildings and other facilities, and the reclamation and revegetation of affected areas. Additionally, in accordance with NRC and WDEQ requirements, an updated Annual Surety Estimate Revision will be submitted to the NRC and WDEQ each year to adjust the surety instrument amount to reflect existing operations and those planned for construction or operation in the following year. After review and approval of the Annual Surety Estimate Revision by the NRC and WDEQ, EMC will revise the surety instrument to reflect the revised amount. EMC will 1) automatically extend the existing surety amount if the NRC has not approved the extension at least 30 days prior to the expiration date; 2) revise the surety arrangement within 3 months of NRC approval of a revised closure (decommissioning) plan, if estimated costs exceed the amount of the existing financial surety; 3) update the surety to cover any planned expansion or operational change not included in the annual surety update at least 90 days prior to beginning associated construction; 4) update the surety in the event that an excursion of mining solutions is not recovered within 60 days; and ~~4~~5) provide NRC a copy of the State's surety review and the final surety arrangement.

Hydrology Open Issue No. 17
Restoration of groundwater to the standards in 10 CFR part 40, Appendix A, criterion 5B is not proposed
May 11 2009 Teleconference

Open Issue discussion:

EMC stated that the goal of the groundwater restoration is to return the groundwater quality of the production zone at Moore Ranch to the standard of baseline water quality using Best Practicable Technology (BPT). If this standard cannot be achieved, EMC stated it will achieve pre-mining class of use based on WDEQ standards. NRC regulations require that the groundwater quality be returned to the standards identified in Criterion 5B(5) of 10 CFR Part 40, Appendix A. Those standards are background, the values in the table in Criterion 5C of 10 CFR Part 40, Appendix A, or an alternate concentration limit established by NRC in accordance with Criterion 5B(6). The applicant's goal of restoration to background would meet the standard in Criterion 5B(5)(a), provided the staff approved the proposed background values. The proposal to restore groundwater to its pre-mining class of use is not consistent with the requirements of Criterion 5B(5) and is, therefore, not acceptable to NRC staff.

Answer:

As stated in the response to request for additional information (RAI) submitted in October 2008, EMC disputes the NRC staff conclusion that the standards contained in Criterion 5B of 10 CFR Part 40, Appendix A apply currently to the restoration of groundwater at ISR facilities. This conclusion is contrary to NRC's long-standing interpretation, guidance and policy regarding applicability of Appendix A criteria to ISR facilities. NRC is in the process of preparing a proposed rule to revise 10 CFR Part 40 to specifically address groundwater protection and restoration at in situ leach uranium recovery facilities. As noted in the RAI response, the groundwater protection requirements in Appendix A were specifically written to address conventional tailings facilities and require revision to apply to in situ facilities, which is the purpose of the current rulemaking. There are a number of reasons that the current standards are not appropriate including the outdated criteria in table 5C and the question of where the point of compliance is for an ISR wellfield located in an exempted aquifer. Until Part 40 Appendix A is revised, the groundwater standards cannot be literally applied to ISR restoration.

The Commission has recognized that the requirements of 40 CFR 192 are generally applied through the use of license conditions. There is no explicit policy statement by the Commission in the voting record for SECY-07-0015 that would indicate that it is now Commission policy to apply Appendix A to groundwater protection at in situ facilities until after the rulemaking process has been completed.

EMC notes that on April 29, 2009, NRC staff issued Regulatory Issue Summary 2009-05, which "clarifies" the NRC position that the groundwater criteria in 10 CFR 40 Appendix

A currently applies to restoration at in situ recovery facilities. However, the RIS provides no guidance to licensees or applicants on the application of Appendix A to groundwater restoration at ISR facilities. On June 1, 2009, the National Mining Association (NMA) submitted a letter to NRC disputing the position taken in RIS 09-005 and requesting that NRC rescind the RIS. EMC supports the position take in the NMA letter. EMC believes that NRC should continue to apply the generally applicable standards in Appendix A to groundwater protection at ISR facilities through license conditions until the current Part 40 rulemaking process is complete.

This issue was raised at a Licensing Workshop held by NRC in Denver, Colorado on November 17 and 18, 2009. NRC Staff indicated that they would discuss the issue and provide the industry with further guidance. They also indicated that they would respond to the June 1, 2009 NMA letter. Until NRC has clarified this issue, EMC cannot respond to this Open Issue. However, EMC requests that if NRC Staff determines that Appendix A criteria currently applies to groundwater restoration, that a License Condition be prepared that clearly provides guidance on how these criteria should be applied.

Proposed Revisions to License Application

No changes are proposed to the license application in response to this Open Issue.

Hydrology Open Issue No. 18
NRC approval of restoration target values (RTVs) is not discussed
May 11 2009 Teleconference

Open Issue discussion:

EMC proposed to set Restoration Target Values (RTVs) for the Moore Ranch wellfields based on the average baseline water quality in the "70 sand" production zone. A list of constituents to be included as RTVs was provided in Table 6.1-1 of the Technical Report. The baseline water quality will be determined from samples collected in wells completed in each wellfield in the planned production zone before mining begins. The NRC staff will have to review and approve the RTVs as appropriately representing baseline water quality.

Answer:

This Open issue is related to Hydrology Open Issue #14 concerning submittal of Wellfield Data Packages to NRC for review and approval. Please see the EMC response to that issue.

Proposed Revisions to License Application

No changes are proposed to the license application in response to this Open Issue.

Hydrology Open Issue No. 19
RTVs for the 68 sand where it coalesces with the 70 sand are not discussed
May 11 2009 Teleconference

Open Issue discussion:

EMC stated that the production zone in Wellfield 2 will include both the "70 sand" and the "68 sand" which coalesce in a large section in the center of the wellfield. EMC has not provided for the determination of RTVs for the "68 sand" in this region.

Answer: The text in the license application will be revised to include establishment of RTVs for the 68 sand in the areas where it coalesces with the 70 sand. The evaluation of restoration of the groundwater within the production zone shall be based on the average baseline quality over the production zone. Baseline water quality will be collected for each wellfield from the wells completed in the planned production zone (i.e., MP-Wells). In the areas where the 70 sand (production zone) and 68 sand coalesce, baseline water quality will also be collected from monitor wells completed in the 68 sand. The evaluation of restoration will be conducted on a parameter by parameter basis. Restoration Target Values (RTVs) are established for the list of baseline water quality parameters. The RTVs for the wellfields will be the average of the pre-mining values. In the areas where the 70 sand (production zone) and 68 sand coalesce, RTVs will also be established for the 68 sand as the average of the pre-mining values for the 68 sand monitor wells. Table 6.1-1 entitled Baseline Water Quality Parameters lists the parameters included in the RTVs.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

The text in Chapter 6, Section 6.1.1, third paragraph of the TR will be modified as follows:

> *The evaluation of restoration of the groundwater within the production zone shall be based on the average baseline quality over the production zone. Baseline water quality will be collected for each wellfield from the wells completed in the planned production zone (i.e., MP-Wells). In the areas where the 70 sand (production zone) and 68 sand coalesce, baseline water quality will also be collected from monitor wells completed in the 68 sand. The evaluation of restoration will be conducted on a parameter by parameter basis. Restoration Target Values (RTVs) are established for the list of baseline water quality parameters. The RTVs for the wellfields will be the average of the pre-mining values. In the areas where the 70 sand (production zone) and 68 sand coalesce, RTVs will also be established for the 68 sand as the average of the pre-mining*

<u>values for the 68 sand monitor wells.</u> Table 6.1-1 entitled Baseline Water Quality Parameters lists the parameters included in the RTVs.

Hydrology Open Issue No. 20
Effect of potential conductivity impairment due to use of dissolved oxygen in lixiviant on restoration is not discussed
May 11 2009 Teleconference

Open Issue discussion:

EMC addressed the issue of conductivity impairment in the ore zone due to the use of dissolved oxygen in the lixiviant. EMC stated that dissolved oxygen may evolve out of solution under reduced hydrostatic heads like those in ore zone "70 sand" unconfined aquifer at Moore Ranch. It stated the free gas phase can lead to "gas lock" in portions of the "70 sand." EMC provided a discussion of experience with "gas lock" and how it was controlled at an ISR in Texas. However, no discussion was presented regarding the restoration of that ISR. NRC staff is concerned that if "gas lock" reduces conductivity in sections of the ore zone, flow can bypass these regions and restoration may be incomplete.

Answer: During the uranium recovery phase of an In Situ Recovery operation, avoidance of gas locking is an operational goal. By design, ISR well fields are completed with the intent of focusing lixiviate flow on the uranium bearing portions of the reservoir. Redirection of lixiviate flow into other, barren, portions of the reservoir because of gas locking or any other means results in a dilution of the uranium content of the recovered lixiviate and is an inherent inefficiency. As a result, prevention of gas locking is an ongoing operational objective. Fortunately, the occurrence of a partial or complete gas lock at or near an injection well is readily apparent as the subject well will display a marked or total loss of injectivity. This loss of injectivity will develop in a matter of hours or, at the outside, a matter of a few days. Operational personnel will observe a significant reduction in the injection or flow capacity of the well at the normal or even maximum allowable well head injection pressure. Normal remedial action involves removal of the well from operational service, installation of a submersible pump, and back flowing the well to stimulate the movement of any gas block back to the subject well where this gas phase escapes from the reservoir in the form of two phase flow through the submersible pump and associated piping. These fluids are routed either to the production lixiviate gathering system or to the well cleanup fluids disposal system. It is important to appreciate that oxygen is readily soluble in aqueous fluids up to its solubility limit. As fluid is "back flowed" to the subject well, unsaturated waters are effectively pushing the gas phase and at the same time reducing the size of the gas phase as oxygen redissolves into the unsaturated fluids.

These same two phenomena occur during the ground water restoration (GWR) phase of an In Situ Recovery operation. In addition, during GWR the oxygen content of circulating waters is deliberately reduced and minimized to halt the oxidation and, hence, mobilization of uranium and other metals. The movement of these highly undersaturated (with respect to oxygen) waters throughout the reservoir provides the means for removing any residual oxygen gas phase from portions of the reservoir by again pushing such gas pockets toward recovery wells while at the same time absorbing portions of the gas phase into the liquid phase. Since several pore volumes of undersaturated waters are required during GWR, any residual gas blockage is removed. Chemical analysis of produced waters during and at the conclusion of GWR is employed to confirm the removal of any elevated concentrations of metals and common ions.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

3.1.3.1 Wellfield Operational Monitoring

As discussed in Section 5.7 of this Technical Report, an extensive water-sampling program will be conducted prior to, during and following mining operations at the Moore Ranch project to identify any potential impacts to water resources of the area. The groundwater monitoring program is designed to establish baseline water quality prior to mining; detect excursions of lixiviant either horizontally or vertically outside of the production zone during mining; and determine when the production zone aquifer has been adequately restored following mining.

Injection well and production well flow rates and pressures are monitored at the headerhouse in order that injection and production can be balanced for each pattern and the entire wellfield. The flow rate of each production and injection well is continuously monitored by monitoring individual electronic flow meters in each wellfield headerhouse. The pressure of each production and injection trunk line will be monitored at the headerhouse with electronic pressure gauges. The flow meters and pressure gauges will be tied into the headerhouse control panel, which will be in communication with the central plant control room.

High and low pressure and flow alarms will be in place to alert wellfield and plant operators if specified ranges are exceeded in conjunction with automatic shutoff valves to stop flow if significant changes in flow or pressure occur.

During the uranium recovery phase, avoidance of potential "gas locking" as a result of dissolved oxygen evolving out of solution is an operational goal. By design, ISR well fields are completed with the intent of focusing lixiviate flow on the uranium bearing portions of the reservoir. Redirection of lixiviate flow into other, barren, portions of the reservoir because of gas locking or any other means results in a dilution of the uranium content of the recovered lixiviate and is an inherent inefficiency. As a result, prevention of gas locking is an ongoing operational objective. The occurrence of a partial or complete gas lock at or near an injection well will be readily apparent as the subject well will display a marked or total loss of injectivity. This loss of injectivity will develop in a matter of hours or, at the outside, a matter of a few days. Operational personnel will observe a significant reduction in the injection or flow capacity of the well at the normal or even maximum allowable well head injection pressure. Normal remedial action involves removal of the well from operational service, installation of a submersible pump, and back flowing the well to stimulate the movement of any gas block back to the subject well where this gas phase escapes from the reservoir in the form of two phase flow through the submersible pump and associated piping. These fluids will be routed either to the production lixiviate gathering system or to the wastewater disposal system. Oxygen is readily soluble in aqueous fluids up to its solubility limit. As fluid is "back flowed" to the subject well, unsaturated waters are effectively pushing the gas phase and at the same time reducing the size of the gas phase as oxygen redissolves into the unsaturated fluids.

These same two phenomena occur during the ground water restoration (GWR) phase. In addition, during GWR the oxygen content of circulating waters is deliberately reduced and minimized to halt the oxidation and, hence, mobilization of uranium and other metals. The movement of these highly undersaturated (with respect to oxygen) waters throughout the reservoir provides the means for removing any residual oxygen gas phase from portions of the reservoir by again pushing such gas pockets toward recovery wells while at the same time absorbing portions of the gas phase into the liquid phase. Since several pore volumes of undersaturated waters are required during GWR, any residual gas blockage is removed. Chemical analysis of produced waters during and at the conclusion of GWR is employed to confirm the removal of any elevated concentrations of metals and common ions.

Hydrology Open Issue No. 21
Pore volume of the 68 sand where it coalesces with the 70 sand is not included in the estimate of the total pore volume for restoration
May 11 2009 Teleconference

Open Issue discussion:

EMC calculated the pore volume for restoration as the product of the affected ore zone area, the average completed thickness, the flare factor and the porosity. NRC staff notes that in Wellfield 2, the pore volume estimate should include both the "70 sand" and portions of the "68 sand" which coalesce in a large section in the center of the wellfield. EMC did not include this area, although it acknowledged that it would be restored as necessary.

Answer: As described in the response to Hydrology Open Issues No. 9 and 11, site hydrologic tests and numerical modeling demonstrate that impacts to the 68 Sand will be minimal during proposed ISR production and restoration operations at Moore Ranch. A pump test conducted in the 68 Sand near the area where confinement is absent indicated that the transmissivity of the 68 Sand is two to three orders of magnitude lower than the transmissivity of the overlying 70 Sand. The large difference in transmissivity (and hydraulic conductivity) implies that groundwater flow patterns within the 70 Sand during ISR operations will be dominated by horizontal flow, with minimal exchange between the 68 and 70 Sands. Numerical modeling was performed to simulate hydraulic stresses and responses that will occur during ISR operations in the area where the confining unit is absent. The numerical modeling confirms that minimal flow will occur into or out of the 68 Sand during ISR production and restoration operations. Net flow between the two sands in a simulation of a small scale wellfield (9 recovery wells, 16 injection wells, with recovery of 180 gpm and injection of 178.2 gpm) with no confining unit between the sands, was less than 0.1 ft^3/d. Additional discussion and results of the modeling are presented in the Technical Memorandum, *Evaluation of Potential Impacts to the 68 Sand from ISR Production in Wellfield 2, Moore Ranch Uranium Project, Wyoming* (Petrotek, October 2009). Because no production is intended within the 68 Sand, and because of the minimal impacts anticipated to the 68 Sand from ISR activities, EMC does not propose to include the 68 Sand in the pore volume estimate. If impacts occur to groundwater within the 68 Sand during production or restoration activities, EMC will restore the aquifer as necessary.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this Open Issue. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

The license will be revised to incorporate the Technical Memorandum <u>Evaluation of Potential Impacts to the 68 Sand from ISR Production in Wellfield 2, Moore Ranch Uranium Project, Wyoming</u> *(Petrotek, October 2009)* as an addendum.

Hydrology Open Issue No. 21a
Determination of Pore volume
May 11 2009 Teleconference

Open Issue discussion:

This is an additional issue that was not identified on the agenda.
EMC stated that it will use the average completion thickness to calculate the pore volume for restoration. As EMC will only be doing partial completions, it will not screen the entire aquifer thickness. During operation there will be vertical gradients and portions of the aquifer above and below the depth of the well screens will be affected. All portions of the aquifer affected by operations will have to be restored. EMC did not discuss why it did not use the saturated thickness of the aquifer when calculating pore volume for restoration.

Answer: EMC has revised its pore volume calculation to incorporate a larger net thickness than previously submitted. The ore zone thickness has been increased from 20 to 29.5 feet. The flare factor included in the pore volume calculation already accounts for fluid movement both horizontally and vertically outside of the ore zone. Numerical modeling demonstrates that the vertical gradients that develop around production and injection wells are very steep. Thus the impacted portion of the aquifer above and below the well screens is a small volume relative to the total volume of the ore zone and is accounted for with the flare factor.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this Open Issue. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

6.6 FINANCIAL ASSURANCE

EMC will maintain surety instruments in the form of an Irrevocable Letter of Credit to cover the costs of reclamation including the costs of groundwater restoration, the decommissioning, dismantling and disposal of all buildings and other facilities, and the reclamation and revegetation of affected areas. Additionally, in accordance with NRC and WDEQ requirements, an updated Annual Surety Estimate Revision will be submitted to the NRC and WDEQ each year to adjust the surety instrument amount to reflect existing operations and those planned for construction or operation in the following year. After review and approval of the Annual Surety Estimate Revision by the NRC and WDEQ, EMC will revise the surety instrument to reflect the revised amount. EMC will 1) automatically extend the existing surety amount if the NRC has not approved the extension at least 30 days prior to the expiration date; 2) revise the surety arrangement within 3 months of NRC approval of a revised closure (decommissioning) plan, if estimated costs exceed the amount of the existing *financial surety; 3) update the surety to cover any planned expansion or operational change not included in the annual surety update at least 90 days prior to beginning associated construction; and 4) provide NRC a copy of the State's surety review and the final surety arrangement.*

Groundwater restoration costs are based on treatment of 1 pore volume for groundwater sweep and 6 pore volumes for reverse osmosis and reductant/bioremediation. Wellfield pore volumes are determined using the following equation:

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

~~*Flare factor has been determined for PRI's Smith Ranch wellfields to be approximately 1.5 to 1.7. This flare factor was estimated using a three dimensional groundwater flow model (MODFLOW) in conjunction with an advective particle tracking technique (MODPATH). Horizontal and vertical flare factors of 1.5 and 1.3, respectively, have been approved by the US Nuclear Regulatory Commission for the Hydro Resources, Inc. Churchrock licensing action in New Mexico. COGEMA Mining, Inc., at the Irigaray/Christensen Ranch sites, uses an overall flare factor of 1.44. The numerical modeling results contained in Appendix B4 indicate a horizontal flare factor of approximately 1.2 and it is assumed that the vertical flare will be similar resulting in a total wellfield flare factor of 1.4 to 1.5. Accordingly, EMC is using a flare factor of 1.5 for the surety estimate attached in Appendix D. Using the equation provided above with a porosity of 0.2, the wellfield pore volume for Wellfields 1 and 2 would be approximately 65,511,727 gallons and 94,151,490 gallons respectively.*~~

Flare factor was estimated for the Moore Ranch project using a three dimensional groundwater flow model (MODFLOW) in conjunction with an adjective particle tracking technique (MODPATH). The numerical modeling results contained in Appendix B4 indicate a horizontal flare factor of approximately 1.2 and it is assumed that the vertical flare will be similar resulting in a total wellfield flare factor of 1.44.

Similar flare factors have been used for other licensed ISR facilities. Horizontal and vertical flare factors of 1.5 and 1.3, respectively, have been approved by the US Nuclear Regulatory Commission for the Hydro Resources, Inc. Churchrock licensing action in New Mexico. COGEMA Mining, Inc., at the Irigaray/Christensen Ranch sites, uses an overall flare factor of 1.44

Accordingly, EMC is using a flare factor of 1.44 for the surety estimate attached in Appendix D. Using the equation provided above with a porosity of 0.26 and an average thickness of 29.7, the wellfield pore volume for Wellfields 1 and 2 would be approximately 95,368,700 gallons and 132,864,000 gallons respectively.

The flare factor included in the pore volume calculation accounts for fluid movement both horizontally and vertically outside of the ore zone. Numerical modeling demonstrates that the vertical gradients that develop around production and injection wells are very steep. Thus the impacted portion of the aquifer above and below the well screens is a small volume relative to the total volume of the ore zone and is accounted for with the flare factor.

Hydrology Open Issue No. 22
Detailed description of monitoring during restoration is not provided
May 11 2009 Teleconference

Open Issue discussion:

EMC stated that the mining zone "70 sand" will be monitored during restoration to determine restoration progress, optimize efficiency of restoration methods, and identify any areas of the wellfield that need attention. EMC did not, however, provide a detailed description of the monitoring, including sampling density, parameters, and frequency to substantiate that it will be able to closely monitor and optimize its restoration strategy to achieve or adjust the initial estimate of six pore volumes for restoration.

Answer:

Section 6.1.7.1 of the Technical Report addresses monitoring during active restoration and states that samples will be analyzed for all of the parameters in Table 6.1-1 (i.e., the proposed restoration parameters) at the start of restoration and for all or some of these parameters through restoration as needed. Uranium One has prepared a table that summarizes the restoration groundwater monitoring and analysis. This table will be added to the Technical Report.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this Open Issue. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

6.1.7.1 Monitoring During Active Restoration

During restoration, lixiviant injection is discontinued and the quality of the groundwater is constantly being improved, thereby greatly diminishing the possibility and relative impact of an excursion. Therefore, the monitor ring wells (M-Wells), overlying aquifer wells (MO or MS-Wells), and underlying aquifer wells (MU or MD-Wells) are sampled once every 60 days and analyzed for the excursion parameters, chloride, total alkalinity and conductivity. Water levels are also obtained at these wells prior to sampling.

In the event that unforeseen conditions (such as snowstorms, flooding, equipment malfunction) occur, the WDEQ will be contacted if any of the wells cannot be monitored within 65 days of the last sampling event.

The mining zone will monitored on a frequent basis adequate enough to determine success of restoration, optimize efficiency of restoration techniques, and determine any areas of the wellfield that need additional attention. Samples will be monitored for all of the parameters shown in Table 6.1-1 at the start of *restoration and all or selected parameters through restoration as needed. Table 6.1-4 provides a summary of the proposed restoration groundwater monitoring schedule and analysis.*

Table 6.1-4
Restoration Groundwater Monitoring Schedule and Analysis

Restoration Phase	Sample Origin	Frequency	Analytical Parameters
Post Mining	Designated Restoration Wells Ore Zone	Once	WDEQ Guideline 8
	Monitor Wells Ore Zone Monitors Underlying Zone Overlying Zone	Biweekly	Excursion Parameters
Restoration	Recovery Stream Composite	Weekly	HCO_3/CO_3, SO_4, Cl, Conductivity, pH, Uranium
		As Needed	Add Na, Ca, TDS, etc.
		End of each pore volume displacement	WDEQ Guideline 8
	Designate Restoration Wells Ore Zone	End of each restoration phase	WDEQ Guideline 8
	Monitor Wells Ore Zone Monitors Underlying Zone Overlying Zone	Every 60 days	Excursion Parameters
Post-Restoration Stability	Designate Restoration Wells Ore Zone	Beginning, Middle and End	WDEQ Guideline 8
	Monitor Wells Ore Zone Monitors Underlying Zone Overlying Zone	Every 60 days	Excursion Parameters

Hydrology Open Issue No. 23
Monitoring of the 68 sand where it coalesces with the 70 sand is not discussed
May 11 2009 Teleconference

Open Issue discussion:

EMC has not indicated that the "68 sand" mining zone will be monitored for restoration success where the "70 sand" and "68 sand" coalesce in Wellfield 2.

Answer: The mining zone will be monitored at a frequency adequate to determine success of restoration, optimize efficiency of restoration techniques, and determine any areas of the wellfield that needs additional attention. Samples will be monitored for all of the parameters shown in Table 6.1-1 at the start of restoration and all or selected parameters through restoration as needed. In the areas where the 70 sand (mining zone) coalesces with the 68 sand, the 68 sand will be monitored as part of the mining zone, during both production and restoration. Monitor wells will placed in the 68 sand at the same density as in the mining zone (one well per three acres). In the areas of coalescing 68 and 70 sands, the 68 sand monitor wells will be monitored at the same frequency and for the same constituents as the 70 sand throughout production and restoration.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

The text in Chapter 6, Section 6.1.7.1, third paragraph of the Technical Report of the application is modified as follows:

> *The mining zone will monitored on a ~~frequent basis~~frequency adequate ~~enough~~ to determine success of restoration, optimize efficiency of restoration techniques, and determine any areas of the wellfield that need additional attention. Samples will be monitored for all of the parameters shown in Table 6.1-1 at the start of restoration and all or selected parameters through restoration as needed. In the areas where the 70 sand (mining zone) coalesces with the 68 sand, the 68 sand will be monitored as part of the mining zone, during both production and restoration. Monitor wells will placed in the 68 sand at the same density as in the mining zone (one well per three acres). In the areas of coalescing 68 and 70 sands, the 68 sand monitor wells will be monitored at the same frequency and for the same constituents as the 70 sand throughout production and restoration.*

Hydrology Open Issue No. 24
Justification of the proposed 6 month stability monitoring period is not provided
May 11 2009 Teleconference

Open Issue discussion:

EMC stated that after restoration is completed, a minimum six month stability monitoring period will begin, with samples collected every 60 days. EMC indicated that the stability monitoring period of six months is specified by WDEQ LQD Guideline 4. It provided no other justification for this time period which represents three samplings.

Answer:

WDEQ-LQD Guideline 4 states, "*When the restoration goal is achieved, active restoration should be discontinued and a stability period of at least 6 months will begin. The end of the 6 months period is a decision making point for the DEQ, i.e., more restoration, longer stability period, or overall success.*" Uranium One, as requested by the WDEQ-LQD in technical comments on the Moore Ranch Permit to Mine application, has agreed to perform stability monitoring for a period of twelve months.

NUREG–1569 states: "*The purpose of a stability monitoring program is to ensure that the chemical species of concern do not increase in concentration subsequent to restoration*". NUREG-1569 provides no specific guidance on sample frequency other than that "*all designated monitoring wells must be sampled for all monitored constituents*". Uranium One believes that extending the stability monitoring period to twelve months as requested by the WDEQ-LQD and implementation of the restoration stability monitoring program presented below meets the requirements of NUREG-1569.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this Open Issue. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

6.1.7.2 Restoration Stability Monitoring

A minimum ~~six~~twelve month groundwater stability monitoring period will be implemented to show that the restoration goal has been adequately maintained. The following restoration stability monitoring program will be performed during the stability period:

- *The monitor ring wells will be sampled once every two months and analyzed for the UCL parameters, chloride, total alkalinity (or bicarbonate) and conductivity; and*

- *At the beginning, middle and end of the stability period, the MP-Wells will be sampled and analyzed for the parameters in Table 6.1-1.*

In the event that unforeseen conditions (such as snowstorms, flooding, equipment malfunction) occur, the WDEQ will be contacted if any of the M-Wells or MP-Wells cannot be monitored within 65 days of the last sampling event.

A minimum~~The~~ six month stability monitoring period is specified in WDEQ-LQD Guideline 4. The criteria to establish restoration stability will be based on wellfield averages for water quality. A determination of aquifer stability should be made upon the "trends" in the data; i.e., a stable aquifer should not exhibit rapid upward or downward trends or be oscillating back and forth over a wide range of values. The data is evaluated against baseline quality and variability to determine if the restoration goal is met and if the water is restored at a minimum to within the class of use. If increasing trends are confirmed during the stability period for all or part of a wellfield, then an evaluation of the potential cause of the increasing trends will be conducted and corrective actions will be taken, including continued restoration using Best Practical Technology if needed.

Hydrology Open Issue No. 25
Identification of hot spots when averages are used to determine that restoration standards are met is not discussed
May 11 2009 Teleconference

Open Issue discussion:

EMC stated that the criteria to establish restoration stability will be based on wellfield averages for water quality. EMC has not, however, proposed a strategy to address how high concentration values, also known as "hot spots," in the "70 sand" and "68 sand" are identified and not masked by wellfield averaging during restoration and stability monitoring. NRC staff notes that depending on location and groundwater flow direction, these "hot spots" can act as potential sources of contamination and may require specific attention if they remain.

Answer: Based on guidance provided by NRC at the Licensing Workshop held in Denver, Colorado on November 18, 2009 and subsequent discussions with Uranium Recovery Branch staff, EMC proposes to use the mean wellfield concentration +/- 2 standard deviations as the indicator of a hot spot. If a hot spot is identified using that criterion, EMC will conduct additional evaluation to determine potential impacts that such a hot spot could have on water quality outside of the exempted aquifer. The additional evaluation may include, but is not limited to, trend analysis, solute transport modeling, collection of extra water samples, or analysis of added parameters (to assess post-restoration redox conditions). Based on the results of the analysis, additional restoration would be conducted as needed to ensure the protection of water quality outside the exempted aquifer.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this Open Issue. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

6.1.1 Groundwater Restoration Criteria

The purpose of groundwater restoration is to protect groundwater adjacent to the mining zone. Approval of an aquifer exemption by the WDEQ and the EPA is required before mining operations can begin. The aquifer exemption removes the mining zone from protection under the Safe Drinking Water Act (SDWA). Approval is based on existing water quality, the ability to commercially produce minerals, and the lack of use as an underground source of drinking water (USDW). Groundwater restoration prevents any mobilized constituents from affecting aquifers adjacent to the ore zone.

The primary goal of the groundwater restoration efforts will be to return the groundwater quality of the production zone, on a wellfield average, to the preoperational (baseline) water quality conditions using Best Practicable Technology. Recognizing that restoration activities are not likely to return groundwater to the exact water quality that existed prior to in situ operations (as discussed in Section 6.5.1), a secondary restoration standard of class of use will be applied. The secondary standard of class of use will be applied only after restoration using BPT no longer shows significant improvement in groundwater quality and continuing restoration activities would not provide a significant benefit. The pre-mining baseline water quality and class of use will be determined by the baseline water quality sampling program which is performed for each wellfield, as compared to the use categories defined by the WDEQ, Water Quality Division (WQD). Baseline, as defined for this project, shall be the mean of the pre-mining baseline data after outlier removals. Restoration shall be demonstrated in accordance with Chapter 11, Section 5(a)(ii) of the WDEQ, Land Quality Division Rules and Regulations and NUREG-1569 Section 6.

The evaluation of restoration of the groundwater within the production zone shall be based on the average baseline quality over the production zone. Baseline water quality will be collected for each wellfield from the wells completed in the planned production zone (i.e., MP-Wells). The evaluation of restoration will be conducted on a parameter by parameter basis. Restoration Target Values (RTVs) are established for the list of baseline water quality parameters. The RTVs for the wellfields will be the average of the pre-mining values. Table 6.1-1 entitled Baseline Water Quality Parameters lists the parameters included in the RTVs.

Baseline values will not be changed unless the operational monitoring program indicates that baseline water quality has changed significantly due to accelerated movement of groundwater, and that such change justifies redetermination of baseline water quality. Such a change would require resampling of monitor wells and review and approval by the WDEQ.

In some instances, residual elevated concentrations may remain following restoration. These residual elevated concentrations, also known as 'hot spots" could potentially impact groundwater outside of the exempted aquifer. The mean wellfield concentration +/- 2 standard deviations will be the primary indicator of a hot spot. If a hot spot is identified using that criterion, additional evaluation will be conducted to determine potential impacts that such a hot spot could have on water quality outside of the exempted aquifer. The additional evaluation may include, but is not limited to, trend analysis, solute transport modeling, collection of extra water samples, or analysis of added parameters (to assess post-restoration redox conditions). Based on the results of the analysis, additional restoration would be conducted as needed to ensure the protection of water quality outside the exempted aquifer.

Hydrology Open Issue No. 26
Restoration schedule inconsistent between figures 1.8-1 and 6.1-1
May 11 2009 Teleconference

Open Issue discussion:

A preliminary wellfield restoration schedule was provided in Figure 6.1-1 of the Technical Report. EMC reported that based on the results of the numerical groundwater flow modeling, it will take approximately four years to restore Wellfield 1 and six years to restore Wellfield 2. This restoration schedule conflicts with Figure 1.8-1 of the Technical Report.

Answer:

Figure 6.1-1 has been revised and is consistent with Figures 1.8-1 and 3.1-6.

Text in Section 6.1.4 Restoration Schedule revised to reflect updated Figure 6.1-1

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this Open Issue. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

Revised Text:

6.1.4 Restoration Schedule

The proposed Moore Ranch mine schedule is shown in Figure 6.1-1 showing the estimated schedule for restoration. The restoration schedule is preliminary based on EMC's current knowledge of the area and are based the completion of mining activities for the three wellfields. As the Moore Ranch Project is developed, the restoration schedule will be defined further. Numerical modeling results indicate that it will take longer than 2.5 years to complete restoration, because of the limited saturated thickness of the aquifer and the need to balance drawdown between the two wellfields during concurrent production and restoration phases. Assuming 6 pore volumes of groundwater is required to reach restoration goals, modeling estimates indicate it will take approximately 4 3.75 years to restore Wellfield 1 and 5.5 ~~6~~ years to restore Wellfield 2 included limited Groundwater sweep. Note that Wellfield 2 now includes what was previously Wellfields 2 and 3 in the Permit Application. This results in a larger pore volume calculation than would be the case if the wellfields were considered separately. Results of the simulation and full description of the model development and model simulations is provided in the Appendix B4 report "Numerical Modeling of Groundwater Conditions Related to Insitu Recovery at the Moore Ranch Uranium Project, Wyoming" (Petrotek 2008b).

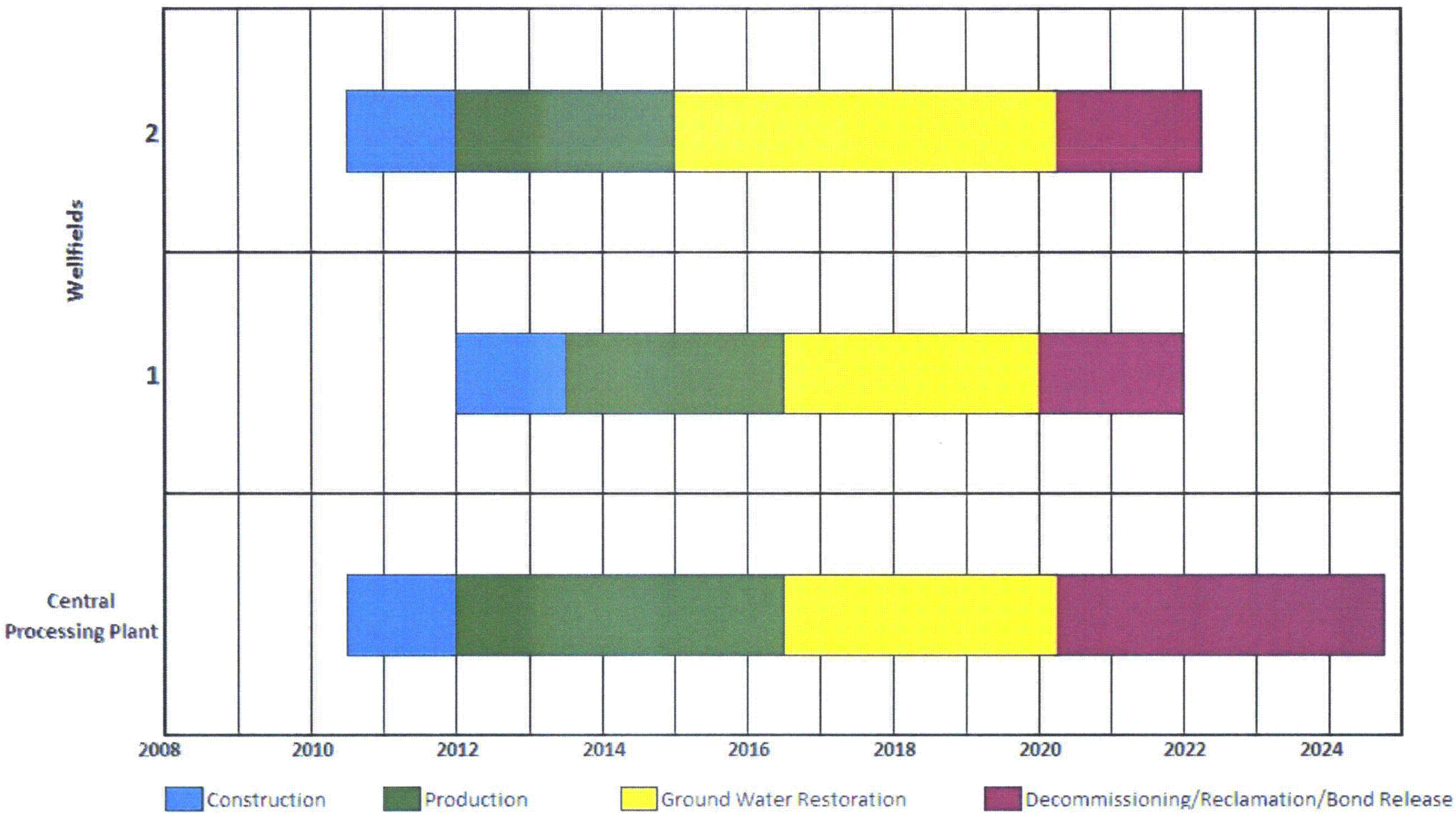


Figure 6.1-1

Proposed Moore Ranch Operations and Restoration Schedule

Hydrology Open Issue No. 27
Five tables missing from GW modeling report 5 ST 1 through 5 not in application (in TOC but not in body of report)
May 11 2009 Teleconference

Open Issue discussion:

Five tables missing from GW modeling report 5 ST 1 through 5 not in application (in TOC but not in body of report).

Answer: The tables are provided in the revised application

See attachment 5st_tbls082908rev.pdf

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

The tables are provided in the revised application

Table 5ST(1). Well Data, 5 Spot Hydrologic Test Recovery, Injection and Monitor Wells, Moore Ranch Uranium Project, Wyoming

Well ID	Northing (feet)	Easting (feet)	Completion Zone	Distance from Recovery Well (feet)	Ground Surface Elevation (ft amsl)	Top of Casing Elevation (ft amsl)	Total Depth (ft bgs)	Top of Screen (ft bgs)	Bottom of Screen (ft bgs)	Screen Length (feet)	Depth to Top 70 Sand (ft bgs)	Elevation Top 70 Sand (ft amsl)	Depth to Bottom 70 Sand (ft bgs)	Elevation Bottom 70 Sand (ft amsl)	70 Sand Thickness (feet)	Depth to Top 68 Sand (ft bgs)	Thickness Underlying Confining Unit (feet)	DTW 5/7/08	WL Elev
IMW-1	1057758.0	321670.0	70 Sand	70.7	5329.60	5330.05	260	160	190	30	120	5209.6	205	5124.6	85.0	221	16	138.34	5191.71
IMW-2	1057758.0	321770.0	70 Sand	70.7	5336.90	5338.43	260	165	192	27	126	5210.9	219	5117.9	93.0	239	20	146.79	5191.64
IMW-3	1057658.0	321670.0	70 Sand	70.7	5330.42	5330.99	260	160	188	28	117	5213.4	212	5118.4	95.0	232	20	139.02	5191.97
IMW-4	1057658.0	321770.0	70 Sand	70.7	5337.67	5338.83	260	160	183	23	125	5212.7	219	5118.7	94.0	239	20	146.83	5192.00
MW-16	1057701.5	321712.5	70 Sand	9.9	5333.13	5334.53	260	160	185	25	121	5212.1	215	5118.1	94.0	234	19	142.68	5191.85
MW-17	1057680.0	321692.0	70 Sand	39.6	5331.77	5332.60	260	158	185	27	120	5211.8	214	5117.8	94.0	233	19	140.72	5191.88
MW-18	1057678.0	321720.0	70 Sand	30.0	5333.88	5334.85	260	160	188	28	122	5211.9	215	5118.9	93.0	235	20	142.92	5191.93
MW-19	1057648.0	321685.0	70 Sand	69.5	5331.51	5332.28	260	157	185	28	119	5212.5	214	5117.5	95.0	232	18	140.26	5192.02
PMW-1	1057708.0	321720.0	70 Sand	0.0	5333.73	5334.32	260	160	188	28	121	5212.7	215	5118.7	94.0	236	21	142.37	5191.95
UMW-5	1057708.0	321780.0	68 Sand	60.0	5338.25	5340.08	290	260	290	30	126	5212.3	220	5118.3	94.0	240	20	149.72	5190.36

Table 5ST (2) Extraction Test- Pumping Rate and Drawdown Results, 5 Spot Hydrologic Test, Moore Ranch Uranium Project, Wyoming

Extraction Rate at PMW1

	DATE/TIME	Comments	Time: Cumulative (min)	Time: Increment (min)	Totalizer 1: Cumulative (gal)	Totalizer 1: Increment (gal)	Totalizer 1: Rate (gpm)	Totalizer 2: Cumulative (gal)	Totalizer 2: Increment (gal)	Totalizer 2: Rate (gpm)	Average Rate (gpm)
Step Test	5/8/08 12:50	Begin Step Test	0	0	0	0	0	0	0	0	0.00
	5/8/08 13:50		60	60	929	929	15.48	935	935	15.58	15.53
	5/8/08 15:00		130	70	2296	1367	19.53	2312	1377	19.67	19.60
	5/8/08 15:13		143	13	2624	328	25.23	2646	334	25.70	25.47
	5/8/08 15:48		178	35	3518	894	25.54	3565	919	26.26	25.90
	5/8/08 16:00	End Step Test	190	12	3817	299	24.92	3870	305	25.42	25.17
Extraction Test	5/12/08 10:40	Begin Extraction Test	0	0	3817	0	0	3870	0	0	0.00
	5/12/08 12:16		96	96	5897	2080	21.67	5979	2109	21.97	21.82
	5/13/08 9:00		1340	1244	32899	27002	21.71	33385	27406	22.03	21.87
	5/13/08 11:34		1494	154	36305	3407	22.12	36792	3407	22.12	22.12
	5/13/08 12:07		1527	33	37015	709	21.49	37530	738	22.37	21.93
	5/14/08 13:38		3058	1531	69862	32848	21.46	70874	33343	21.78	21.62
	5/14/08 14:50		3130	72	71406	1544	21.44	72458	1585	22.01	21.73
	5/15/08 9:53		4273	1143	95880	24474	21.41	97362	24904	21.79	21.60
	5/15/08 10:22		4302	29	96572	691	23.83	98656	1294	44.62	34.23
	5/16/08 9:12		5672	1370	125761	29189	21.31	127731	29075	21.22	21.26
	5/16/08 9:32	End Extraction Test	5692	20	126126	365	18.25	128114	383	19.15	18.70
					Average Extraction Rate for Test		22.13			22.51	22.32

Drawdown at End of Extraction Test, 5-Spot Hydrologic Test Wells

Well ID	IMW-1	IMW-2	IMW-3	IMW-4	MW-16	MW-17	MW-18	MW-19	PMW-1
Initial DTW (ft)	138.34	146.79	139.02	146.83	142.68	140.72	142.92	140.26	142.37
Drawdown (ft)	4.09	3.78	3.79	3.66	6.92	5.03	5.50	3.88	21.29
Drawdown - BP Corrected (ft)	3.61	3.29	3.3	3.16	6.43	4.57	5.00	3.38	20.79

BP - barometric pressure

Table 5ST (3) Slug Test Results, Pre- and Post-Development of Injection Wells, 5 Spot Hydrologic Test, Moore Ranch Uranium Project, Wyoming

Well ID	Slug Test Results	
	Pre Development K (ft/d)	Post Development K (ft/d)
IMW-1	0.42	4.71
IMW-2	0.24	1.71
IMW-3	0.19	5.29
IMW-4	0.18	6.28

K - hydraulic conductivity
Analytical method - Hvorslev (1951)

Table 5ST (4) Extraction/Injection Test Rates and Results, 5 Spot Hydrologic Test, Moore Ranch Uranium Project

Extraction/Injection Test Rate Summary

	1st Stage		2nd Stage		3rd Stage	
	Rate	Duration	Rate	Duration	Rate	Duration
Well ID	(gpm)	(days)	(gpm)	(days)	(gpm)	(days)
IMW-1	5.0	2.06	0.0	1.0	0.0	0.92
IMW-2	5.0	2.06	0.0	1.0	0.0	0.92
IMW-3	5.0	2.06	10.0	1.0	0.0	0.92
IMW-4	5.0	2.06	10.0	1.0	20.5	0.92
PW1	-20.0	2.06	-20.0	1.0	-20.5	0.92

Positive value indicates injection, negative value indicates extraction

Extraction/Injection Test Well Response Summary

Well ID	DTW Start of Test	DTW End 1st Stage	Net Change 1st Stage	BP Corr 1st Stage (+0.08 ft)	DTW End 2nd Stage	Net Change 2nd Stage	BP corr 2nd Stage (+0.18 ft)	DTW End 3rd Stage	Net Change 3d Stage	BP corr 3rd Stage (+0.21 ft)
	(ft)									
IMW-1	140.57	138.28	2.29	2.37	141.60	-1.03	-0.85	141.54	-0.97	-0.76
IMW-2	148.95	123.01	25.94	26.02	149.75	-0.80	-0.62	150.03	-1.08	-0.87
IMW-3	141.24	139.05	2.19	2.27	131.94	9.30	9.48	126.54	14.70	14.91
IMW-4	149.02	145.31	3.71	3.79	139.91	9.11	9.29	149.53	-0.51	-0.30
MW-16*	143.00	140.36	2.64	2.72	140.74	2.26	2.44	140.51	2.49	2.70
MW-17	140.81	141.87	-1.06	-0.98	141.05	-0.24	-0.06	140.80	0.01	0.22
MW-18	142.96	144.35	-1.39	-1.31	143.99	-1.03	-0.85	144.08	-1.12	-0.91
MW-19	140.37	140.15	0.22	0.30	138.05	2.32	2.50	137.01	3.36	3.57
PW1	143.06	158.10	-15.04	-14.96	156.60	-13.54	-13.36	159.60	-16.54	-16.33

DTW - Depth to Water
BP Corr. - Barometric Pressure Correction
* DTW in MW16 at start of test is estimated - all remaining values are relative to start value
Positive value indicates net rise in water level
Negative value indicates net decrease in water level

Table 5ST (5) Extraction Test Analytical Results, 5 Spot Hydrologic Test, Moore Ranch Uranium Project, Wyoming

	Theis		Cooper-Jacob		Theis Recovery		Neuman			Average All Methods	
	T	K	T	K	T	K	T	K	Sy	T	K
Well ID	(ft^2/d)	(ft/d)	(ft^2/d)	(ft/d)	(ft^2/d)	(ft/d)	(ft^2/d)	(ft/d)		(ft^2/d)	(ft/d)
IMW1	619	8.60	461	6.40	253	3.51	367	5.10	0.0012	425	5.90
IMW2	594	8.25	497	6.90	253	3.51	359	4.99	0.0013	426	5.91
IMW3	615	8.54	475	6.60	221	3.07	433	6.01	0.0015	436	6.06
IMW4	594	8.25	447	6.21	251	3.49	384	5.33	0.0015	419	5.82
MW16	327	4.54	471	6.54	180	2.50	327	4.54	0.0066	326	4.53
MW17	608	8.44	457	6.35	228	3.17	408	5.67	0.0007	425	5.91
MW18	369	5.13	489	6.79	246	3.42	278	3.86	0.0041	346	4.80
MW19	555	7.71	440	6.11	239	3.32	327	4.54	0.0023	390	5.42
PW1	-	-	-	-	237	3.29	-	-		237	3.29
Average	535	7.43	467	6.49	234	3.25	360	5.01	0.0024	399	5.54
Maximum	619	8.60	497	6.90	253	3.51	433	6.01	0.0066	451	6.06
Minimum	327	4.54	440	6.11	180	2.50	278	3.86	0.0007	306	4.53
Std dev	117.7	1.6	19.7	0.3	23.2	0.3	49.5	0.7	0.0020	66.6	0.58

T - Transmissivity
K - Hydraulic Conductivity
Sy - Specific Yield

Confirmatory Issue No.1
Pump Test
May 11 2009 Teleconference

Confirmatory Issue discussion:

Text does not reflect revisions in Appendix B1 noting original pump test only appropriate for scoping purposes.

Answer: The text has been revised to note that the original pump test was only appropriate for scoping purpose and that additional hydrologic testing will be performed to provide data relevant to operational issues.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

In Section 2.7.2.2 under the following heading:

2007 Pump Tests

EMC conducted three pump tests in 2007 to evaluate aquifer properties of the 70 Sand. The initial pump test plan called for a single pump test. The limited historic data (Conoco) suggested it might be possible to test the entire Moore Ranch Project Area in one test (e.g., by pumping from only one well). For this reason, the pumping well (PW-1) was centrally located between the ore bodies and installed specifically for use as a pumping well. However, based on the results from the first test that indicated greater than anticipated transmissivity and hydraulic conductivity, two additional pump tests were conducted. Table 2.7.2.1 provides basic well information for the pumping wells and observation wells used in the tests. Table 2.7.2.5 summarizes the pump test parameters. The location of pumping wells and observation wells are provided in Figure 2.7.2.10. Details regarding the pump test procedures and results are provided in Appendix B1.

Deleted: In February 2007, EMC and PEC initiated a pump test designed to accomplish the following objectives:¶

Deleted: <#>Demonstrate hydraulic communication between the production zone (70 Sand) pumping well and the surrounding monitor wells;¶
<#>Assess the hydrologic characteristics of the production zone aquifer within the test area;¶
<#>Evaluate the presence or absence of hydrologic boundaries in the production zone within the project area; and,¶
<#>Demonstrate sufficient confinement between the production zone and the overlying and underlying sands for the purposes of ISR mining.¶

The data collected from the 2007 pump tests was suitable for general scoping purposes to determine if ISR methods could be successfully applied at the site. However, the data collected from the 2007 pump tests were not conducive to detailed analysis of aquifer properties because of the limited radius of influence and the strong impacts that barometric changes had on water level data during the tests.

Table 2.7.2-5 Summary of Moore Ranch 2007 Pump Test Parameters					
Test No.	*Pumping Well*	*Duration (minutes)*	*Duration (days)*	*Flow Rate (gpm)*	*Comments*
1	PW1	13,275	9.2	16.5	20.6' drawdown in PW1; only other response observed was in MW-1 (distance of 109')
1	PW-1	14,285	9.9	15.6	20.6' drawdown in PW1; only other response observed was in MW-1 (distance of 109')
2	MW-2	1,465	1.0	26.0	19.4' drawdown in MW-2; response in Well 1805 (70 Sand, distance of 346'); UMW-2 (68 Sand; distance of 10'), 1807 (68 Sand; distance of 252')
3	MW-3	5,535	3.8	14.4	17.8' drawdown in MW-3; no response in any other monitor wells

Transmissivity (T) results from the analysis of the 2007 pump test data for the 70 Sand range from 329 to 724 ft^2/d, with an average value of 538 ft^2/d. Based on an average thickness of 71 feet, the average hydraulic conductivity (K) is 7.5 ft/d. Assuming a water viscosity of 1.35 cp (50 degrees F) and a density of 1.0, this equates to a permeability of approximately 2,000 millidarcies (md). No storativity values were determined because two of the tests were run under unconfined conditions and the third test did not include an observation well completed within the pumped aquifer. Details of the methods of analysis of the pump tests and the results are discussed in Appendix B1. Table 2.7.2-6 provides a summary of the aquifer properties estimated from the 2007 pump test results.

Deleted: for the 70 Sand range from 321 to 711 ft^2/d, with an average value of 586 ft^2/d. Based on an average thickness of 80 feet, the average hydraulic conductivity (K) is 7.3 ft/d.

Deleted: The only storativity (S) was obtained from MW-1 at a value of 4.4 x 10^{-3}.

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Table 2.7.2-6 Summary of Production Zone (70 Sand) Aquifer Properties Estimated From 2007 Pump Test Results	
Pump Test	**Representative Value**
Central Location Between Wellfields 1, 2 and 3 (PW-1 Test)	
Transmissivity (T; ft2/d)	542
Hydraulic Conductivity (k; ft/day)	8.4
Net Sand Thickness (h; ft)	64
Wellfield 1 Test (MW-3 Test)	
Transmissivity (T; ft2/d)	329
Hydraulic Conductivity (k; ft/day)	4.6
Net Sand Thickness (h; ft)	72
Storativity (S)	
Wellfield 2 Test (MW-2 Test)	
Transmissivity (T; ft2/d)	640
Hydraulic Conductivity (k; ft/day)	8.2
Net Sand Thickness (h; ft)	78
Storativity (S)	64

All results are with respect to the Production Zone Aquifer (70 Sand)

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No water-level change of significance was observed in the overlying OMW-1 or underlying UMW-1 completions as a result of pumping the PW-1 well completed in the 70 Sand. The UMW-1/OMW-1 wells are located approximately 109 feet from PW-1. No changes of significance were observed in the overlying monitor well during the MW-2 pump test. Well OMW-2 declined slightly during the pumping period, however, the decline continued during recovery. Underlying completions UMW-2 and 1807 (completed in the 68 Sand 252 feet distant) directly responded to pumping, which was expected as the 70 and 68 Sands coalesce in that area.

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No significant change in water level was observed in OMW-3 (overlying completion) during the MW-3 pump test. As previously discussed, the potentiometric surface of the overlying 72 Sand is approximately 50 feet higher than the 70 Sand. This difference in potentiometric surfaces supports the testing data that demonstrate isolation between the 72 and 70 Sands.

The underlying well (UMW-3) declined steadily during the background monitoring, pumping, and recovery periods (Appendix B1, Figure 5-15). The declining trend in UMW-3 continued through July of 2007 followed by a recovery trend until October 2007. In October 2007, UMW3 was purged prior to sampling. The water level was lowered as a result of the purging and took several months to recover to static levels. As discussed previously, the cause of the decline is not known; however, long-term monitoring data clearly indicate that the initial decline was not a result of the MW-3 pump test and has not had an impact on water levels in MW-3.

Deleted: , but has since shown a recovering trend.

As previously discussed, the potentiometric surface of the overlying 72 Sand is approximately 50 feet higher than the 70 Sand. This difference in potentiometric surfaces supports the testing data that demonstrate isolation between the 72 and 70 Sands. Hydrographs illustrating the hydraulic relationship between the 70 and 72 Sands are attached (Figures 2.7.2-11a through 2.7.2-11d). Water level data used to develop the hydrographs are included in Table 2.7.2-2. The large difference in heads between the hydrostratigraphic units demonstrates a lack of hydraulic communication between them. Available data indicates the 72 Sand is a perched aquifer system. The uppermost portion of the 70 Sand is unsaturated across much of the site. This unsaturated zone between the 70 Sand and the 72 Sand hydrostratigraphic units provides a buffer that will prevent hydraulic communication between the sands during production and restoration activities. Furthermore, the production and restoration phases of the project will be operated under a net bleed (overpumpage), resulting in declining water levels within the 70 Sand that will further separate the 72 and 70 Sands hydraulically.

Deleted: The difference in potentiometric surface between the 68 and 70 Sand is variable across the site, indicating a downward gradient in some areas and upward gradient in others. There is very little difference in potentiometric heads in the vicinity of MW-2/UMW-2 where coalescing of the 68 and 70 Sands occurs.¶

The 2007 test results demonstrate that:

- The 70 Sand monitor wells located in the near proximity to the pumping well are in communication, indicating that the 70 Sand production zone has hydraulic continuity. While communication was not exhibited over the entire area, geologic information clearly shows that the 70 Sand is a contiguous sand body across the

Moore Ranch Project Area. Additional (mine unit) scale testing required by NRC and WDEQ will demonstrate communication throughout each mine unit between the pumping well(s) and the monitor well ring;

- To adequately stress the 70 Sand, future pump tests will require multiple pumped wells. Results of a numerical model simulation indicate that it will take numerous pumping tests to demonstrate hydraulic communication with all wells in the monitor well ring (Numerical Modeling of Groundwater Conditions Related to Insitu Recovery at the Moore Ranch Uranium Project, Wyoming, Petrotek Engineering Corporation, 2008) The hydrologic testing to be conducted to complete the requirements of the wellfield data package will be designed in such a way as to: adequately characterize the aquifer properties of the production zone aquifer; indicate hydraulic communication between the production zone and the monitor well ring; identify confinement or lack of confinement with overlying and underlying aquifers; and identify hydrologic boundaries within the production zone aquifer.

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- Within the proposed Wellfield areas, the 70 Sand has been adequately characterized with respect to hydrogeologic conditions within the test area at the Moore Ranch Project Area;

- Adequate confinement exists between the 70 Sand production zone and the overlying 72 Sand in the areas of the proposed Wellfields for ISR operations;

Deleted: throughout the Moore Ranch Project Area;

- Adequate confinement exists between the 70 Sand production zone and the underlying 68 Sand in the area of proposed Wellfield 1. Where the 68 and 70 Sands coalesce in the center of Section 35 (proposed Wellfield 2), mining operations will be designed to account for this variation in geology and mine-unit scale testing will demonstrate the validity of the recommended approach(s); and,

Deleted: throughout the northern and western portions of the Moore Ranch Project Area.

- Sufficient testing has been conducted to date at Moore Ranch to proceed with a Class III UIC permit application and a NRC license application.

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Storativity (S)	4.39×10^{-3}

Confirmatory Issue No. 2
Gas Locking
May 11 2009 Teleconference

Confirmatory Issue discussion:

Gas locking discussion needs to be in application.

Answer: See the answers provided to Hydrology Open Issues 10 and 20.

Proposed Revisions to License Application

See the proposed revisions provided to Hydrology Open Issues 10 and 20.

Confirmatory Issue No. 3
Addendum 5.7.1
May 11 2009 Teleconference

Confirmatory Issue discussion:

Addendum 5.7.1, need to remove reference with new modeling.

Answer: The model simulations included in the original version of Addendum 5.7.1 have been replaced with simulations using the revised model that is described in Appendix B4 "Numerical Modeling of Groundwater Conditions Related to Insitu Recovery at the Moore Ranch Uranium Project, Wyoming" (Petrotek 2008)". Model simulations demonstrating the adequacy of a 500 foot monitor well spacing using the revised model are included in Addendum 5.7.1. Because the Addendum has been replaced in its entirety, no changes to the text in Section 5.0 of the Technical Report is required.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this SER question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

Addendum 5.7.1 is replaced in its entirety

Confirmatory Issue No. 4
Restoration Analogs
May 11 2009 Teleconference

Confirmatory Issue discussion:

Restoration analogs (chapter 6) need to include discussion from response to RAI. Has to be in application.

Answer: **Addendum 6.1-A**

Analogs for Estimation of Groundwater Restoration at Moore Ranch ISR Project, Wyoming

Analysis has been performed on the comparison of the Uranium One Moore Ranch ISR uranium project and the COGEMA Irigaray and Christensen Ranch ISR uranium projects. Both COGEMA sites have completed production and restoration operations. The Irigaray site has received approval of aquifer restoration from the Wyoming Department of Environmental Quality (WDEQ). COGEMA has submitted a Wellfield Restoration Report for the Christensen Ranch project that is currently under review by WDEQ. These two ISR projects are located within the same geologic trend as the Moore Ranch Project. Hydrogeologic characteristics of Irigaray and Christensen Ranch are also similar to Moore Ranch.

Table 6.1-A(1) summarizes geologic, hydrogeologic and water chemistry properties of the Irigaray, Christensen Ranch and Moore Ranch ISR projects. All three of the projects target uranium ore within fluvially deposited channel sands of the Eocene Wasatch Formation. Depths to the ore bearing units are similar in each site (100 to 500 feet below ground surface). Hydrologic properties of the sites are also similar although, aquifer transmissivity and hydraulic conductivity are generally higher at Moore Ranch.

One primary difference between the sites is that the production zone aquifer at Moore Ranch is unconfined whereas at Irigaray and Christensen Ranch, confined conditions exist in the production zone aquifer. However, recent hydrologic testing and numerical modeling indicate that unconfined conditions will not result in extensive dewatering of the production zone aquifer within well patterns during normal operating rates. Any dewatering that may occur locally can be readily reversed by "pulsing" of well patterns to ensure all portions of the aquifer that are contacted with lixiviant will also be contacted with restoration fluids/methods.

As noted, aquifer properties determined from site hydrologic tests indicate that transmissivity and hydraulic conductivity of the Moore Ranch production zone are generally greater than those properties at both Christensen Ranch and Irigaray. The increased hydraulic conductivity may be the result of generally coarser grain size, less consolidated sediments, less pervasive cementation, or any combination of these factors. Regardless of the cause of the increased transmissivity/hydraulic conductivity at Moore Ranch, this phenomenon should enhance aquifer restoration activities. Higher transmissivity will allow for easier transfer of water during production and restoration operations, (higher production/injection rates). Greater volumes of fluids can be moved through the impacted aquifer in less time when the transmissivity/hydraulic conductivity is higher.

Baseline water quality of the three site are generally similar although the Moore Ranch site is more of a calcium sulfate to calcium bicarbonate water type whereas Irigaray and Christensen Ranch are predominately sodium sulfate type water. TDS and sulfates levels are similar for all three sites. Trace minerals arsenic, manganese, and selenium and radionuclides uranium and radium–226 are in the same range at all three sites. Based on these similarities and the projected use of similar lixiviant, it is anticipated that mining impacts to Moore Ranch water quality prior to restoration, will be similar to post-mining water quality at Christensen Ranch and Irigaray.

Preliminary leach amenability tests have been completed on samples collected from the Moore Ranch production zone. The water chemistry after an equivalent of 30 pore volumes of leaching is summarized in Table 6.1-A(2). Results of the test are provided in Attachment 6.1-A(1). Although the test was not designed to approximate insitu conditions of permeability, porosity and pressure, the results provide an indication of the leachability of uranium and other associated minerals. The water quality analysis at the end of the test provides a general sense of water quality that may be present at the end of production at Moore Ranch. Also included in the table is the post-mining mean concentration of key water chemistry constituents from Irigaray and Christensen Ranch. The table shows that the water quality from the amenability testing is of similar or better quality than post-mining water quality at Irigaray and Christensen Ranch. Note that chlorides and sulfates tend to be very low in the amenability test leachate. The uranium concentration in the leachate is similar to the range observed in post-mining water at Christensen Ranch and Irigaray. The leach amenability tests indicate that Moore Ranch post-mining water quality will be similar to or better than post-mining water quality at Christensen Ranch or Irigaray.

Based on the comparison of geologic, hydrologic and water chemistry properties of Irigaray, Christensen Ranch and Moore Ranch, it is reasonable to expect that aquifer restoration can be achieved at Moore Ranch. Furthermore, there are several reasons to expect that restoration can be achieved with fewer pore volumes (PVs) of treatment and reinjection or disposal as described below.

Additional evaluation is provided with respect to the number of PVs of treatment that will be required to achieve restoration of the production zone aquifer. Table 6.1-A(3) presents a summary of the restoration schedule and volumes for Irigaray and Christensen Ranch. As shown on the table, the average number of PVs extracted and treated/reinjected/or disposed was 13.6 for Irigaray and 12.4 for Christensen. However, several points are presented that suggest that the number PVs required to restore the aquifer at Moore Ranch will be less than what was required at Christensen Ranch and Irigaray. Circumstances at both those ISR projects resulted in increased PVs to achieve restoration goals including the following:

- Production and restoration were not conducted sequentially, and were plagued with extended periods of shut-in and standby, with delays of up to several years in some cases;
- Groundwater sweep, the initial phase of restoration, was often largely ineffective and in some cases may have exacerbated the problem; and
- RO was continued in some wellfields after it was apparent that little improvement in water quality was occurring.

Restoration was not performed immediately following the completion of production, and in some cases, there were long periods of inactivity during the production and restoration phases. At Irigaray, production was interrupted for a period of almost six years in MU1 through MU5 [Figure 6.1-A (1)]. Similarly, there was a three-year break in production in MU6 through MU9, when the operation was in standby status. Restoration did not commence at MU1 through MU3 until a year after production had ended. At MU4 and MU5, restoration operations did not begin until two years following production Restoration commenced shortly after the end of production at MU6 through MU9. However the project was on standby status between the completion of groundwater sweep and the beginning of the RO phase of production, resulting in a break of one to two years, depending on the MU. Restoration was initiated sooner after the end of production at Christensen Ranch, with the exception of MU3 and MU4. However, there were periods of standby between groundwater sweep and RO treatment/injection of up to a year. These delays between and during production and restoration operations most likely increased the number of PVs required to complete aquifer restoration. Uranium One will commence restoration activities upon completion of production within a wellfield.

Results of the effectiveness of groundwater sweep (or lack of it) were clearly demonstrated in the Christensen Ranch Wellfield Restoration report (CRWR) (COGEMA 2008). Examples of plots from that report of mean wellfield water quality at the end of mining, groundwater sweep, RO and stabilization monitoring are attached. Plots of TDS for MU3, MU5 and MU6 (Figures 5-7, 5-8 and 5-7, from the respective Mine Unit Data Packages of the CRWR), indicate minimal improvement following groundwater sweep at MU3 and MU5 and an actual increase at MU6. Following application of RO, the TDS values at MU5 and MU6 decreased to levels below the target Restoration Goal. Uranium increased in MU5 and MU6 following groundwater sweep (Figures 5-12 and 5-13 from the respective Mine Unit Data Packages of the CRWR), and then was significantly lowered during RO. Approximately 1,8. 4.8 and 1.5 PVs of groundwater were removed from MU3, MU5 and MU6, respectively, during groundwater sweep. This water removal was totally consumptive by design, in that none of it was returned to the aquifer. Based on the results, minimal benefit, if any, was derived from this phase of restoration. Eliminating groundwater sweep, an unnecessary, ineffective and consumptive step in the restoration process, will reduce the number of PVs required to reach restoration goals.

In some cases, RO was continued longer than necessary or at least longer than any improvements to water quality were occurring. A review of the uranium and conductivity trend plots from the Irigaray recovery wells during restoration (included in the Irigaray Mine Wellfield Restoration Report (COGEMA 2004) show this to be the case. Figures 4-4 through 4-7 from the Irigaray report show that RO was often continued for several PVs beyond the point that water quality had stabilized. The additional PVs of RO resulted in no direct benefit to aquifer water quality and only resulted in consumptive use of the groundwater resources. RO typically results in disposal of approximately 20 percent of the recovered groundwater with reinjection of the remaining 80 percent following treatment. Terminating RO once water quality has stabilized will minimize the consumptive use of groundwater and reduce the number of PVs of treatment.

One additional strategy proposed by Uranium One to reduce the volume of water required to restore the aquifer is groundwater transfer. Groundwater transfer was described in section 6.1.3.1 of the Moore Ranch Uranium Project License Application-Technical Report (Uranium One, 2007). Groundwater transfer entails the transfer of water from a wellfield commencing restoration to another wellfield that is beginning production. Baseline water quality is pumped from the wellfield beginning production and then injected into the wellfield that is starting restoration. Concurrently, the higher TDS water from the wellfield in restoration is pumped and then injected into the wellfield beginning production. The objective of groundwater transfer is to blend water in two wellfields until they have similar water quality. Groundwater transfer has much of the benefit of groundwater sweep without the large consumptive use of water.

The net result of each of these strategies (immediate restoration following production, elimination of groundwater sweep, terminating RO once restoration is achieved or water quality has stabilized, and groundwater transfer) should significantly reduce the number of PVs required to achieve aquifer restoration. It is difficult to quantify how effective each of these strategies will be until actual field measured data become available. Substantial justification of the number of PVs estimated for restoration of Moore Ranch following ISR mining using analytical methods or numerical modeling, given the degree of uncertainty that exists in many of the parameters that would be used in such a demonstration, does not seem appropriate at this time. The preferred approach is the one presented in this response; to use existing analogs to the site, and to adjust the PV approximation based on "lessons learned" from those sites.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method. The restoration analog discussion above is appended to the end of section 6 as Addendum 6.1-A

Addendum 6.1-A
Analogs for Estimation of Groundwater Restoration at Moore Ranch ISR Project, Wyoming

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Confirmatory Issue No. 5
Biological Reduction
May 11 2009 Teleconference

Confirmatory Issue discussion:

Remove discussion of biological reduction (still in Technical Report; remove).

Answer:

EMC will remove all reference to bioremediation from the Technical and Environmental Reports. Through an oversight during preparation of the revised Technical Report in response to the RAI in October 2008, bioremediation is still referenced in section 6.1.3.

Proposed Revisions to License Application

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

6.1.3 Groundwater Restoration Method

The commercial groundwater restoration program consists of two stages, the restoration stage and the stability monitoring stage. The restoration stage typically consists of three phases:

1) Groundwater transfer;
2) Groundwater sweep;
3) Groundwater treatment.

These phases are designed to optimize restoration equipment used in treating groundwater and to minimize the volume of groundwater consumed during the restoration stage. EMC will monitor the quality of groundwater in selected wells as needed during restoration to determine the efficiency of the operations and to determine if additional or alternate techniques are necessary. Online production wells used in restoration will be sampled for uranium concentration and for conductivity to determine restoration progress on a pattern-by-pattern basis.

The unconfined conditions present in the 70 Sand result in development of relatively steep drawdown cones during pumping that are of limited areal extent. Therefore the area of "dewatering" tends to be localized around the production well. Data collected during the 5-Spot Pump Test indicates that aquifer recovery occurs rapidly once an extraction well is shut in. Efficient groundwater sweep for both production and restoration can be accomplished by "pulsing" of extraction wells by cycling them on and off. The pulsing can be achieved by either switching groups of extraction wells on and off or by alternating between injection and *extraction cycles within individual well patterns. Pulsing of wells will effectively resaturate portions of the aquifer that may have been temporarily dewatered by any individual extraction well. A model simulation illustrating this technique and a description of the model development is provided in Appendix B2 (technical memorandum "5 Spot Pump Test, Results, Analysis and Modeling, Moore Ranch Uranium Project," Petrotek 2008a).*

The sequence of the activities will be determined by EMC based on operating experience and waste water system capacity. Not all phases of the restoration stage will be used if deemed unnecessary by EMC.

A reductant may be added at any time during the restoration stage to lower the oxidation potential of the mining zone. Either a sulfide or sulfite compound may be added to the injection stream in concentrations sufficient to establish reducing conditions within the mining zone. ~~*EMC may also employ bioremediation as a reduction process.*~~