Revised Section 6.5:

6.5 QUALITY ASSURANCE PROGRAM

A quality assurance program will be implemented at the Moore Ranch Project for all relevant operational monitoring and analytical procedures. The objective of the program will be to identify any deficiencies in the sampling techniques and measurement processes so that corrective action can be taken and to obtain a level of confidence in the results of the monitoring programs. The QA program will provide assurance to the regulatory agencies and the public that the monitoring results are valid. The Uranium One Quality Assurance Plan for Wyoming ISR Operations is provided in Addendum 6.5-A

The QA program will address the following:

- *Formal delineation of organizational structure and management responsibilities. Responsibility for both review/approval of written procedures and monitoring data/reports will be provided.*

- *Minimum qualifications and training programs for individuals performing radiological monitoring and those individuals associated with the QA program.*

- *Written procedures for QA activities. These procedures will include activities involving sample analysis, calibration of instrumentation, calculation techniques, data evaluation, and data reporting.*

- *Quality control (QC) in the laboratory. Procedures will cover statistical data evaluation, instrument calibration, duplicate sample programs and spike sample programs. Outside laboratory QA/QC programs are included.*

- *Provisions for periodic management audits to verify that the QA program is effectively implemented, to verify compliance with applicable rules, regulations and license requirements, and to protect employees by maintaining effluent releases and exposures ALARA.*

QA procedures will include:

1. *Environmental monitoring procedures.*

2. *Testing procedures.*

3. *Exposure procedures.*

4. *Equipment operation and maintenance procedures.*

5. *Employee health and safety procedures.*

6. *Incident response procedures.*

ADDENDUM 6.5-A

WYOMING ISR OPERATIONS QUALITY ASSURANCE PLAN

Wyoming In Situ Recovery Projects Quality Assurance Plan

Prepared by
Uranium One Americas
Casper, Wyoming

Policy and Signature Page

Uranium One Americas is committed to establishing, maintaining, and implementing an effective Quality Assurance program that achieves quality in all activities through planning, performing, assessing, and continually improving the process.

The achievement of quality is an interdisciplinary function led by management and is the responsibility of all personnel. Work is accomplished through the resources of people, equipment, and procedures. Managers are responsible for ensuring that people have the information, resources, and support necessary to complete the work in a safe, efficient, and quality manner. All work performed by Uranium One Americas at Wyoming In Situ Recovery (ISR) sites must comply with the requirements of this Quality Assurance Project Plan.

Prepared By: Date:

_____ _____

Approved By: Date:

_____ _____

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1 INTRODUCTION

This Quality Assurance Plan is applicable to the environmental monitoring program implemented by Uranium One Americas at Wyoming ISR sites. The plan provides the quality requirements for field collection of samples and the subsequent analysis of those samples at a laboratory.

2 QUALITY PLAN REVIEW, REVISION AND DISTRIBUTION

This Quality Assurance Plan will be reviewed by affected project managers in accordance with the company policy for controlled documents. Revisions will be made at the direction of the Manager of Environmental and Regulatory Affairs, Wyoming to reflect changes in work scope, organizational interfaces or new regulatory requirements. This plan will be reviewed annually to ensure the content is valid and applicable to monitoring activities. Revisions to this plan will require approvals at the same level as the original document. At a minimum, copies of this QA Plan shall be available to all affected employees and support organizations.

3 REGULATORY REQUIREMENTS

This Quality Assurance Plan is designed to incorporate quality assurance/quality control requirements and guidance the following regulatory references:

– USNRC Regulatory Guide 4.14, *Radiological Effluent and Environmental Monitoring at Uranium Mills*, Revision 1, April 1980.

– USNRC Regulatory Guide 4.15, *Quality Assurance for Radiological Monitoring Programs (Normal Operations) – Effluent Steams and the Environment*, Revision 1, February 1979.

4 ORGANIZATION

Administration of the environmental monitoring programs in Wyoming is assigned to the Manager of Environmental and Regulatory Affairs, Wyoming. The Manager may delegate the day-to-day implementation of the environmental monitoring program to other EMC employees or to outside contractors, but he may not delegate the ultimate responsibility. Such assignment shall be in writing.

Key positions within the Uranium One Americas management system include:

Senior Vice President, ISR Operations – The Senior Vice President, ISR Operations has responsibility for overall management of Wyoming operations for Uranium One Americas. The Senior Vice President, ISR Operations reports to the Executive Vice President, Uranium One Americas.

Director of Environmental and Regulatory Affairs - The Director of Environmental and Regulatory Affairs has responsibility for preparation and oversight of environmental monitoring programs for Uranium One Americas. The Director of Environmental and Regulatory Affairs reports to the Executive Vice President, Uranium One Americas.

Manager of Environmental and Regulatory Affairs, Wyoming – The Manager of Environmental and Regulatory Affairs, Wyoming has responsibility for the overall management of the environmental monitoring programs for Uranium One Americas. The Manager of Environmental and Regulatory Affairs, Wyoming reports to the Senior Vice President, ISR Operations.

Senior Environmental Specialist – The Senior Environmental Specialist has responsibility for the day-to-day supervision of the environmental monitoring programs for Uranium One Americas. The Senior Environmental Specialist reports to the Manager of Environmental and Regulatory Affairs, Wyoming.

Radiation Safety Officer – The Radiation Safety Officer has responsibility for the overall management of the radiation safety program for Uranium One Americas including implementation of QA Program requirements related to radiation safety programs. The Radiation Safety Officer reports to the Manager of Environmental and Regulatory Affairs, Wyoming.

5 QUALITY OBJECTIVES

Environmental data for the Wyoming ISR sites, derived through long-term monitoring and data interpretation, will be of sufficient quantitative and qualitative value to determine whether performance criteria are being met. The type and quality of data provided to the appropriate regulatory agencies will be used to document the performance of the uranium recovery operation and later attainment of reclamation and restoration goals.

Monitoring strategy for sampling and analytical QA objectives for data include:

- Data will be of sufficient quality to withstand scientific and legal scrutiny.
- Data will be acquired in accordance with procedures appropriate for their intended use.
- Data will be of known accuracy and precision.

– Data will be complete, representative, and comparable.

5.1 Field Quality Objectives

The field and analytical methods chosen for use in completing the work are industry standards and are consistent with accepted standards for conducting environmental investigations.

5.2 Laboratory Quality Objectives

The quality of data generated by the analytical laboratory is dependent on method precision, accuracy, and sensitivity and the basic nature of the analysis and type of equipment used to perform an analysis. Precision is a measure of the reproducibility of an analytical measurement, and accuracy is the difference between a measured value and a true or known value. These considerations are dependent upon the sample matrix and performance criteria, and method sensitivity may not be achieved in all sample matrices.

5.2.1 Precision

Precision is the agreement between a set of replicate measurements without assumption about or knowledge of the true value. Precision is assessed on the basis of repetitive measurements. Replicate field measurements of ground water are not needed because they are sequentially recorded during well purging. Evaluations will be performed to judge the precision of both field and laboratory measurement processes.

Duplicate sample analyses are used to monitor the overall precision that can be expected for a particular environmental medium within an analytical sample batch. Requirements for the collection frequency of QA samples will be specified in the site-specific environmental planning document sample events.

In the laboratory, precision is a measure of reproducibility and may be determined by repeated analysis of laboratory control samples (LCSs) or reference standards or by duplicate analysis. The laboratory will demonstrate precision through analysis of replicate standards and performance samples prior to analysis of investigative samples as required by the particular analytical method.

5.2.2 Bias

Bias is the systematic or persistent distortion of a measurement process that causes errors in one direction. The analytical laboratory will analyze reference materials to verify that

the analytical results are not biased. Calibration and operational checks of field instruments will verify that no bias is present in field measurements.

5.2.3 Accuracy

Accuracy is the nearness of a measurement or the mean of a set of measurements, to the true value and is usually expressed as the difference between the two values or the difference as a percentage of true value.

It is not possible to directly assess accuracy of field measurements and water levels because true values for these measurements are not known. To ensure accuracy of the field data, instruments and equipment used in surveying, sampling, or obtaining the measurements will be maintained and calibrated. Accuracy of surface water and ground water field measurements is addressed indirectly through instrument checks and calibrations, which will be documented in field logbooks or on field data sheets, as appropriate.

Accuracy will be assessed for analytical data by examining the results obtained from laboratory Quality Control (QC) samples. The primary means of determining the accuracy of an analytical method is to compare the results of repeated measurements of laboratory control samples and reference material with published known values. The secondary method of accessing accuracy is to analyze matrix spike samples. Accuracy requirements of routine analytical services are specified in the analytical methods. Accuracy for each analysis will be stated as a percent recovery in laboratory analytical reports.

5.2.4 Representativeness

Representativeness is generally ensured through the use of standard sampling protocols. Representativeness will be accomplished:

- Through extensive sampling that includes implementation of field QA/QC procedures.
- By careful and informed selection of sampling sites, sampling depths, and analytical parameters
- Through the proper collection and handling of samples to avoid interferences and to minimize constituent loss
- By monitoring field activities to ensure procedure compliance and adherence to sampling protocols
- By meeting sample care and custody requirements

5.2.5 Comparability

Comparability is the confidence with which one data set can be compared to another. Comparability is ensured by employing approved sampling plans, standardized field procedures, and experienced personnel using properly maintained and calibrated instruments. In the laboratory, sample handling and preparation procedures, analytical procedures, holding times, and QA protocols will be adhered to. All data in a particular data set will be obtained by the same methods and will use consistent units for reportable data. Prescribed QC procedures will be used to provide results of known quality. Data will be grouped and evaluated according to similar sampling methods, sampling media, and laboratory analytical methods.

5.2.6 Sensitivity

Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of the analyte of interest. An evaluation of sensitivity is included in the analytical methods that are used to analyze samples.

6 PERSONNEL AND TRAINING

6.1 Personnel Requirements

6.1.1 Training

Personnel will be qualified to perform their assigned job through meeting basic job description requirements, education standards, experience, and ongoing performance reviews. Training will be provided when needed to maintain proficiency; to adapt to new technologies, equipment, or instruments; and to perform new assigned responsibilities.

The Senior Environmental Specialist is responsible for determining site-required training and communicating the requirements to appropriate managers. Managers are responsible for determining training needs of their staff. Personnel assigned to environmental monitoring activities are responsible for ensuring that their required training are documented and are maintained in a current status for their assignments. At a minimum, individual training requirements will be reviewed annually and updated as needed.

The Senior Environmental Specialist is responsible for ensuring that personnel assigned to environmental monitoring tasks are sufficiently familiar with the implementing documents (e.g., plans, procedures, and drawings) and the requirements established for environmental monitoring, sample collection, analysis, documenting and reporting activities, and demonstrating proficiency.

The Senior Environmental Specialist will ensure that personnel assigned to field sampling activities can demonstrate proficiency when performing the work or that they are properly supervised by a person who is proficient.

6.1.2 Certifications

QA staff that performs independent assessments of environmental monitoring activities or management systems will be qualified as lead assessors.

Laboratories used for analysis of samples collected for characterization, compliance, or other purposes will be required to pass an audit or be certified by the National Environmental Laboratory Accreditation Conference (NELAC).

7 DATA GENERATION AND ACQUISITION

This section addresses aspects of the measurement system design and implementation to ensure that appropriate methods for sampling, analysis, data handling, and QC are employed and will be thoroughly documented.

7.1 Sampling Process Design

The data obtained through monitoring site conditions will be of sufficient quantity and quality to achieve environmental monitoring objectives.

Monitoring procedures for the Wyoming ISR sites have been established. These monitoring programs are designed to ensure that monitoring data would satisfy applicable regulations and would ensure that there were no unacceptable risks to human health or the environment. The site-specific environmental monitoring plan defines the sample locations and sampling frequency and determines the types of analyses that will be conducted on the samples collected from these locations. The plans are reviewed every 5 years, and changes to sampling strategies may be proposed on the basis of analytical results, site conditions, or regulatory requirements.

7.2 Sampling Methods

Field measurements and sample collection will follow procedures attached to nationally recognized consensus standards such as EPA methods, American Society for Testing and Materials standards, or instrument manufacturer recommended procedures. Deviation from approved procedures requires approval by the Senior Environmental Specialist before the start of work.

7.2.1 Sample Collection Procedures

Sampling procedures used at Wyoming ISR sites will be managed as controlled documents and will be amended according to the requirements of this plan.

Procedures must be followed for documenting field activities and delivering the samples to the laboratory. Procedures will identify the methods employed to obtain representative field measurements and samples of specified media. The procedures will identify the equipment, instruments, and sampling tools that are needed and, where appropriate, performance criteria (e.g., special handling, operational checks, field calibrations) to ensure the quality of the field data.

The Senior Environmental Specialist is responsible for ensuring that inspections, operations and maintenance activities, field measurements, and specified samples are properly documented, occur at the prescribed frequency and locations, and are obtained in compliance with procedures and requirements specified in the project documents. Daily QC checks and data reviews will ensure that requirements have been met. If field conditions prevent inspections, required field measurements, and/or specified sample collection, the conditions will be fully documented in the field book as a field variance.

7.2.2 Field Measurements and Sampling Methods

Field measurements and sampling schedules are summarized in the environmental monitoring procedures. The data obtained through these activities will be used to monitor compliance with performance requirements. Field procedures used in well inspections, field measurements, sample collection methods, field data, equipment and supplies applicable to the field activities, sample preservation requirements, and QC sample requirements are described in the environmental monitoring procedures.

7.3 Preparation and Decontamination Requirements for Sampling Equipment

7.3.1 Requirements for Sample Containers, Preservation, and Holding Times

Nondedicated equipment used in obtaining samples will be visually inspected and cleaned before use at each sample location. Measures will be taken (e.g., storage in trays, plastic bags, or boxes) to protect clean or decontaminated equipment while it is not being used. Sample containers will be inspected for integrity and cleanliness before being used. Suspect containers will be discarded in a manner that will preclude their inadvertent use, or they will be tagged and segregated for return to the supplier.

7.3.2 Container Requirements

Sample containers will be new or pre-cleaned. Containers will be of an adequate size to contain the required sample volume and of an approved material (e.g., amber/clear glass or HDPE) that does not promote sample degradation. As appropriate, supplier provided certificates of cleanliness will be retained with the project documentation.

Water samples collected for analysis will be filled to near 90 percent of capacity to allow for expansion.

7.3.3 Preservation and Holding Times

Efforts to preserve the integrity of the samples through prescribed chemical additives and/or temperature-controlled storage will be maintained as appropriate from the time the containers are received, throughout the sample collection and shipping process, and will continue until all analyses are performed. Procedures that will be employed to collect and preserve the integrity of the samples are described in the procedures. Holding times begin at the time the sample is collected, not when the sample is received by the laboratory.

7.3.4 Decontamination Procedures and Materials

Where practical, dedicated pumps will be installed in monitor wells and disposable materials will be used to minimize the decontamination requirements. The final rinse following equipment decontamination will be collected as an equipment blank QC sample.

7.4 Sample Handling and Custody Requirements

Sample handling, custody, and shipping procedures are addressed in the environmental monitoring procedures. A minimum number of individuals should be involved in sample collection and handling to ensure integrity of the sample and compliance with custody procedures. To maintain evidence of authenticity, the samples collected must be properly

identified and easily discernable from like samples. To maintain the integrity of the sample, proper preservation, storage, and shipping methods will be used.

Unused sampling equipment, sample containers, and coolers that have been shipped or transported to a sampling location will be kept in a clean, temperature-controlled, and secure location to minimize damage, tampering, degradation, and possible cross-contamination.

7.4.1 Identification, Handling, Packaging, and Storage

7.4.1.1 Sample Identification

Environmental samples and associated QC samples will be assigned a unique identification number. In addition to the unique number, QC samples will be assigned a fictitious location identifier that is consistent with the sample location identification scheme.

Samples will be identified by a label or tag attached to the sample container that specifies, as appropriate, the project, sample location, unique identification number, preservatives added, date and time collected, and the sampler's name. Sample labels, tags, and/or container markings should be completed with indelible (waterproof) ink. Clear tape may be placed over each sample label for added protection, if needed.

7.4.1.2 Sample Handling and Storage

During field collection, sample containers may be stored in boxes, trays, or coolers, as dictated by protection and preservation needs. Samples that require refrigeration will be stored in coolers with sufficient ice to maintain the required temperature controls during field collection, packaging, and shipping. Samples that are not transported to the laboratory the day of collection must be stored in containers that will prevent damage or degradation of the sample. In addition, samples must be stored in locked containers or buildings when they are out of the direct control of the responsible custodian. Samples stored overnight or at locations where access is not solely controlled by the custodian will have custody seals placed on the outside of the container (cooler or box) as a measure of security.

7.4.1.3 Sample Custody

To ensure the integrity of the sample, the field custodian is responsible for the care, packaging, and custody of the samples until they are transferred to the laboratory.

Chain of Custody forms will be used to list all samples and transfers of sample possession to provide documentation that the samples were in constant custody between

collection and analysis. The filled-in Chain of Sample Custody form, a copy of which is retained by the originator, will accompany samples that are sent or transported to the analytical laboratory.

7.4.1.4 Sample Packaging and Shipping

All samples will be handled, packaged, and transported or shipped in accordance with applicable U.S. Department of Transportation requirements. Sample storage containers (e.g., boxes or coolers) and sample containers will be securely packaged to protect the contents from damage, spilling, leaking, or breaking. Void space in shipping containers should be filled with an inert material or additional ice, if appropriate, to further protect and secure the contents.

Custody seals are not required for containers or samples that are transported directly to the analytical laboratory for analysis or interim storage. Custody seals are required for shipping containers (e.g., coolers or boxes) that are sent by common carrier. Clear tape should be placed over the seals as protection against tearing during shipment.

Mailed sample packages will be registered with return receipt requested. If packages are sent by common carrier, receipts are retained as part of the chain of custody documentation. Other commercial carrier documents shall be maintained with the chain of custody records.

7.4.2 Laboratory Requirements

7.4.2.1 Laboratory Sample Receipt

The subcontract analytical laboratory personnel are responsible for the care and custody of samples from the time they are received until the time the sample is analyzed and archive portions are discarded. On arrival at the laboratory, laboratory personnel must examine the container and document the receiving condition, including the integrity of custody seals, when applicable. When opening the shipping container, laboratory personnel will examine the contents and record the condition of the individual sample containers (e.g., bottles broken or leaking), the temperature (when applicable), method of shipment, carrier name(s), and other information relevant to sample receipt and log-in. Laboratory personnel verify that the information on the sample containers matches the information on the Chain of Sample Custody form.

7.4.2.2 Discrepancies Identified During Sample Receipt

If discrepancies are identified during the sample receiving process, laboratory personnel will attempt to resolve the problem by checking all available information (e.g., other markings on sample containers and type of sample), recording appropriate notes on the Chain of Sample Custody form, and contacting the Senior Environmental Specialist to resolve any questions.

If the laboratory judges the sample integrity to be questionable (e.g., samples arrive damaged or leaking, or the temperature range is exceeded), the Senior Environmental Specialist will be contacted and will bring in appropriate technical staff to make a decision regarding rejecting or flagging the data and/or re-sampling the location. Damaged samples will be rescheduled for collection and analysis, if necessary.

Discrepancies noted during sample receiving at a subcontracted laboratory or testing facility will be resolved in accordance with the procurement documents. In general, the Senior Environmental Specialist will be contacted to facilitate resolution of a problem.

7.4.2.3 Sample Disposition

When sample analyses and necessary QA/QC checks have been completed in the laboratory, the residual sample material and wastes generated as a result of the analytical process will be treated, shipped, and disposed of in accordance with all applicable federal, state, and local transportation and waste management requirements. When samples are stored, they will be protected to prevent damage or degradation. At a minimum, samples shall not be removed from the laboratory sooner than 60 days after the delivery of laboratory data reports.

7.4.3 Analytical Methods

Laboratories involved in the analysis of samples will have a written QA/QC program that provides rules and guidelines to ensure reliability and validity of the work conducted at the laboratory.

The analytical procedures to be used by subcontracted laboratory services will be specified in the procurement documents. These procedures typically consist of EPA methods. The use of these methods will ensure that required method detection limits and project reporting limits are achieved for each of the requested analytes.

Required analytical methods will be documented in appropriate site-specific documents.

7.4.3.1 Subcontracted Laboratory Requirements

The subcontracted laboratory will have a documented QA program in place, the implementation of which may be independently verified through proposal reviews, prior history, and/or pre-award survey. As appropriate, subcontracted laboratories will use EPA or EPA-approved methods or other methods specified and approved within the provisions of the procurement documents. Subcontracted laboratories are required to pass an audit or be certified by NELAC. Internal method requirements for analysis of spikes, duplicates, or replicates will be followed and may be used as performance indicators for these services.

Data turnaround times, sample disposition, and other requirements of the analytical laboratory are identified in procurement documents. The laboratory must obtain authorization from the Senior Environmental Specialist for changes to the procurement documents.

Work submitted to the laboratory may not be subcontracted by the laboratory without the prior consent of Uranium One Americas.

7.4.4 Quality Assurance/Quality Control

7.4.4.1 Field QA/QC

A variety of instruments, equipment, sampling tools, and supplies will be used to collect samples and to monitor site conditions. Proper inspection, calibration, maintenance, and use of the instruments and equipment are required to ensure field data quality. In addition, field QA will be implemented through the use of approved procedures, proper cleaning and decontamination, protective storage of equipment and supplies, and timely data reviews during field activities. The QC objective of these data collection activities is to obtain reproducible and comparable measurements to a degree of accuracy consistent with the intended use of the data.

QC samples will consist of field duplicates, equipment rinsate blanks, and trip blanks, as appropriate, for the matrix and analytes involved. An additional volume of ground water for selected analyses will be collected for matrix spike/matrix spike duplicate (MS/MSD) use, as requested by the laboratory. Field QC samples will be used to quantitatively and qualitatively evaluate the analytical performance of the laboratory and to assess external and internal effects on the accuracy and comparability of the reported results. Field QC samples will be uniquely identified.

Where applicable, field measurement data will be compared to previous measurements obtained at the same location. Large variations (greater than 30 percent) in field

measurement data at a location will be examined to evaluate whether general trends are developing. Variations in data that cannot be explained will be assigned a lower level of confidence through assignment of qualifiers or will be flagged for additional sampling or evaluation.

7.4.4.2 Laboratory QA/QC

Laboratory QC checks are internal system checks and control samples introduced by the laboratory into the sample analysis stream. These checks are used to validate data and calculate the accuracy and precision of the data. The objectives of the laboratory QA/QC program should be to:

- Ensure that procedures and any revisions are documented
- Ensure that analytical procedures are conducted according to sound scientific principals and have been validated
- Monitor the performance of the laboratory by a systematic inspection program and provide for corrective measures, as necessary.
- Collaborate with other laboratories in establishing quality levels, as appropriate
- Ensure that data are properly recorded and archived

Internal QA procedures for analytical services will be implemented by the laboratory in accordance with the laboratory's standard operating procedures. Data sheets, which also report the blank and spiked sample checks that have been performed, will be provided and will indicate when a QC check was performed. Analytical data that do not meet acceptance criteria will be qualified and flagged in accordance with standard operating procedures.

Laboratory quality control procedures are defined within the particular analytical method or are defined in procurement documents.

7.4.5 Instrument/Equipment Testing, Inspection, Calibration, and Maintenance

A variety of equipment, instruments, and sampling tools will be used to collect data and samples for the Wyoming ISR sites. Proper maintenance, calibration, and use of equipment and instruments are imperative to ensure the quality of all the data that are collected.

Field and laboratory equipment, instruments, tools, gauges, and other items used in performing work tasks that require preventive maintenance will be serviced in

accordance with manufacturers' recommendations and instructions. When applicable, technical procedures will identify the manufacturers' instructions and recommended frequency for servicing the equipment. Preventive maintenance for calibrated measuring and test equipment will be performed either by field or laboratory personnel who are knowledgeable of the equipment, or by manufacturer's authorized service center as part of routine calibration tasks. Records of equipment calibration, repair, or replacement of controlled instruments will be filed and maintained in accordance with the applicable records management requirements.

Instruments that are not calibrated to the manufacturers' specifications will display a warning tag to alert the sampler and analyst that the instrument has only limited calibration.

7.4.5.1 Field Equipment and Instruments

Field equipment, instruments, and associated supplies used to obtain field measurements and collect samples are specified in sampling procedures.

Field personnel will conduct visual inspections and operational checks of field equipment and instruments before they are shipped or carried to the field and before using the equipment or instruments in field data collection activities. Whenever any equipment, instrument, or tool is found to be defective or fails to meet project requirements, it will not be used, and as appropriate, it will be tagged defective and segregated to prevent inadvertent use. Backup equipment, instruments, and tools should be available on site or within 1-day shipment to avoid delays in the field schedule.

The Senior Environmental Specialist is responsible for the overall maintenance, operation, calibration, and repairs made to field equipment, instruments, and tools. He is also responsible for ensuring that the field book has adequate documentation that describes any maintenance, repairs, and calibrations performed in the field.

Equipment and instruments used to obtain data will be maintained and calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of results are consistent with the manufacturers' specifications. Calibration of equipment and instruments will be performed at approved intervals, as specified by the manufacturer, or more frequently as conditions dictate. Calibration standards used as reference standards will be traceable to the National Institute of Standards and Technology or other recognized standards when available. Instruments found to be out of tolerance will be tagged defective and segregated to prevent inadvertent use.

In some instances, calibration periods will be based on usage rather than periodic calibration. Equipment will be calibrated or checked as a part of its operational use.

Records of field calibration will be documented on forms provided for technical procedures or recorded in the field logbook. Calibration checks will be performed in accordance with procedures.

Procedures recommended by the manufacturer will be used for equipment preventive maintenance. Backup equipment, supplies, and critical spare parts (e.g., tape, bottles, filters, pH paper, tubing, probes, electrodes, and batteries) will be kept on site to minimize downtime. The Senior Environmental Specialist is responsible for ensuring that routine maintenance is performed and that tools and spare parts used to conduct routine maintenance are available.

7.4.5.2 Laboratory Equipment and Instruments

As part of the QA/QC program for the analytical laboratory, routine preventive maintenance is conducted to minimize the occurrence of instrument failure and other system malfunctions. The laboratory will maintain a schedule for servicing critical items and will perform routine maintenance, scheduled maintenance and repair, or coordinate with a vendor to arrange for maintenance and repair service, as required. All laboratory instruments will be maintained in accordance with the manufacturers' specifications and the requirements of the specific method employed. Equipment will be tested during routine calibration, and deficiencies will be corrected as specified in procedures.

The concentration of standards and frequency of initial and continuing calibration of analytical instruments will be as specified in the laboratory procedures. Calibration data will be provided with the analytical data package. Calibration records pertaining to subcontracted laboratory services will be filed and maintained by the laboratory in accordance with internal procedures.

7.4.6 Instrument/Equipment Calibration and Frequency

Calibration of analytical laboratory equipment will be based on approved written procedures. The concentration of standards and frequency of initial and continuing calibration of analytical instruments will be as specified in the laboratory SOPs. The analytical laboratory will maintain calibration records. Calibration data will be provided with the analytical data package, as specified in the procurement documents.

7.4.7 Inspection/Acceptance of Supplies and Consumables

7.4.7.1 Sample Containers

Sample containers for water, soil, sediment, and other media will be provided by the subcontracted laboratory and will be new or pre-cleaned. As appropriate, supplier-provided certificates of cleanliness will be retained with field documentation.

Containers will be visually inspected for integrity and cleanliness before being used. Suspect containers will not be used and will be discarded in a controlled manner to prevent inadvertent future use. If sufficient quantities of containers are suspect, the laboratory will immediately be notified of the condition and requested to provide a sufficient quantity of replacement containers. Suspect containers will be collected, segregated, and tagged for return to the analytical laboratory. The Senior Environmental Specialist will describe the situation in the field book as a field variance.

7.4.7.2 Supplies and Consumables

The Senior Environmental Specialist is responsible for ensuring that supplies, materials, and consumable items used during field activities are properly inspected for integrity, cleanliness, and compliance with specified tolerances and that they are appropriate to the activity. Items with a specified shelf life or expiration date will be labeled. Expired materials will not be used and will be properly disposed of or returned to the laboratory for disposal, as appropriate. Supplies, materials, and equipment will be inventoried at the conclusion of the sampling event in preparation for the next scheduled event.

7.4.8 Data Acquisition Requirements through Non-Direct Measurements

Data acquired through non-direct measurements may include data from historical databases, literature references, background information from historical facility files, climatic data, and regional geology or hydrology descriptions. Generally, these data are ancillary to the project.

Data from historical databases or historical facility files should be evaluated within the context in which they are presented and a determination made as to how accurate the data of interest may be. The exact nature of the evaluation likely will have to be made on a case-by-case basis. Information obtained from literature references should be from peer-reviewed journals or books whenever possible. Information such as climatic data and regional geology or hydrology descriptions should be obtained from documents produced by state or federal agencies whenever possible.

7.4.9 Data Management

Project data are generated mainly from routine sampling of monitor wells, routine operations system sampling, and occasional soil sampling events. The Senior

Environmental Specialist is responsible for managing project data in compliance with Uranium One Americas requirements.

Field data books are assembled for most sampling events. These books contain information such as sample location identification (ID), date, QA sample ID, well purge method, sampling method, and field measurements. These are completed at the time of sample collection.

Data from samples submitted to an analytical laboratory are received as both hard copy and as electronic data. The hard copy analytical reports are archived in the project records along with the original field data forms and other relevant hard copy forms or documents containing project data. The hard copy forms are categorized in the project records according to the project filing procedures. Electronic data are also archived in the project records according to the project filing procedures.

7.5 Data Validation and Usability

Technical data, including field data and results of laboratory analyses, will be routinely verified and validated to ensure that the data are of sufficient quality and quantity to meet the project's intended data needs. Results of data validation efforts will be documented and summarized in the site-specific validation reports. The Senior Environmental Specialist is responsible for initiating the review, verification, validation, and screening associated with field and/or laboratory data.

7.5.1 Field Measurement Data

The objective of field data verification is to ensure that data are collected in a consistent manner and in accordance with procedures and schedules established in the Wyoming ISR environmental planning documents. Field data validation procedures include a review of raw data and supporting documentation generated from field investigations. The data are reviewed for completeness, transcription errors, compliance with procedures, and accuracy of calculations.

The person doing the validation (in consultation with the Senior Environmental Specialist, if required) may correct problems that are found or noted in field documentation. Corrections to data forms will be made by lining through the incorrect entry, correcting the information, then initialing and dating the corrected information. The person validating the document, with the consent of the Senior Environmental Specialist, may also determine that incorrect data should not be entered into a database or that the data should have an additional qualifier.

7.5.2 Laboratory Data

The laboratory performing the analyses will document the analytical data in accordance with standard procedures inherent in the analytical methods and as approved by the Senior Environmental Specialist, if required.

Once the data package is received from the analytical laboratory, laboratory records and data package requirements will be checked to assess the completeness of the data package, and the data will be validated by personnel qualified and experienced in laboratory data validation.

The QC data provided by the laboratory (method blanks, matrix spikes, etc.) will be evaluated to see if they are within the acceptance range. If they are not, the data set affected by the QC samples will be evaluated to determine if corrective action is necessary.

7.5.2.1 Quality Control Samples

QC samples consisting of trip blanks, equipment rinsate blanks, field duplicate samples (replicated or co-located samples), laboratory spikes, laboratory blanks, laboratory duplicates, and laboratory control samples (including thermoluminescent dosimeters) are evaluated in the data validation process.

7.5.3 Qualification of Data and Corrective Actions

Qualification criteria are defined in the Uranium One Americas procedures. In addition to the process of qualifying the data, other corrective actions may be used. These may include reanalysis of the data by the laboratory or re-sampling of the affected locations. Other corrective actions to prevent contamination of future samples may also be proposed.

7.5.4 Determination of Anomalous Data

The final aspect of data validation involves the screening of both field and laboratory analytical data for potentially anomalous data points.

7.5.4.1 Data Screening

The initial step in determining potentially anomalous data points consists of screening all data from a sampling event for values that fall outside a designated historical data range. The historical data range used for comparison will be from previous sampling events.

7.5.4.2 Technical Review

The next step involves a review of the screened data by a qualified individual experienced in data review. Each data point will be evaluated to determine if the data point is acceptable or if follow-up action is required. This evaluation will consider factors such as number of historical data points, analyte concentration, magnitude of the deviation from the historical data range, number of historical non-detects, variability of the historical data, location of the sample point relative to other potential interfering activities, and correlation with other analytes.

7.5.4.3 Follow-up Actions

Follow-up actions can include one or more of the following:

- Requesting a laboratory check of calculations and dilutions
- Sample reanalysis
- Re-sampling
- Comparison to results from the next sampling event
- Data qualification

Based on the results of the follow-up action, the Senior Environmental Specialist will make a final determination of validity of the data point. The data point will be considered acceptable or it will be qualified, and a record of the action will be made. A summary of any anomalous data will be included in the site-specific data validation report.

7.5.4.4 Data Qualification

After the Senior Environmental Specialist has determined that a data point is anomalous, the data point will be qualified with an "R" flag (unusable) in the database. Qualification of data will be noted with a brief justification for the qualification.

7.6 Documentation and Records

The requirements for documentation and records management apply to the preparation, review, approval, issue, use, and revision of documents or forms that prescribe processes, specify requirements, or establish design. Records must be specified, prepared, reviewed, approved, and maintained as directed by Uranium One Americas policy.

Field and laboratory data will be sufficiently documented to provide a scientifically defensible record of the activities and analyses performed. Records of field variance reports, internal reviews, field and laboratory records of tests and analyses, field logs,

Chain of Custody forms, and project reports will be used in interpreting and assessing the usability of the data. Standardized forms and computer files, codes, programs, and printouts will be designed to eliminate errors made during data entry and reduction. Calculation steps are described in the technical and analytical procedures and software lists. Routine data-transfer and data-entry verification checks are performed.

Laboratories must demonstrate continued proficiency through participation in performance evaluation programs required by the USNRC and WDEQ.

7.6.1 Records Management Plan

A site-specific records management plan shall be prepared to identify the records to be generated, file locations, and retention schedule for the Wyoming ISR site. The records management plan establishes the requirements for preparing, preserving, and storing records. Project personnel will work with the Senior Environmental Specialist, or his designee, to ensure that environmental monitoring records are correctly identified and maintained in accordance with the plan. Modifications to the plan shall be submitted to the Senior Environmental Specialist and are subject to his review and approval.

7.6.2 Document Control and Changes

Uranium One Americas policy and procedures will be followed to ensure that the preparation, issuance, and revisions to project documents and forms will be controlled so that current and correct information is available at the work location. These project documents (e.g., plans, procedures, drawings, and forms) and subsequent revisions will be reviewed for adequacy and approved before being issued for use. Written records and photo documentation will be handled in a manner that ensures association to the activity, the samples, and their locations. The Senior Environmental Specialist can authorize minor changes to project documents without requiring a formal review process.

At a minimum, personnel responsible for environmental monitoring activities at the Wyoming ISR site will have access to the applicable documents and will be knowledgeable of the contents before the associated work assignment.

Nonroutine sampling and field investigations will be documented in the file. The Senior Environmental Specialist will be briefed on and will approve all nonroutine field investigations before the work begins.

7.6.3 Corrections to Documents

When practical, correction of errors should be made by the individual who made the entry. The method used to make a correction is to draw a line through the error, enter the correct information, then initial and date the entry. The erroneous material must not be obscured.

When a document requires replacement due to illegibility or inaccuracies, the document will be voided, and a replacement document will be prepared. A notation will be made on the voided document that a replacement document was completed. The voided document will be retained with the field documentation.

7.6.4 Project Documents

Project documents are written materials that provide a background or history of the work, establish the basis for the work, give guidance to the work, and provide a summary of the work. They may be documents such as technical reports, technical and administrative plans, inspection or test documents, and design or as-built drawings. Documents prepared for the Wyoming ISR site that establishes instructions or procedures will be developed in accordance with the applicable requirements. Documents that are subject to revision will be managed and issued as controlled documents. These include, but are not limited to, the following documents:

- Quality Assurance Plans and Procedures
- Site-Specific Environmental Monitoring and Sampling Plans

7.6.5 Procedure Requirements

Uranium One Americas personnel will comply with the requirements of all approved written procedures or other instructions. Any deviation from approved field procedures must be authorized by the Senior Environmental Specialist. Field changes to project plans or deviation from procedures will be documented in the field book as a field variance and communicated to the Senior Environmental Specialist as soon as possible.

The Senior Environmental Specialist will be notified of any changes to subcontract laboratory procedures. He will be informed of and review changes to laboratory procedures. Impacts will be identified to the Senior Environmental Specialist. As appropriate, procedure changes that affect laboratory data will be identified and documented during the data review, verification, and validation activities. As appropriate, the Senior Environmental Specialist will inform Uranium One Americas

management of technical or other substantive changes to laboratory procedures that may affect reporting limits or analytical sensitivity.

7.6.6 Field Documentation

Field documentation requirements are specified in the sampling procedures. All entries in field documents will be made with indelible (waterproof) ink and will be legible, reproducible, accurate, complete, and traceable to the sample measurements and/or site location. These documents will be retained as project records. Field documents are intended to provide sufficient data and observations to enable participants to reconstruct events that occurred during the field sampling activities. Field logbooks and forms (e.g., sample collection data sheets, field measurement data forms, Chain of Custody forms, and shipping forms) will be stored in a manner that protects them from loss or damage.

The Senior Environmental Specialist will adequately document and identify field measurements and each sample collected. Field records will be completed at the time the observation or measurement is made and when the sample is collected. Project documents and written procedures will be available at the work site. The Senior Environmental Specialist will ensure that specified requirements are followed so that an accurate record of sample collection and transfer activities is maintained.

As appropriate, sample disposition will be specified to the subcontract laboratory in the appropriate procurement documents.

7.6.6.1 Field Books and Forms

Any person conducting field sampling will maintain a field book to provide a daily record of field activities associated with monitoring and sampling events and to document relevant operations and measurements. If initials are used in place of signatures, a signature/initials log will be maintained to identify personnel who are authorized to record, review, and authenticate field data.

Field books for project activities will be prepared, managed, and maintained in accordance with project records requirements. Project field books will be prepared and issued by the Senior Environmental Specialist. Field book information may include documentation associated with routine or ad hoc field measurements and sampling, chain of custody, soil boring and well installation, sampling equipment, calibration records and standards, and general field notes, including repairs made to equipment and instruments.

7.6.6.2 Field Variance and Nonconformance Documentation

Changes from specified field protocols established in planning documents or standard operating procedures must be authorized by the Senior Environmental Specialist and fully documented by the person doing the sampling. Field variances will be reported in a timely manner to evaluate the impact the variance has on the data or system operations. Field variance reporting applies to deviations from (1) prescribed field sampling and measurement requirements; (2) specified shipping, handling, or storage requirements; and (3) decontamination procedures.

A variance must be documented whenever an activity is performed or sample is obtained where:

- The activity performed or sample collection technique does not fall within the methods or protocols specified.
- The monitoring or measurement instrument that was used was out of calibration or had failed an operational check.
- Insufficient documentation results in the inability to trace the activity, measurement, or sample to the prescribed or selected location
- There is a loss of or damage to records that cannot be duplicated.

The variance should be fully described, and corrective action, if applicable, should be taken immediately. Comments describing the variance will be used during data evaluation to assess the use of associated results and validity of the data. Field variances should be noted in the field data sheet, on a general log sheet, or in the activity logbook. As appropriate, field variances will be summarized in the report at the conclusion of the activity.

7.6.6.3 Chain of Sample Custody

The custody of individual samples will be documented by recording each sample's identification, number of containers, and matrix on a standardized Chain of Custody form. This form will be used to list all transfers of sample possession.

7.6.7 Laboratory Documentation

The format and content of laboratory reports depend on contract requirements, regulatory reporting formats, and whether explanatory text is required. At a minimum, the laboratory data report will include the following items:

- Analytical method used

- Date and time of analysis
- The Chain of Custody form
- Sample receiving documentation
- QC data results and report
- Sample data results by analysis, including method detection limits, reporting limits, and dilution factors
- Summary of results (e.g., case narrative)
- Certification by the laboratory that the analytical data meet applicable data quality requirements

Analytical data that do not meet specified criteria will be qualified and flagged to allow data evaluation before use. Any nonconformances or difficulties encountered during analyses will be documented with each data package.

7.6.8 Reports Received from Subcontractors

7.6.8.1 Laboratory or Other Data Reports

Reporting requirements and formats will be defined in procurement documents issued for subcontracted services. The Senior Environmental Specialist will be consulted regarding difficulties or nonconformance associated with subcontracted analytical services and will resolve disputes that could affect data quality.

7.6.8.2 Plans and Technical Reports

The criteria for technical reports received from subcontracted services may include a deliverable schedule for draft and final documents, required reviews, format, software type and version requirements, and contents of the document, including any supporting documents, data, and references.

7.7 Quality Improvement, Assessment, and Oversight

All personnel must continually seek to improve the quality of their work. This section addresses the activities for assessing the effectiveness of the implementation of the project and associated QA/QC requirements.

7.7.1 Quality Improvement

Management encourages innovation and continuous improvement in the work environment by fostering a "no fault" attitude to encourage the identification of problems

and to create an atmosphere of openness to suggestions for improvement. All personnel are encouraged to identify and suggest improvements.

Personnel have the freedom and authority to stop work until effective corrective action has been taken. Work that is performed by subcontractors will be subject to oversight. The work may be suspended immediately for imminent threats to health, safety, environmental release, or significant adverse quality issues. Re-start of such work stoppages will be at the direction of the Senior Vice President, ISR Operations.

7.7.2 Assessment and Response Actions

Assessments of project activities will be planned and scheduled with the appropriate levels of management. The Director of Environmental and Regulatory Affairs is responsible for scheduling and administering the internal assessment plan. When the assessment is conducted, results will be evaluated to measure the effectiveness of the implemented quality system. Assessment activities may include management assessments and independent assessments.

Assessment activities will be documented. Reports resulting from management assessments will be issued to the responsible manager and distributed internally to project management. Assessment activities involving subcontracted services will be coordinated with the appropriate levels of project management and will be documented.

The Senior Environmental Specialist will promptly define corrective actions and correct deficiencies identified through assessments. Corrective actions will be independently verified by staff not organizationally reporting to the Senior Environmental Specialist. Verification will be documented and retained in the assessment file.

7.7.2.1 Management Assessments

Included in the management assessments are human resource issues, operations issues, resource allocation, financial performance, financial controls, and quality control. The Senior Vice President, ISR Operations is responsible for ensuring that project staff supports these activities as delegated, that they observe firsthand the work in progress, communicate with those performing the work, identify potential or current problems, and identify good practices.

The Senior Vice President, ISR Operations shall determine the scope, schedule, and responsibilities for site-specific management assessment. All levels of management are responsible for responding to assessment findings and completing agreed-upon corrective actions.

7.7.2.2 Independent Assessments

Independent assessments (e.g., audits and surveillances) will be planned, performed, and documented in accordance with written instructions, procedures, or checklists.

Personnel who lead independent assessments (audits or surveillances) must be qualified, have reporting independence, and have access to the areas of inquiry. The Senior Vice President, ISR Operations or designee will track, report on the status, and verify closure of independent assessments and external assessment findings.

The Senior Vice President, ISR Operations is responsible for responding to assessment findings and ensuring that agreed-upon corrective actions are completed in a timely manner.

7.7.3 Reviews

Reviews are an integral component to the success of project activities. Reviews are conducted during planning and throughout the project to ensure that project objectives will be met. Reviews conducted at the project level may consist of:

- Management reviews—to ensure the adequacy of planning and availability of resources
- Administrative and technical reviews—typically include reviews of project documents to ensure that project objectives are clearly described and sufficiently planned, scheduled, and managed in accordance with project management strategies.
- Procurement Reviews—typically Uranium One Americas policies and procedures that apply to purchasing goods and services. Subcontracted analytical laboratories are required to have a documented QA program. Laboratory capability may be evaluated through review of the QA program description or through pre-award survey or vendor audit activities. The results of the survey are documented and provided to the laboratory.
- Readiness Reviews—Readiness reviews are routinely conducted to ensure that appropriate planning has taken place to allow the work to proceed safely and effectively and to ensure that as many contingencies and prerequisites as possible have been reviewed and addressed for the work. The Senior Vice President, ISR Operations is responsible for determining the level of rigor and formality of project readiness reviews based on complexity, frequency, and risk of work. Readiness reviews are routinely planned and conducted before the start of major project activities, before the start of new or infrequent tasks, and prior to scheduled sampling events.
- Independent Peer Reviews—May be conducted to solicit input for the planned technical approach and data quality objectives of the project or task.

- Data Review—to ensure that the data collected and used for each activity of the project are of sufficient quality. The Senior Environmental Specialist will conduct data reviews as a quality measure to ensure the adequacy and completeness of field activities. In addition, data review, verification, and validation will be conducted after a sampling event. Analytical data will be reviewed and summarized in the laboratory report. The results will include an explanation of any laboratory problems and their possible effects on data quality.

7.7.4 Reports to Management

Management assessments, internal assessments, and external appraisal report findings are documented. The QA organization maintains the schedule and file for these reports that are typically issued to the responsible manager.

Quality improvement actions (e.g., planning, lessons learned, nonconformance reporting, tracking and follow-up, and reviews) will be documented and reported to management.

LAND CULTURAL AND HISTORIC

RAI Question:

Please provide more information regarding the proximity of the planned project facilities and infrastructure in relation to the Bozeman trail, and how recreational uses related to the Bozeman trail may be affected by the proposed facility

Answer:

The Bozeman trail runs diagonally west and east, T45N, R71W in Sections 5, 8, and 9 near the southwest corner of the Moore Ranch License boundary. The trail is approximately 1 mile out side the proposed license boundary. The distance between the trail and the closest proposed disturbance is approximately 12,000 feet (2.25 miles). The entire segment of the Bozeman Trail near the Moore Ranch Project is located on private lands only accessible through landowner consent.

Moore Ranch Environmental Report
RAI Responses
August 27, 2009

Planned Changes to Section 4.4 – Water Resources Impacts

4.4 WATER RESOURCES IMPACTS

4.4.1 Surface Water Impacts

4.4.1.1 Impacts on Surface Waters and Wetlands

EMC plans to construct two wellfields and a central plant facility for the Moore Ranch Project. No wetlands will be impacted due to the construction of the central plant and the two western wellfield sites (Wellfields #1 and #3). Wetlands or surface water channels may be impacted in the easternmost wellfield site (Wellfield #2), which is located in Section 35. The second tributary to Simmons Draw runs north to south in the northern half of the eastern wellfield site. The section of the tributary is between waypoint W70 (a CBM outfall location) and W37. There is a small POW stock pond (0.02 acres) at W36. The tributary in the eastern wellfield area is considered PUB on the drainage bottom and is approximately 1.66 acres. As previously noted in Section 3.5, wetlands located within the Moore Ranch boundaries are recommended as non-jurisdictional.

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No drainages or bodies of water will be significantly modified or altered within the Moore Ranch Project area during project construction or operations. If significant changes or alterations were to occur, the impact to the second tributary to Simmons Draw wetlands would be minimal as the disturbance is short-term and the draw is ephemeral. The potential for erosion is present due to the construction of the wells near the drainage; however, disturbance is short-term and disturbed areas will be reseeded soon after the wellfields are constructed.

4.4.1.2 Surface Water Impacts from Sedimentation

Normal construction activities within the wellfields, process plant, and along the pipeline courses and roads have the potential to increase the sediment yield of the disturbed areas. However, the relative size of these disturbances is small when compared to the size of the overall areas and to the size of the watersheds, and also have a short term impact. Since well field decommissioning and reclamation activities will be on-going throughout the life of the project, the area to be reclaimed at the conclusion of operations will be reduced, although a slight increase in sediment yields and total runoff can still be expected. Since all natural flow within the project boundaries is ephemeral with no intermittent or perennial streams, potential impacts to surface water from construction and decommissioning activities are also limited to uncommon precipitation or runoff events.

The physical presence of the surface facilities including wellfields and associated structures, access roads, office buildings, pipelines, facilities and other structures associated with ISR mining and processing of uranium are not expected to significantly change peak surface water flows because of the relatively flat topography of the drainages at the site, the low regional precipitation, the absorptive capacity of the soils, and the small area of disturbance relative to the large drainage within and adjacent to the proposed License Area.

Mitigation and control measures to eliminate or reduce surface water impacts from sedimentation are discussed in Section 5.4.2.3.

4.4.1.3 Potential Surface Water Impacts from Accidents

Surface water quality could potentially be impacted by accidents such as excessive rainwater or runoff in impacted soil areas or failure or an uncontrolled release of process liquids due to a wellfield leak. Section 5.4.2 discusses measures to prevent and control wellfield spills. Process buildings and chemical storage areas will be constructed with sumps or secondary containments, and a regular program of inspections and preventive maintenance will be implemented.

4.4.2 Groundwater Impacts

The potential groundwater impacts of ISR mining are related to the consumption of groundwater and short-and long-term changes to groundwater quality. Perhaps the most significant environmental impact that can occur as a result of ISR mining is the degradation of water quality in the ore-bearing aquifer.

4.4.2.1 Groundwater Consumption

Based on a bleed of 0.5% to 1.5% which has been successfully applied at other ISR operations, the potential impact from consumptive use of groundwater is expected to be minimal. In this regard, the vast majority (e.g., on the order of 99%) of groundwater used in the mining process will be treated and re-injected. Potential impacts on groundwater due to consumptive use outside the proposed License Area are expected to be negligible.

A numerical groundwater flow model was used to quantify the potential impact of drawdown due to mining and restoration operations. Details regarding the model development, calibration and simulations are provided in the report "Numerical Modeling of Groundwater Conditions Related to Insitu Recovery at the Moore Ranch Uranium Project, Wyoming" (Petrotek 2008) that is included as attachment X to the Technical

Report. The model incorporates aquifer properties determined from site pump tests and also replicates the transition from unconfined conditions in the southern portion of the site to confined groundwater conditions in the northern portion of the site within the 70 Sand.

The model was used to simulate the full cycle of ISR production and restoration at Moore Ranch. The production cycle was divided into three phases with initial production over a portion of Wellfield 2 (2,960 gpm), a second phase with production in both Wellfields, (totaling 2,840 gpm) and the final phase with production only in a portion of Wellfield 1 (1,980 gpm). Each production phase was simulated as 18 months. In order to maintain an inward hydraulic gradient toward Wellfield 2 while Wellfield 1 was finishing production, limited groundwater sweep (20 gpm) was simulated in Wellfield 2 during the phase three production cycle. Restoration was assumed to require removal of 6 pore volumes from each wellfield. Restoration was simulated in two phases with the first phase being concurrent restoration of Wellfields 1 and 2 that runs for 4.3 years. The assumption for restoration is that RO capacity is 500 gpm with a 20 percent reject brine. The RO rate was evenly divided between the two Wellfields (250 gpm each) during the first restoration phase. The second restoration phase includes restoration of Wellfield 2 (at 500 gpm) for an additional period of 1.8 years. The additional time needed for Wellfield 2 is because the Pore Volume estimate for Wellfield 2 (125.9 million gallons) is larger than Wellfield 1 (90.3 million gallons). Total length of the simulation is 10.5 years. The operational parameters for this simulation are summarized in Table 4.4.1 below:

Table 4.4.1 Simulated Production and Injection Rates, Moore Ranch ISR Project

	Wellfield	Production Rate	Injection Rate	Net Bleed	Bleed (%)
Production	-	(gpm)	(gpm)	(gpm)	-
Phase P1	2	2959.8	2935.5	24.3	0.8
Phase P2	2	1619.9	1598.8	21.1	1.3
Phase P2	1	1219.9	1206.4	13.5	1.1
Phase P2 Totals		2839.8	2805.2	34.6	
Phase P3	1	1979.9	1959.5	20.4	1.0

Restoration	Wellfield	Extraction/Treatment	ReInjection	Consumptive Use
-	-	(gpm)	(gpm)	(gpm)
Phase R1	2	250.0	200.0	50.0
Phase R1	1	250.0	200.0	50.0
Phase R1 Totals		500	400	50.0
Phase R2	2	500.0	400.0	100.0

The simulated drawdown throughout the model domain at the end of production operations, the end of restoration of Wellfield 1, and the end of restoration of Wellfield 2 is shown on Figures 4.4.1, 4.4.2 and 4.4.3, respectively. Wells completed in the 70 or 68 sand (excluding monitor wells) potentially impacted by drawdown induced by production or restoration operations are shown on the figures.

A total of fourteen domestic, industrial, stock or miscellaneous use wells within two miles of the License Area are projected as being completed within the 68 or 70 Sands. None of those wells are within the License Area. Information regarding the wells is summarized in Table 4.4.2. The simulated drawdown for wells completed within the 70 (or the combined 68-70 or 70-72 Sands) are summarized in Table 4.4.3. The table cross references the wells with Figures 4.4.1, 4.4.2 and 4.4.3. Three of the wells (P120983W, P22296P and P78124W) that are projected as 70 Sand completions are located south of the model domain and therefore, no model predicted drawdowns are provided for those wells. The largest predicted drawdown (almost 8 feet after restoration of Wellfield 1) occurs at well P14660 (located in T42N, 75 W, Section 28, approximately 1 mile northwest of proposed Wellfield 1). This well is identified as a stock well and is located in an area where the 70 Sand is fully saturated and under confined conditions. The less than 8 feet of drawdown at the location of well P14660 is not anticipated to negatively effect the ability of that well to produce water for stock purposes. Most other wells had less than 1 foot of drawdown at any time during the life of the ISR operations. The simulated drawdowns represent a small percentage of the total available drawdown which is typically greater than 70 feet within the License Area.

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¶
Mining/restoration and plant life: . 12.5 years¶
Average net consumptive use: . 105 gpm¶
Location of pumping centroid: . NE ¼ of Section 34¶
Observation radius: . Variable based on water use¶
. . 5,000 feet (nearest stock well)¶
. . 6,500 feet (nearest permit boundary)¶
. . 16,000 feet (nearest water supply well)¶
Formation transmissivity . 586 ft^2/d (preliminary pump test results)¶
Formation thickness . 80 feet¶
Formation hydraulic conductivity . 7.3 ft/d¶
Formation storativity . 4.0×10^{-3} (pump test results)¶
¶
The data were used to predict drawdown over time with a Theis semi-steady state analytical solution, which includes the following assumptions:

Table 4.3 Simulated Drawdown at Water Wells in the Vicinity of the Moore Ranch License Area

Permit #	Township Range Section QtrQtr	Uses	Well Depth (ft bgs)	Static Depth (ft bgs)	Estimated Completion Zone	Simulated Drawdown (ft) End Production	End Restoration Wellfield 1	End Restoration Wellfield 2	Cross Reference to Figures
P12244P	42N74W S 28 SESW	STO	200	100	70 sd	0.00	0.00	0.00	A
P14660P	42N75W S 28 NESE	STO	355	150	70 sd	3.53	7.87	5.90	B
P14683P	42N74W S 30 NWNW	STO	275	175	68-70 sd	0.08	0.68	1.08	C
P14684P	42N74W S 18 SWSW	STO	350	235	68-70 sd	0.23	0.91	1.20	D
P17301P	41N74W S 4 NESE	STO	130	55	68 sd	0.00	0.00	0.00	E
P17302P	41N74W S 4 NESE	DOM, STO	165	90	68 Sd?	0.00	0.00	0.00	F
P17304P	41N74W S 4 SENE	DOM, STO	137	80	68 Sd?	0.00	0.00	0.00	G
P17305P	41N74W S 7NENW	STO	50	18	70-72 sd	0.00	0.06	0.12	H
P6972W	42N74W S 33 SWSE	STO	210	95	60-68 sd	0.00	0.01	0.01	I
P6973W	41N74W S 5 SWNW	STO	170	60	68 sd	0.01	0.01	0.04	J
P85802W	42N74W S 17SENE	STO	300	180	70-72 sd	0.06	0.22	0.30	K

Estimates of completion zones with greatest uncertainty are indicate with a ?
Use categories include domestic, stock, industrial or miscellaneous
gpm – gallons per minute
ft bgs – feet below ground surface
Cross reference to Figures 4.4.1, 4.4.2 and 4.4.3

The limited drawdown that likely will be induced from mining, groundwater restoration and plant operations will have little if any impact on local water users.

Mitigation measures associated with groundwater consumption are discussed in Section 5.4.2.1.

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<#>The aquifer is confined and has apparent infinite extent;¶
<#>The aquifer is homogeneous and isotropic, and of uniform effective thickness over the area influenced by pumping;¶
<#>The piezometric surface is horizontal prior to pumping;¶
<#>The well is pumped at a constant rate;¶
<#>No recharge to the aquifer occurs;¶
<#>The pumping well is fully penetrating; and,¶
<#>Well diameter is small, so well storage is negligible.¶
¶
Based on these assumptions and results from the Moore Ranch Pump Test, drawdown after 12.5 years of operation at various distances from the centroid of pumping (e.g., the center of the NE ¼ of Section 34) were estimated to be 11.3, 9.8 and 5.1 feet, respectively. This amount of drawdown is approximately 10 to 15 percent of the available drawdown (approximately 70 feet, depending ... [1]

4.4.2.2 Impacts on Groundwater Quality During Construction and Wellfield Development

During facility construction, potential impacts to shallow water could occur from consumptive use of groundwater, introduction of drilling fluids and muds during well installation, discharge of pumped water during hydrologic testing and surface spills of fuels and lubricants. Groundwater use during construction is minor relative to the available water supply in the shallow Wasatch aquifers. Most water used for the Moore Ranch project is extracted from a well completed in the 40 and 50 Sand at depths of 470 to 590 ft below ground surface, much deeper than the shallow aquifers beneath the site. Consumptive use of groundwater is generally limited to dust control, drilling support and cement mixing. Impacts from groundwater consumptive use during construction would be minor and temporary to water supplies of the Powder River Basin.

The volume of drilling fluids and muds used during well installation is limited and would have negligible to small impacts on shallow aquifers beneath the License Area. The depth to the water table is generally more than 40 feet across most of the site so infiltration of drilling fluids and muds are unlikely to cause noticeable changes in water quality. Drilling fluids and muds will be placed into mud pits to control the spread of the fluids, to minimize the area of soil contamination and to enhance evaporation.

Pumped waters from hydrologic testing during construction of the wellfields will be discharged in accordance with approved permits. The permits protect near surface aquifers by limiting the discharge volume and prescribing concentration limits to waters that can be discharged.

Groundwater quality of near surface aquifers will be protected by best management practices including implementation of a spill prevention and cleanup program to prevent soil contamination. The volume of fluids and lubricants kept on the License Area is generally small and any spills or leaks will result in immediate cleanup response.

Best management practice will include implementation of a spill prevention and cleanup program, extracting water from deeper, more prolific aquifers to minimize consumptive use impacts, compliance with WDQE approved discharge permits, and minimization of surface disturbance through the use of mud pits.

4.4.2.3 Impacts on Ore Zone Groundwater Quality

During ISR mining operations, water quality impacts are usually of greater concern than water consumption impacts because water consumption during mining is relatively small. Contamination of groundwater from the proposed lixiviant is caused by (1) the addition of sodium bicarbonate and oxygen to the groundwater, (2) the addition of chloride to the groundwater by the processing plant, and (3) the interaction of these chemicals with the mineral and chemical constituents of the aquifer being mined. The result is that during mining, the concentration of most of the naturally occurring dissolved constituents in the mining zone will be appreciably higher than their concentrations in the original groundwater.

EMC has estimated the post-mining water quality based on the experience of COGEMA Mining, Inc. in Production Units 1 through 9 at the Irigaray ISR project located in the Powder River Basin near the proposed Moore Ranch Uranium Project. The Irigaray data was selected because of the proximity and similar geologic conditions to Moore Ranch. Cogema employed ammonium bicarbonate with hydrogen peroxide as the oxidant during early mining operations. In May 1980, the lixiviant system for the entire site was converted to sodium bicarbonate chemistry with gaseous oxygen as the oxidant. The water quality database is extensive because it represents nine production units located in a 30 acre site.

The water quality of the Irigaray ore zone after mining was established by sampling each of the designated restoration wells. The post-mining mean of the analytical results from Production Units 1 through 9 is presented in Table 4.4-1. The chemical alteration of the ore zone aquifer can be observed through comparison of the post-mining mean concentrations with the baseline concentrations.

Table 4.4-1 Irigaray Post-Mining Water Quality

Parameter (units)	Irigaray Baseline Range	Irigaray Post-Mining Mean
Dissolved Aluminum (mg/l)	<0.05 – 4.25	<1.037
Ammonia Nitrogen as N (mg/l)*	<0.05 – 1.88	23
Dissolved Arsenic (mg/l)	<0.001 – 0.105	<0.601
Dissolved Barium (mg/l)	<0.01 – 0.12	<1.067
Boron (mg/l)	<0.01 – 0.225	<0.442

Table 4.4-1 Irigaray Post-Mining Water Quality

Parameter (units)	Irigaray Baseline Range	Irigaray Post-Mining Mean
Dissolved Cadmium (mg/l)	<0.002 – 0.013	<0.979
Dissolved Chloride (mg/l)*	5.3 – 15.1	277
Dissolved Chromium (mg/l)	<0.002 – 0.063	<1.018
Dissolved Copper (mg/l)	<0.002 – 0.04	<0.828
Fluoride (mg/l)	0.11 – 0.66	<1
Total and Dissolved Iron (mg/l)	0.02 – 11.8	<1.098
Dissolved Mercury (mg/l)	<0.0002 - <0.001	<0.971
Dissolved Magnesium (mg/l)	0.02 – 9.0	45.7
Total Manganese (mg/l)	<0.005 – 0.190	1.249
Dissolved Molybdenum (mg/l)	<0.02 - <0.1	<1.067
Dissolved Nickel (mg/l)	<0.01 - <0.2	<1.018
Nitrate + Nitrite as N (mg/l)	<0.2 – 1.0	<3
Dissolved Lead (mg/l)	<0.002 - <0.050	<1.018
Radium-226 (pCi/L)	0 – 247.7	200.5
Dissolved Selenium (mg/l)	<0.001 – 0.416	0.247
Dissolved Sodium (mg/l)	95 - 280	827
Sulfate (mg/l)	136 - 824	639
Uranium (mg/l)	<0.0003 – 18.8	7.411
Vanadium (mg/l)	<0.05 – 0.55	<1.067
Dissolved Zinc (mg/l)	<0.01 – 0.200	<0.065
Dissolved Calcium (mg/l)*	1.6 – 33.5	199.2
Bicarbonate (mg/l)*	5 - 144	1343
Carbonate (mg/l)	0 - 96	<2
Dissolved Potassium (mg/l)	0.4 – 17.5	9
Total Dissolved Solids (TDS) @ 180°F (mg/l)	308 - 1054	2451

* Parameters with RTV other than baseline

In general, these post-mining concentrations are within the range of those projected by NRC for ISR operations at the Crownpoint Uranium Project. EMC expects similar baseline and post-mining water quality at the Moore Ranch site.

Mitigation measures for impacts on groundwater quality are discussed in Section 5.4.2.2.

4.4.2.4 Potential Groundwater Quality Impacts from Accidents

4.4.2.4.1 Lixiviant Excursions

Water quality impacts in adjacent aquifers from ISR mining activities are related to the identification, control, and clean-up of excursions. During production, injection of the lixiviant into the wellfield results in a temporary degradation of water quality compared to pre-mining conditions. Movement of this water out of the wellfield results in an excursion. Excursions of contaminated groundwater in a wellfield can result from an improper balance between injection and recovery rates, undetected high permeability strata or geologic faults, improperly abandoned exploration drill holes, discontinuity and unsuitability of the confining units which allow movement of the lixiviant out of the ore zone, poor well integrity, or hydrofracturing of the ore zone or surrounding units. Past experience from other commercial scale in-situ recovery projects in the Powder River Basin has shown that when proper steps are taken in monitoring and operating a wellfield, excursions, if they do occur, can be controlled and recovered and that serious impacts on the groundwater are prevented.

Excursions of lixiviant at ISR facilities have the potential to contaminate adjacent aquifers with radioactive and trace elements that have been mobilized by the mining process. These excursions are typically classified as horizontal or vertical. A horizontal excursion is a lateral movement of mining solutions outside the mining zone of the ore-body aquifer. A vertical excursion is a movement of solutions into overlying or underlying aquifers.

The historical experience at other ISR uranium operations indicates that the selected excursion indicator parameters and UCLs allow detection of horizontal excursions early enough that corrective action can be taken before water quality outside the exempted aquifer boundary is significantly degraded. As noted in NUREG/CR-6733, significant risk from a horizontal excursion would occur only if it persisted for a long period without being detected.

Vertical excursions can be caused by improperly cemented well casings, well casing failures, improperly abandoned exploration wells, or leaky or discontinuous confining layers.

Mitigation measures to prevent excursions are described in Section 5.4.2.3.

4.4.2.4.2 Wellfield Spills

Potential impacts to groundwater and surface water may occur during operations as a result of an uncontrolled release of process liquids due to a wellfield leak. Should an uncontrolled wellfield release occur, there would be a potential for contamination of the shallow aquifer as well as surrounding soil. With a slow leak that remains undiscovered or a catastrophic failure, a shallow excursion is one potential impact.

The rupture of an injection or recovery line in a wellfield, or a trunkline between a wellfield and the plant, would result in a release of injection or production solution which would contaminate the ground in the area of the break. *Small leaks in wellfield piping typically occur in the injection system due to the higher system pressures. These leaks seldom result in soil contamination.*

Occasionally, small leaks at pipe joints and fittings in the headerhouses or at the wellheads may occur. Until remedied, these leaks may drip process solutions onto the underlying soil. These leaks seldom result in soil contamination.

Mitigation measures to prevent wellfield spills are described in Section 5.4.2.3.

The aquifer is confined and has apparent infinite extent;
The aquifer is homogeneous and isotropic, and of uniform effective thickness over the area influenced by pumping;
The piezometric surface is horizontal prior to pumping;
The well is pumped at a constant rate;
No recharge to the aquifer occurs;
The pumping well is fully penetrating; and,
Well diameter is small, so well storage is negligible.

Based on these assumptions and results from the Moore Ranch Pump Test, drawdown after 12.5 years of operation at various distances from the centroid of pumping (e.g., the center of the NE ¼ of Section 34) were estimated to be 11.3, 9.8 and 5.1 feet, respectively. This amount of drawdown is approximately 10 to 15 percent of the available drawdown (approximately 70 feet, depending on location) in the 70 Sand.

As shown in Figure 3.4-1, few water wells are present in the vicinity of Moore Ranch. There is little use of shallow ground water in the immediate vicinity of Moore Ranch. The closest industrial well is approximately 2,900 feet from the centroid of pumping (NE ¼ of Section 34). The closest stock well is approximately 5,000 feet from the centroid of pumping; the closest domestic well is approximately 16,000 feet.

Moore Ranch Environmental Report
RAI Responses
August 27, 2009

Planned Changes to Section 3.4 – Water Resources

3.4 WATER RESOURCES

3.4.1 Water Use

3.4.1.1 Regional Groundwater Use

The license area is located at the southwestern edge of the Northern Great Plains aquifer system, which underlies most of the Dakotas and parts of Montana and Wyoming (USGS 1996). The major aquifers of the Northern Great Plains aquifer system are sandstones of Tertiary and Cretaceous age and carbonate rocks of Paleozoic age. These are overlain by unconsolidated deposits of Quaternary age, some of which are locally highly permeable and underlain by crystalline rocks that yield little water (USGS 1996).

Regional movement of water in the Northern Great Plains aquifer system comes from recharge areas at high altitudes, down the dip of the aquifers and then upward to discharge into shallower aquifers or to the land surface. The regional direction of flow in the deep, confined aquifers follows long flow paths and trends from southwest to northeast. Most of the recharge to the aquifer system is either from precipitation or snowmelt. Much of the discharge from the aquifer system is by upward leakage of water into shallower aquifers where the hydraulic head in the shallower aquifer is less than that of a deeper aquifer (USGS 1996).

The water-bearing units in the Northern Great Plains aquifer system can be divided into six major aquifer systems. From shallowest to deepest, these include:

- Quaternary Aquifers
- Middle Tertiary Aquifers
- Lower Tertiary Aquifers
- Upper Cretaceous Aquifers
- Lower Cretaceous Aquifers
- Paleozoic Aquifers

Table 3.4.1-1 shows these units along with the corresponding geologic formation, general transmissivity and water yields, and general water quality for the Northern Great Plains

aquifer systems. Units younger than Lower Tertiary are typically not present within the vicinity of Moore Ranch and therefore are of no significance with respect to groundwater supply. Aquifer systems and geologic formations applicable to the Moore Ranch Project are discussed in greater detail in Section 3.4.3.

Water use estimates for Campbell County for different water use types are presented in Table 3.4.1-2.

Table 3.4.1-1 Northern Great Plains Aquifer Systems and Formations General Characteristics

Aquifer System	Formations	General Transmissivity (gpd/ft).	General Water Yields (gpm)
Quaternary Aquifers	Alluvium, Terrace, and Eolian Deposits	15 to 64,000	Up to 1,000
Middle Tertiary Aquifers	Arikaree Formation	Up to 77,000	Up to 1,000
Lower Tertiary Aquifers	Wasatch and Fort Union Formations	1 to 5,000	1 to 60
Upper Cretaceous Aquifers	Lance and Fox Hills Formations	76 to 2,100	Up to 350 gpm (Lance) and 700 gpm (Fox Hills)
Lower Cretaceous Aquifers	Dakota Sandstone Formation	220-810	Up to 150
Paleozoic Aquifers	Madison Limestone Formation	1,000 to 300,000	Up to 1,000

(HKM et al. 2002).

Table 3.4.1-2 Estimated Water Use in Campbell County, Wyoming

Water Use Type	Withdraws (MGD)
Public Supply	1.88
Domestic GW	0.01
Industrial GW	0.25
Industrial SW	0.15
Irrigated Acres, sprinkler	0.00184
Irrigated Acres, surface flood	0.01096
Irrigated Acres, total	0.01280
Irrigation GW	1.26
Irrigation SW	40.85
Irrigation, total	42.11
Mining GW	56.67
Mining SW	13.29
Mining, total	69.96
Thermoelectric, total	0.41
Total GW, fresh	41.26
Total GW, saline	18.97
Total GW	60.22
Total SW, fresh	54.55
Total SW, saline	0
Total SW	54.55

Source: Hutson et al. 2000
Notes: GW = Groundwater
SW = Surface water
MGD = Million gallons per day

3.4.1.2 Site Area Groundwater Use

The License Area is situated in the southwestern part of the Powder River Basin. The surface unit in the area is Wasatch Formation which is underlain by Fort Union Formation. The Wasatch Formation is further divided into sand layers interbedded with coal and mudstone. The target production zone is referred to as the 70 Sand. The thickness of 70 Sand is normally in the range of 60 to 80 feet and the dip is generally less than one degree toward the northwest. Recharge to the 70 Sand occurs mainly in the outcrop area located southeast of the License Area. The first water bearing formation above the 70 Sand is the 72 Sand (overlying) and first water bearing stratum below is represented by the 68 Sand (underlying).A shallow water bearing stratum, identified as the 80 Sand, is present above the 72 sand as a localized

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discontinuous unit. Deeper water bearing strata, identified as the 40 and 50 Sands, extend areally and are locally considered significant aquifers (Conoco 1980).

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Groundwater rights in Wyoming are permitted on a well by well basis through the Wyoming State Engineers Office (SEO). Groundwater rights within the review area are listed in Addendum 3.4-A. To the extent the data are available, the well yield, well depth, static water level and completion interval associated with each groundwater right (well) is included in Addendum 3.4.A. The date the permit was issued is also included. The yields listed in the Addendum are simply the yields that were reported to the SEO and are not a permit limit. However, domestic and stock wells are limited to 25 gpm per well. There are no minimum heads entitled with the rights listed in the Addendum. Priority of the rights is as listed in the Addendum based on the date of issuance. Not all available groundwater rights have been granted in the area of the facility as permits are granted on a well by well basis and for the completion interval of the specific well. Conceivably, several wells could be placed in the same general vicinity, but could be screened across different intervals. The vast majority of the water rights permitted in the vicinity of Moore Ranch are for CBM activities within the Fort Union Formation, at depths exceeding 800 feet.

According to the SEO, there are 559 active wells located within the 2-mile radius of the License Area boundary as of June 2009. Of those wells, 465 are indicated as CBM or stock-CBM wells. All of the CBM and stock-CBM wells for which records are available are over 700 feet deep, deeper than the 60 through 72 sands would be projected within the two mile radius. The CBM and stock-CBM wells which have no records of completion depth are unlikely to have been completed in shallow Wasatch Sands as the target for CBM in the area of Moore Ranch is the Fort Union Formation. The Fort Union is encountered at depths exceeding 800 feet within the area of Moore Ranch. Most of the groundwater pumped from active wells surveyed within a 2-mile radius of the License Area boundary is used either for stock or CBM production. Groundwater rights within 2 miles of the License Area are summarized in the following table.

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Table 3.4.1 Groundwater Rights within 2 Miles of the Moore Ranch License Area

Category	No. Wells in Category	No. Wells with TD <700 ft,	No. Wells With TD >700 ft,	No. Wells with No Completion Interval Listed	No. Non-Monitor Wells Probably Completed in 60 68, 70 or 72 Sands
Cancelled	125	NA	NA	NA	NA
CBM	162	0	125	37	0
Stock, CBM	303	0	119	184	0
Stock	27	25	2	0	25
Monitor	57	57	0	0	0
Domestic, Irr, Indust, Misc	10	4	3	3	4
Total	684	86	147	235	31

Deleted: Groundwater rights within the review area are in Addendum 3.4-A.

Figure 3.4.1-1 shows the locations of all water wells in the License Area and the 2-mile radius review area. Within this area, there are three domestic water wells ranging from 137 to 440 feet in depth. Licensed yields for these wells vary between 15 and 40 gpm, and static water level ranges between 60 to 90 feet below ground surface (ft bgs). While these wells are licensed for domestic use, there are no current occupied residences within the License Area and 2-mile radius. Therefore, these wells are not being primarily utilized for human consumption. There are no irrigation wells located within the surveyed 2-mile radius of the License Area boundary. There are 27 permitted stock wells within 2 miles of the License Area. Stock water wells depths range between 2 and 800 feet bgs, with static level depth from 0 to 320 feet bgs and yields between 2 and 40 gpm. CBM and stock-CBM wells are up to 1,410 feet deep and generally deeper than 700 feet. Static water levels range from 188 to over 1000 ft bgs. Water levels from 57 monitoring wells within the License Area boundary range between 65 and 330 feet bgs. Depth of these monitoring wells ranges between 66 to 630 feet bgs (WSEO 2009).

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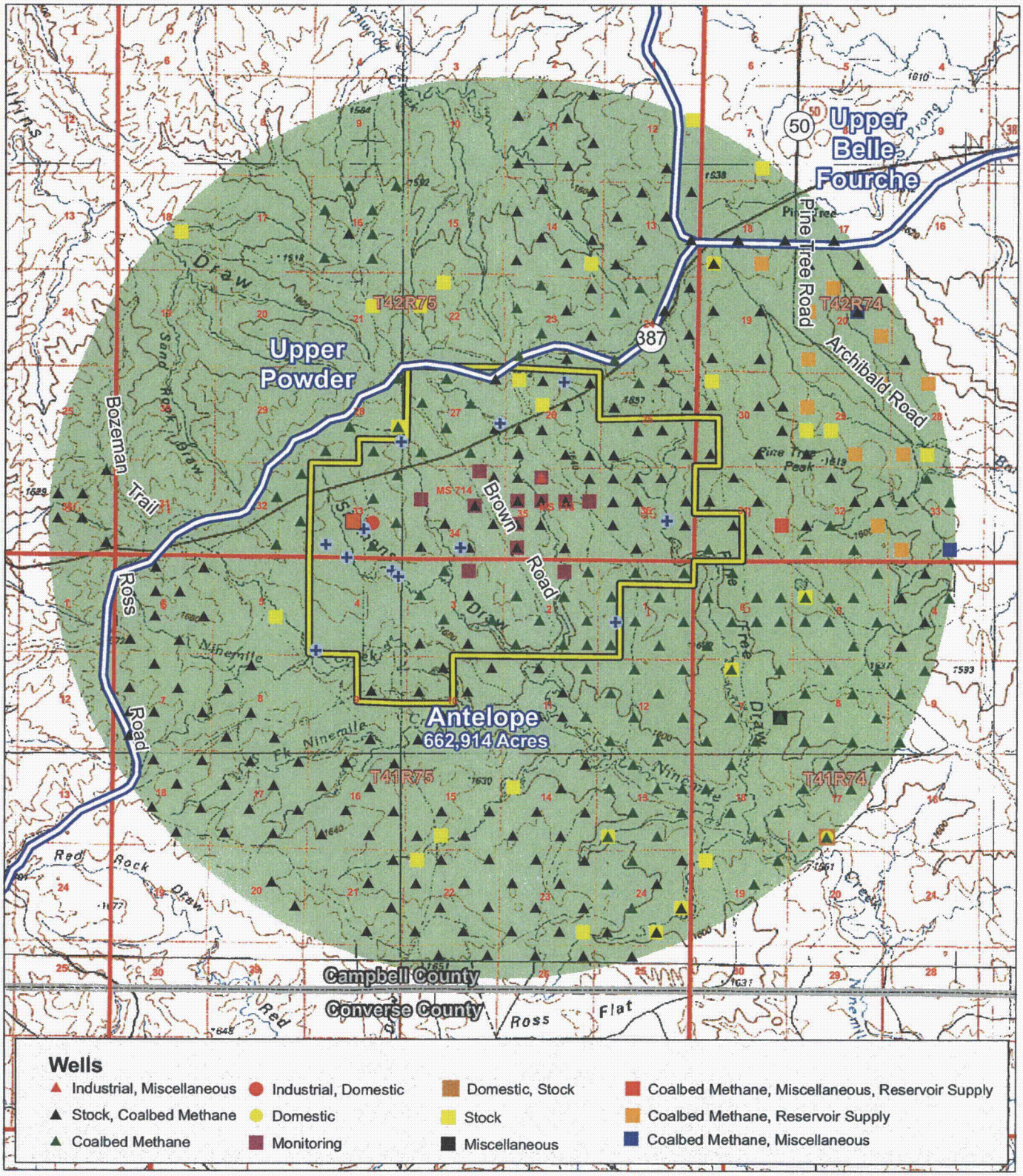
Additionally, there are four stock wells located within the License Area that are older and as a result not licensed through the State Engineers Office. There is also a windmill and a shallow well located in the License Area. However, it is not functional.

In summary, there are three water wells licensed for domestic use and no irrigation groundwater wells within the 2-mile radius review area. Based on population projections, future water use within the 2-mile radius review area would likely be a continuation of present use.

3.4.1.3 Operational Water Use

Based on a bleed of 0.5% to 1.5% which has been successfully applied at other ISR operations, the potential impact from consumptive use of groundwater is expected to be minimal. In this regard, the vast majority (e.g., on the order of 99%) of groundwater used in the mining process will be treated and re-injected (Figure 3.1-5). Potential impacts on groundwater quality due to consumptive use outside the license area are expected to be negligible. Impacts from operational water consumption are described in detail in Section 4 of this Environmental Report.



Legend

- Moore Ranch Project Area
- Unoccupied Residence
- Pond
- 2 Mile Buffer
- Fourth Level Watershed Boundary

Source: Wyoming State Engineers Office

0 1 2 Miles

Note: Some wells have multiple uses.

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FIGURE 3.4.1-1
MOORE RANCH PROJECT
AREA WATER RESOURCES

Project Number: CO001252.0001.0002

3.4.2 Surface Water

The Moore Ranch License Area, as well as the western, southern, and eastern portions of the 2-mile radius review area (located in Campbell County, Wyoming) are drained by Ninemile Creek, an intermittent stream which flows through the far southern portion of the property in a southeasterly direction, within the Antelope Basin, Hydrologic Unit Code (HUC) 10120101 (US EPA 2007) (Figure 3.4.2-1). Simmons Draw, an intermittent stream, flows through the License Area from the northwest to the southeast and joins with Ninemile Creek just south of the License Area near the Van Gordon Ranch. Another unnamed intermittent stream flows through the center of the License Area from north to south and converges with Ninemile Creek on the south side near the Van Gordon Ranch. Pine Tree Draw is an intermittent stream located in the eastern portion of the License Area, and flows from north to south joining with Ninemile Creek southeast, just upstream from Ninemile Ranch. Pine Tree Draw is composed of three distinct branches within the License Area. The most easterly branch of Pine Tree Draw is fed by Pine Tree Spring, which is located at an elevation of 5,244 feet above mean sea level (amsl). Ninemile Creek joins with Antelope Creek southeast of the License Area in Converse County, WY about 8 miles downstream. Antelope Creek eventually flows easterly through Thunder Basin National Grassland to its confluence with the Cheyenne River in eastern Wyoming (USGS 1977). The Antelope Basin drains a total of 1,036 square miles and is part of the greater Cheyenne River Basin, which is part of the Northeastern Wyoming River Basin area (US EPA 2007 and HKM et al. 2002).

About nine small ponds are located within the License Area (Figure 3.4.1-1). The ponds are located on ephemeral streams including Ninemile Creek, Simmons Draw, an unnamed stream, and Pine Tree Draw. Ponds are used to supply range and pasture animals with drinking water or may be used for holding water discharged from coal bed methane and other oil and gas mining operations.

The northern/northwestern portion of the 2-mile review area drains to the Upper Powder River Basin (HUC 10090202) via Collins Draw and Cottonwood Creek (Figure 3.4.2-1). Collins Draw and Cottonwood Creek flow northward and join with the Dry Powder River in Johnson County, WY northwest of the License Area. The Dry Powder River flows northwesterly to its confluence with the Powder River just north of Sussex, WY. The total drainage area of the Upper Powder Basin is 2,518 square miles (US EPA 2007).

The northeasternmost portion of the 2-mile review area drains to the Belle Fourche River and the Upper Belle Fourche Basin, HUC 10120201, which has a drainage area of 2,934 square miles (Figure 3.4.2-1) (US EPA 2007). In the upper potion of the Belle Fourche River is an intermittent river which eventually joins with the Cheyenne River east of the South Dakota boundary. The Cheyenne River joins the Missouri River in South Dakota.

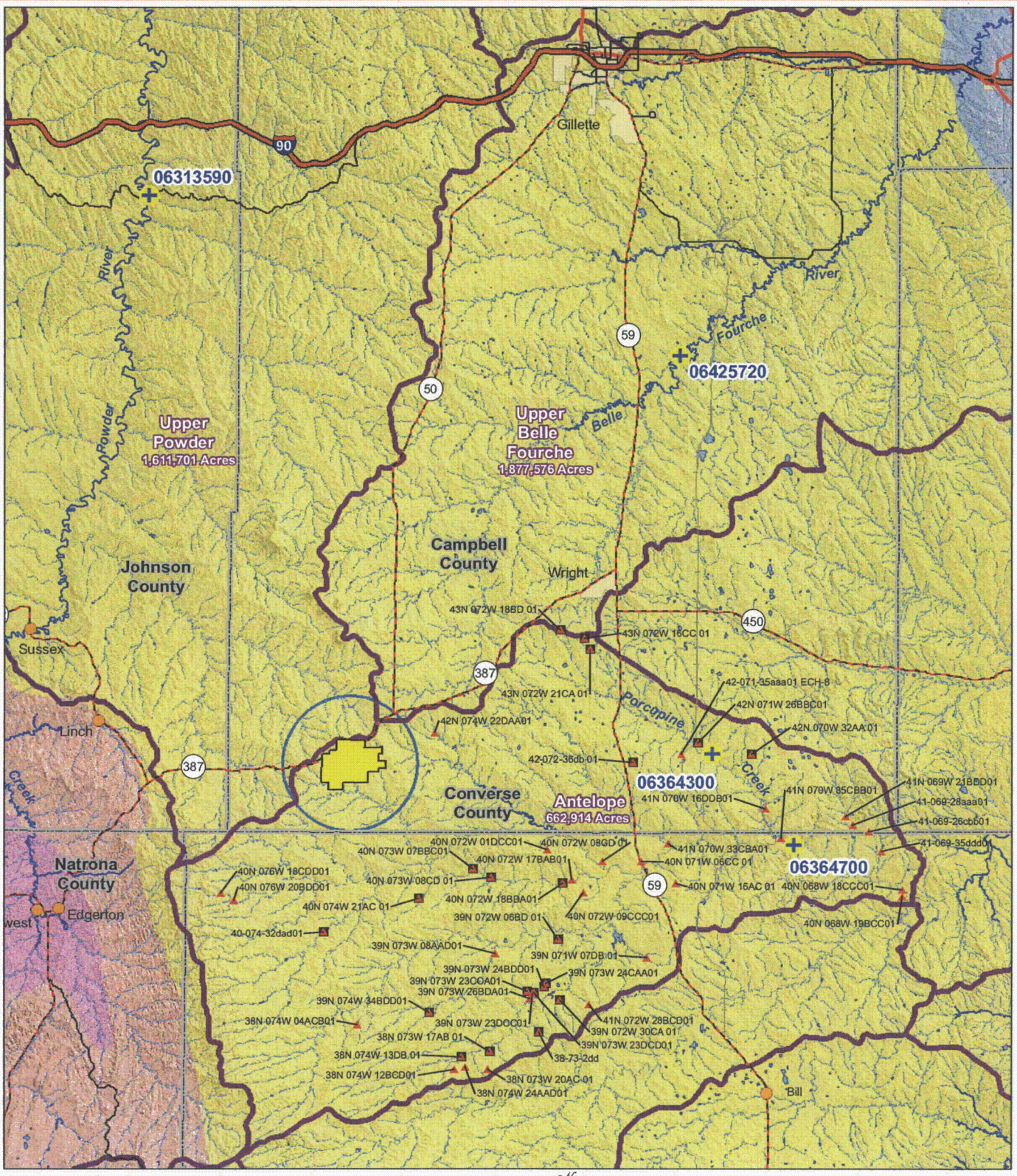
Elevations near the License Area and its surrounding 2-mile review area are approximately 5,500 feet. Climate in the area is arid, typical of a high desert area, with low annual

precipitation (13 inches/year) and high evaporation rates. Hydrographs for streams in the upper portions of the Antelope, Upper Belle Fourche, and Upper Powder River watersheds peak during snowmelt in the late spring/early summer. Summer thunderstorms also influence smaller hydrograph peaks.

3.4.2.1 Surface Water Quantity and Runoff

Surface water data for the Antelope Creek Basin (HUC 10120101) are scarce. No stream flow data are available for drainages located within the License Area or within the 2-mile review area. One U.S. Geological Survey (USGS) stream gage on Antelope Creek near Teckla, WY (USGS 06364700) is located southwest and downstream of the License Area (Figure 3.4.2-1). In the Upper Powder River Basin (HUC 10090202), which receives drainage from the northwest portion of the 2-mile review area, a USGS stream gage (USGS 06313590) is located above Burger Draw near Buffalo, WY. The Upper Belle Fourche River Basin (HUC 10120201), which receives a small portion of the drainage from the northeastern tip of the 2-mile review area, has a USGS stream gage located below Rattlesnake Creek near Piney, WY. Streamflow data from these USGS gage sites were analyzed to describe water quantities that may be influenced from activities within the License Area (USGS 2007).

Available daily mean discharge data for Antelope Creek is limited to September of 1977 through September of 1981. Analysis of daily mean discharge for Antelope Creek near Teckla, WY (USGS 06364700) during this period revealed an average of 9.8 cubic feet per second (cfs) and a median of 0.3 cfs. The maximum daily mean discharge of 2,560 cfs was recorded on May 18, 1978. Analysis of annual instantaneous peak discharge recorded from August 17, 1979 through August 5, 1981 revealed a peak flow of 1,760 cfs measured on August 17, 1979. Average peak flows were 836 cfs, ranging from 70 to 1,760 cfs, and the median peak flow was 836 cfs (USGS 2007) (Figure 3.4.2-2). Flood frequency data analysis was not possible due to the limited record of annual peak instantaneous data.



Legend

- Project Area
- USGS Stream Gage Location
- Fourth Level Sub-watershed Boundary
- County Boundary
- Two Mile Buffer
- USGS Groundwater Well
- USGS Groundwater Monitoring Well

0 5 10 20 Miles

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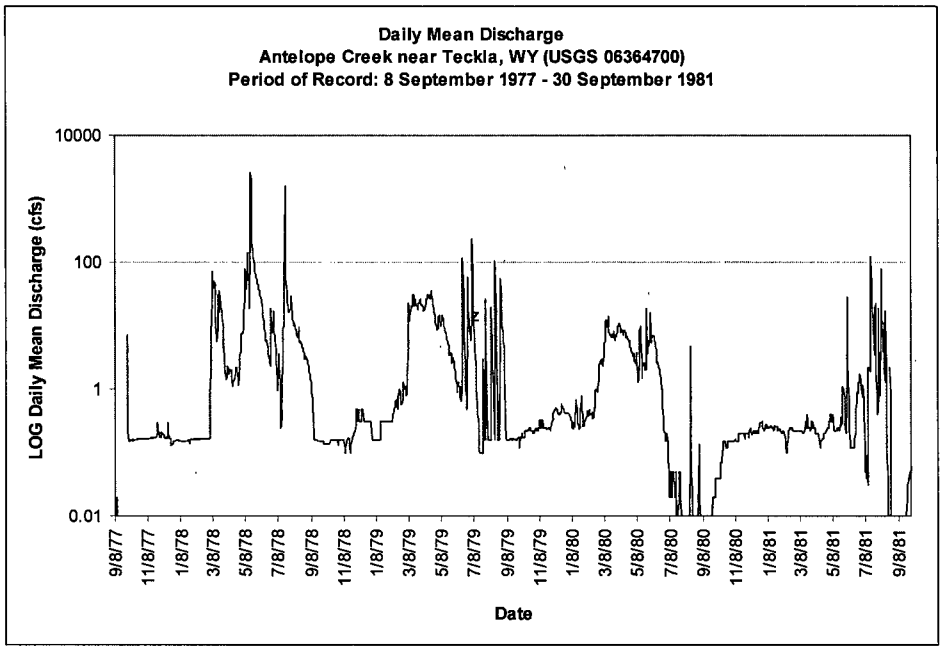
FIGURE 3.4.2-1
MOORE RANCH PROJECT
REGIONAL WATER RESOURCES

Project Number: CO001252.0001.0002

Figure 3.4.2-2 Daily Mean Discharge for Antelope Creek near the Town of Teckla

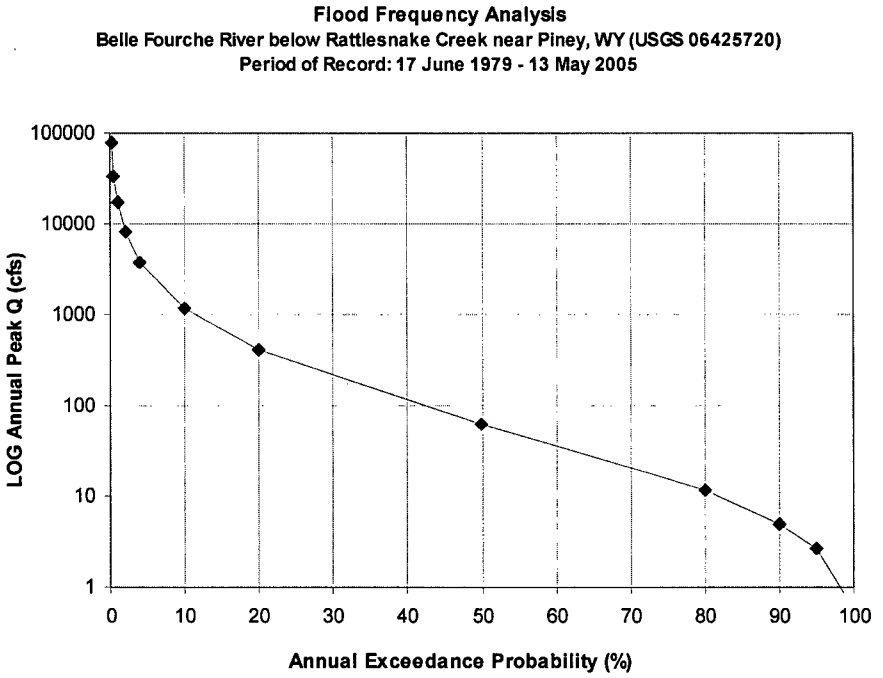


Analysis of daily mean discharge for the Powder River above Burger Draw near Buffalo, WY (USGS 06313590) from June 12, 2003 through June 28, 2007 revealed an average flow of 127 cfs and a median flow of 100 cfs. Daily mean discharge ranged from a minimum of 0.03 cfs to a maximum of 3,050 cfs, which occurred on May 7, 2007. Analysis of annual peak instantaneous discharge for the period of June 18, 2003 to May 12, 2005 revealed an average of 2,360 cfs and a median of 2,200 cfs. Annual instantaneous peaks flows ranged from 1,140 cfs to 3,740 cfs, which was recorded on May 12, 2005 (USGS 2007). Flood frequency data analysis was not possible due to the limited record of annual peak instantaneous data.

Analysis of daily mean discharge for the Belle Fourche River below Rattlesnake Creek near Piney, WY (USGS 06425720) revealed an average flow of 9.0 cfs and a median flow of 0.3 cfs. Daily mean discharge ranged from 0 cfs to 2,740 cfs, which was recorded on December 28, 2003. Analysis of annual instantaneous peak discharge from June 17, 1979 to May 13, 2005 indicated a mean peak flow of 357 cfs and a median peak flow of 36 cfs. Annual instantaneous peak discharges ranged from 4 cfs to 1,300 cfs, which was recorded on June 17, 1979 (USGS 2007).

Flood frequency analysis was performed using the USGS standard method, in which a log-Pearson Type III frequency distribution is fit to the logarithms of the peak flow cumulative distribution. Parameters of the log-Pearson Type III were estimated from the logarithmic peak flows (mean, standard deviation, and coefficient of skewness) with adjustments for low and high outliers, historic peaks and generalized skew (Riggs 1968). Log-Pearson III flood frequency analysis revealed a flood that has the probability of occurring once every 10 years, has a magnitude of about 1,100 cfs. Similarly, a flood that has the probability of occurring once every 100 years has a magnitude of 12,000 cfs (Figure 3.4.2-3).

Figure 3.4.2-3 Flood Frequency Analysis for Belle Fourche River near Piney, Wyoming



Antelope Creek has a drainage area of 980 square miles with an approximate channel length of 62 miles and an average gradient of 0.006 (ft/ft). The elevation at Antelope Creek's headwaters is approximately 6,225 feet above mean sea level (msl), and 4,400 feet at its confluence with the South Cheyenne River. The U.S. Geological Survey has a stream gaging station on Antelope Creek approximately ten miles upstream from its mouth. The drainage area is 959 square miles, at the gage.

Ninemile Creek has a total drainage area of 63 square miles, a channel length of approximately 20 miles, and an average channel gradient of 0.006 (ft/ft). The elevation difference from headwaters to mouth is 610 feet with a maximum basin elevation of approximately 5,500 feet above msl. The channel length within this area is approximately 10.5 miles with an average gradient of 0.007 (ft/ft).

Simmons Draw is a Ninemile Creek tributary flowing southeasterly through the project (Figure 3.4.2-4). Its total drainage area is 8.1 square miles. The channel length is 6.8 miles with an average gradient of 0.007 (ft/ft). Total basin elevation difference is 260 feet with a maximum elevation of approximately 5,475 feet above msl.

Pine Tree Draw, with a drainage area of 8.2 square miles, flows from the north into Ninemile Creek on the eastern edge of the project area (Figure 3.4.2-4). The channel length is approximately 7.6 miles, and the average gradient is 0.009 (ft/ft). The maximum basin elevation approaches 5,470 feet above msl, and the minimum is approximately 5,110 feet.

Simmons Draw has two tributaries which flow in a predominantly southerly direction in the project area. These tributaries are labeled Washes Nos. 1 and 2 on Figure 3.4.2-4. Wash No. 2 is further subdivided into Upper Wash No. 2 and Lower Wash No. 2 based on the channel reach being upstream and downstream of the proposed mining Pit 35N. Wash No. 4, which is tributary to Ninemile Creek, is also further divided into Upper Wash No. 4 and Lower Wash No. 4 at the location of the proposed mill tailings evaporation pond dam.

Wash No. 1 has a drainage area of 1.7 square miles, a channel length of 2.8 miles, and an average channel gradient of 0.014 (ft/ft). The basin elevation difference is approximately 205 feet with a maximum elevation of 5,475 feet above msl.

Upper Wash No. 2 and Lower Wash No. 2 have drainage areas of 1.9 and 0.95 square miles, respectively. Their respective channel lengths are 3.1 and 2.2 miles with average gradients of 0.012 and 0.007 (ft/ft).

The drainage areas of Upper Wash No. 4 and Lower Wash No. 4 are 0.70 and 0.53 square miles respectively. Channel lengths are 0.46 and 1.3 miles with respective gradients of 0.017 and 0.013 (ft/ft).

Wash No. 3 (Figure 3.4.2-4) drains into Pine Tree Draw from the northwest in Section 36 of T42N-R75W. Its drainage area is 1.8 square miles, the channel length and average gradient are 3.2 miles and 0.014 (ft/ft), respectively, and the basin elevation difference is approximately 230 feet. The maximum basin elevation is approximately 5,480 feet above msl.

Drainage basin characteristics for Antelope Creek, Ninemile Creek, and all of the tributaries relevant to the Moore Ranch project area are summarized in Table 3.4.2-1.

Table 3.4.2-1 Drainage Basin Characteristics for the Moore Ranch Project Area

Drainage Basin	Drainage Area (mi^2)	Channel Length (mi)	Elevation Differences (ft)	Channel (ft/mi)	Gradient (ft/ft)
Antelope Creek (total)	980	62	1,825	29.4	0.006
Antelope Creek (at USGS gage)	959	52	1,775	34.1	0.006
Ninemile Creek (Total)	63	20	610	30.5	0.006
Ninemile Creek (@ 1-7)	34	10.5	390	37.1	0.007
Pine Tree Draw	8.2	7.6	370	48.9	0.0009
Simmons Draw	8.1	6.8	260	38.2	0.0007
Wash No. 1	1.7	2.8	205	73.2	0.014
Upper Wash No. 2	1.9	3.1	190	61.3	0.012
Lower Wash No. 2	0.95	2.2	80	36.4	0.007
Wash No. 3	1.8	3.2	230	71.9	0.014
Upper Wash No. 4	0.70	0.46	130	90.2	0.017
Lower Wash No. 4	0.53	1.3	90	69.2	0.013

Site Surface Water Runoff

Peak flood estimates for each of the drainage basins within and directly adjacent to the Moore Ranch Project area were previously calculated and presented to the NRC in the Environmental Report for the Sand Rock Mill Project, Docket No. 40-8743 (1980) and subsequent Draft Environmental Statement prepared by the NRC (1982). Those documents were referenced to provide the following runoff estimates. These estimates are considered valid.

In those reports, three techniques were utilized for estimating flood flows and volumes ephemeral basins for different recurrence intervals as described below.

- Lowham (1976) presented a basin characteristics technique whereby peak flow was related to drainage area with consideration of different regions in the state. Lowham's

regression equations can be used for basins with drainage areas between 5 and 5,300 square miles. However, using a graphical approach, his technique can be used for basins slightly less than one square mile in area.

- For small basins (approximately 10 square miles and less) Craig and Rankl (1977) developed basin characteristics regression equations which utilize other basin parameters in addition to drainage area to compute peak flows and flood volumes (Craig and Rankl, "Analysis of Runoff from Small Drainages in Wyoming, US Geological Survey, Open-File Report 77-727, 1977).

- Also, for small basins, the U.S. Soil Conservation Service (SCS) has developed a technique to estimate peak flows and flood volumes. These techniques are published in their Engineering Field Manual (1969). The SCS technique utilizes peak rainfall values published by the U.S. Weather Bureau and then takes into consideration soil and vegetation characteristics and basin slope and drainage area to make the flood flow and volume estimates.

The technique presented in Lowham (1976) has since been superseded by Lowham, 1988, and subsequently by Miller, 2003. Therefore, the flood estimates calculated from the techniques in Lowham (1976) are not considered valid and are not presented in this report. The methods used in Craig and Rankl (1977) for analysis for small drainage basins in Wyoming (later published in Craig and Rankl, "Analysis of Runoff from Small Drainages in Wyoming, US Geological Survey, Water Supply Paper 2056, 1978) and the SCS method are considered valid techniques for estimating runoff as described WDEQ-LQD Guideline 8.

Table 3.4.2-2 presents flood flow and volume estimates for the 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year events. For comparison purposes, values obtained by utilizing the two techniques described above are tabulated.

Values listed in Table 3.4.2-2 under the SCS method were obtained using curve number 75 and 24-hour duration precipitation values from Miller and others (1973). Table 3.4.2-3 shows precipitation for selected recurrence intervals for different duration periods.

Table 3.4.2-2 Peak Flood Discharge Estimates for 5-, 10-, 25-, 50-, and 100-Year Recurrence Intervals for Drainages within the Moore Ranch Project Boundary

Drainage	Drainage Area (mi^2)	Craig and Rank's Method (CFS)					SCS Method (CFS)				
		5-year	10-year	25-year	50-year	100-year	5-year	10-year	25-year	50-year	100-year
Ninemile Creek	63	4,700	6,900	9,800	14,000	18,000					
Pine Tree Draw	8.2	1,100	1,600	2,200	3,100	3,900					
Simmons Draw	8.1	1,400	2,000	2,600	3,600	4,500					
Wash No. 1	1.7	410	580	770	1,100	1,310	150	250	350	450	550
Upper Wash No. 2	1.9	480	670	890	1,200	1,500	160	260	370	480	580
Lower Wash No. 2	0.95	500	640	770	990	1,200	100	150	240	310	360
Wash No. 3	1.8	400	560	760	1,000	1,300	160	260	360	470	570
Upper Wash No. 4	0.7	260	360	460	610	740	85	140	190	250	300
Lower Wash No. 4	0.53	270	350	440	570	670	70	110	150	210	250

Reference: Conoco, Inc. 1980. Environmental Report for the Sand Rock Mill Project, Campbell County, Wyoming, Docket No. 40-8743. July, 1980.

More recent peak discharge evaluations for similar drainages in the Powder River Basin were conducted to evaluate the performance of reconstructed stream channel reclamation at coal mines (Western Water Consultants, 1995). Rainfall-runoff simulations were based on the SCS triangular hydrograph method to estimate flood discharges for 10 and 100-year events. Flood discharge values calculated for drainage areas in Campbell County of similar size are shown to be relatively similar to 100-year flood discharge values for drainages within the Moore Ranch project area using the SCS method. Table 3.4.2-4 shows a comparison of the Moore Ranch 100-year flood estimates and 100-year flood estimates from similar size drainage basins evaluated in the Western Water Consultants, 1995 report.

Table 3.4.2-3 Precipitation Values For Selected Recurrence Intervals and Durations in the Moore Ranch Project Area (Inches)

Duration	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	500-Yr	Duration
5-Min	.25	.35	.42	.52	.59	.66	.83	5-Min
10-Min	.38	.54	.65	.80	.92	1.03	1.29	10-Min
15-Min	.48	.69	.83	1.01	1.16	1.30	1.64	15-Min
30-Min	.67	.95	1.14	1.40	1.61	1.81	2.27	30-Min
1-Hour	.85	1.21	1.45	1.78	2.03	2.29	2.87	1-Hour
2-Hour	.95	1.33	1.59	1.94	2.22	2.49	3.12	2-Hour
3-Hour	1.03	1.44	1.71	2.09	2.38	2.67	3.33	3-Hour
6-Hour	1.25	1.71	2.01	2.44	3.47	3.10	3.86	6-Hour
12-Hour	1.47	2.00	2.35	2.84	3.22	3.60	4.47	12-Hour
24-Hour	1.70	2.29	2.69	3.24	3.67	4.10	5.09	24-Hour

Table 3.4.2-4 Comparison of Moore Ranch Project SCS Method 100-year Flood Estimates with Recent Flood Estimates for Similar Size Drainage Basins in Campbell County

Drainage	Area (Square Miles)	SCS Method 100-year Peak Discharge (cfs)	Drainage	Area (Square Miles)	SCS Method 100-year Peak Discharge (cfs)
Wash No. 1	1.7	550	Russel Draw	1.8	590
Upper Wash No. 2	1.9	580	Russel Draw	1.8	590
Lower Wash No. 2	0.95	360	HA Creek Tributary	1.03	351
Wash No. 3	1.8	570	Russel Draw	1.8	590
Upper Wash No. 4	0.70	300	Lone Tree Prong	0.68	279
Lower Wash No. 4	0.53	250	School Creek	0.49	260

3.4.2.2 Flooding Potential For Facility Areas

Figures 2.8.5-2 and 2.8.5-8 show surface water features within the Moore Ranch Project Area in relation to proposed facilities and wellfields. Figures 2.1-2 and 2.1-3 also show the facilities in relation to surrounding topography. The central processing area and wellfield are located well above any surface water features that would be inundated during flooding events, and also located in a manner that insignificant runon will occur from upgradient sources. Runoff in these areas will consist primarily of overland sheet flow. The central plant and facilities area will be graded and sloped to direct precipitation runoff away from building foundations in all directions to a storm water conveyance system. Potential runon will also be intercepted and directed around the central plant area. The stormwater conveyance system will be designed to pass the 50-year flood. Due to the location of Wellfield 1 and the central plant area related to the surrounding topography, impacts from flooding are expected to be minimal. The stream channel in Upper and Lower Wash No. 2 is

located near the center portion of Wellfield 2. The previous hydrologic analysis conducted by Conoco determined representative channel cross sections for Upper and Lower Wash No. 2 and water crest heights for 100-year and 5-year floods (see Appendix B5 for previous hydrologic analysis conducted by Conoco. Channel cross sections for Upper Wash No. 2 in the vicinity of Wellfield 2 (approximately 650 feet upstream) show a channel inundation depth of approximately 2.9 feet at a velocity of 7.4 ft/second. As shown Figure 2.8.5-8, the channel widens somewhat through Wellfield 2, so the water depth and velocity in the channel during a 100-year flood through Wellfield 2 is anticipated to be less than 2.9 feet and 7.4 ft/second. However, due to the ephemeral nature of the drainages in the area, this channel typically contains no flow.

3.4.2.3 Surface Water Quality

No streams within the Antelope Creek Basin are listed on the US EPA Section 303(d) list, which categories impaired surface water bodies. The Upper Powder River Basin is listed on the Section 303(d) list for chloride and selenium from the South Fork of the Powder River to an undetermined distance downstream below Sussex, WY. The Upper Belle Fourche River Basin is listed on the Section 303(d) list for ammonia and total residual chlorine downstream of the Hulett Wastewater Treatment Plant (US EPA 2007).

According to the Wyoming Department of Environmental Quality (WY DEQ), Antelope Creek is classified as a 3B surface water, meaning its designated use is for recreation, other aquatic life, wildlife, agriculture, industry, and scenic value. The North Fork of the Powder River is classified as a 2AB surface water, which means its designated use is for drinking water, game and non-game fisheries, fish consumption, other aquatic life, recreation, wildlife, agriculture, industry, and scenic value. The Upper Belle Fourche River is classified as a 2ABWW surface water, and its associated designated uses are drinking water, game and non-game fisheries, fish consumption, other aquatic life, recreation, wildlife, agriculture, industry, and scenic value (WY DEQ 2001).

Water quality data were available from only one USGS stream gage (06364700) located on Antelope Creek near Teckla, WY from October 3, 1977 through September 7, 2005. Water quality data analyses revealed a mean temperature of 10.4 degrees Celsius (°C) and a range from 0 to 30 °C. Mean dissolved oxygen was 7.8 milligrams/liter (mg/l) and ranged from 2.8 to 11.7 mg/L. Total nitrogen averaged 0.55 mg/L and ranged from 0.21 to 1.8 mg/l. Mean ammonia as nitrogen concentrations were 0.04 mg/L and ranged from 0 to 0.13 mg/l. Nitrite plus nitrate as nitrogen averaged 0.04 mg/L, with a range from 0 to 0.29 mg/l. Average phosphate was 0.03 mg/L and average selenium (water filtered) was 0.56 mg/l (USGS 2007). EMC has conducted surface water quality sampling at 10 monitoring locations at the Moore Ranch site. Sampling was performed on a quarterly basis since last quarter 2006.

Within the Moore Ranch Project Area, surface water samples were collected from 9 sampling locations (all locations are existing stock ponds or areas in drainages where ponding occurs) at upstream and downstream locations from proposed mining areas during late fall of 2006, early spring of 2007, and late spring of 2007. Locations of these sample sites are shown on Figure 3.4.2-4. No surface water was available for sites MRSW-10 and MRSW-11 for sampling during these periods. Water quality data collected from theses surface water sites is summarized in Tables 3.4.2-5 through 3.4.2-13, overall average concentrations are shown in Table 3.4.2-15, and seasonal averages are shown in Table 3.4.2-14. Detection limit values were used for non-detectable results for calculation purposes. (Tables 3.4.2-5 through 3.4.2-15 are at the end of this section).

In general, surface water contained in the ponds at the sampling locations will exhibit typical saline characteristics of coal-bed methane surface discharge (higher values for conductivity, TDS, and bicarbonate) during summer and fall months. Sampling data shows that surface water quality changes during spring months when dilution occurs from snow melt or heavy precipitation events. Significantly higher values for bicarbonate, carbonate, chloride, conductivity, fluoride, TDS, gross alpha, gross beta, nitrogen, arsenic, potassium, magnesium, sodium, occurred during the fall sampling when the surface water contained was largely comprised of CBM discharge. Values for these parameters were typically the lowest during the samples taken in late March, which were taken soon after a large snowmelt event. Samples taken in June, while showing slightly higher concentrations than the March sampling, were also significantly lower than the fall sample due to the influence of spring runoff water contained in the ponds. Another round of surface water samples will be collected in the third quarter of 2007 (late summer) at locations with available water. It is anticipated that water quality from these samples will resemble results from the samples taken in the fall of 2006.

Average water quality during the fall sampling exceeded Wyoming Class I (domestic use) for TDS pH, and iron, and just slightly exceeded Class II (agriculture use) and Class III (livestock use) for pH. Averages for the other sampling periods also exceeded all class of use standards for pH. Overall averages for all sample rounds combined also exceed all class of use standards for pH and the Class I standard for TDS. The data tables also show lead average values for the fall and overall averages above the Class I standard, however these values are inaccurately high due to the use of a detection limit of 0.05 mg/L for the fall of 2006 samples in the calculations. This detection limit in itself exceeds the Class I standard of 0.015 mg/L. Sample results for the next two sample rounds show much lower results below the Class I standard. Also, one value for lead activity at MRSW-1 for the fall of 2006 shows and extremely high anomalous value of 170 pCi/L, and as a result, was believed to be lab error and excluded from the average calculations.

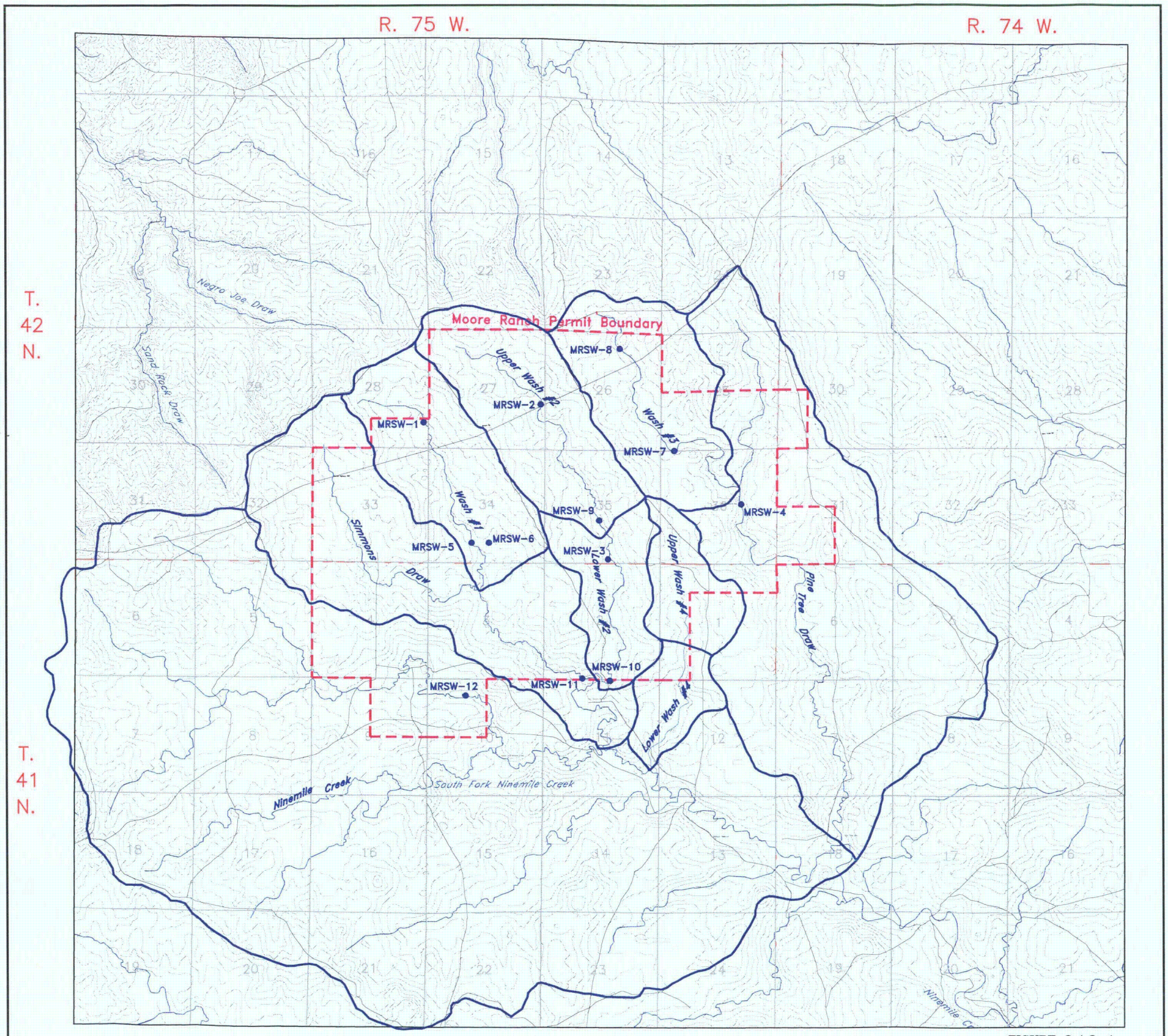


FIGURE 3.4.2-4

LEGEND
● SURFACE WATER SAMPLING SITES

N

0' 1 MILE 2 MILES

ENERGY METALS CORPORATION, US
139 West 2nd St. Casper, WY 82601 307-234-8235

REVISIONS

NO.	DATE	BY
1	06/06/07	JT
2	03/07/08	JT
3	06/26/08	JT

MOORE RANCH
URANIUM PROJECT
DRAINAGE BASINS

PORTIONS OF T. 41 & 42 N., R. 74 & 75 W.

GEOL. SH. ____ DATE ____ APPR. SH. ____ DATE ____
ENG. SH. ____ DATE ____ APPR. SH. ____ DATE ____
DRAFT. SH. ____ DATE ____ SCALE ____ FILE ____
SEC. NO.

Table 3.4.2-5 Water Quality from MRSW-1

Parameters	11/3/2006	3/23/2007	6/15/2007	Average
Bicarbonate as HCO3, mg/L	1140	814	391	782
Carbonate as CO3, mg/L	19	43	50	37
Chloride, mg/L	10	3	3	5
Conductivity, umhos/cm	1940	1260	714	1305
Fluoride, mg/L	0.5	0.7	0.4	0.5
pH, s.u.	8.48	9.06	9.44	8.99
Solids, Total Dissolved TDS @ 180 C, mg/L	1160	772	472	801
Sulfate, mg/L	39	1	2	14
Gross Alpha, pci/L	6.8	1.0		3.9
Gross Beta, pci/L	21.8	10.3		16.05
Lead 210, pci/L	170*	1.0	1.0	57.3
Polonium 210, pci/L	<1.0	<1.0	<1.0	<1.0
Radium 226, pci/L	<0.2	<0.2	<0.2	<0.2
Radium 228, pci/L	<1.0	<1.0	<1.0	<1.0
Thorium 230, pci/L	<.2	<0.2	<0.2	<0.2
Nitrogen, Ammonia as N, mg/L	0.15	0.08	0.12	0.12
Nitrogen, Nitrate+Nitrite as N, mg/L	0.8	<0.1	<0.1	0.3
Aluminum, mg/L		<0.01	1.1	0.6
Arsenic, mg/L	0.002	0.002	0.006	0.003
Barium, mg/L	0.5	0.5	0.1	0.4
Boron, mg/L	<0.1	<0.1	<0.1	<0.1
Cadmium, mg/L	<0.005	<0.005	<0.005	<0.005
Calcium, mg/L	43	13	7	21
Chromium, mg/L	<0.05	<0.05	<0.05	<0.05
Copper, mg/L	<0.01	<0.01	<0.01	<0.01
Iron, mg/L	0.07	0.07	0.6	0.25
Lead, mg/L	<0.05	<0.001	<0.001	<0.05
Magnesium, mg/L	56	35	14	35
Manganese, mg/L	<0.01	<0.01	<0.01	<0.01
Mercury, mg/L	<0.001	<0.001	<0.001	<0.001
Molybdenum, mg/L	<0.1	<0.1	<0.1	<0.1
Nickel, mg/L	<0.05	<0.05	<0.05	<0.05
Potassium, mg/L	17	11	7	12
Selenium, mg/L	<0.001	<0.001	<0.0002	<0.0002
Silica, mg/L	4.7	2.3	8.4	5.1
Sodium, mg/L	355	243	133	244
Uranium, mg/L	0.0052	0.0007	0.0006	0.0022
Vanadium, mg/L	<0.1	<0.1	<0.1	<0.1
Zinc, mg/L	<0.01	<0.01	<0.01	<0.01
Iron, TOTAL mg/L	0.26	0.38	1.31	0.65
Manganese, TOTAL mg/L	0.01	0.02	0.04	0.02
Lead 210, suspended pci/L	<2.0	<1.0	<1.0	<1.0
Polonium 210 suspended, pci/L	<2.0	<1.0	<1.0	<1.0
Radium 226 suspended, pci/L	<0.4	<0.2	<0.2	<0.2
Thorium 230 suspended, pci/L	<0.4	<0.2	<0.2	<0.2
Uranium suspended, pci/L	<0.0003	<0.0003	<0.0003	<0.0003

* Anomalous value considered analytical error

Table 3.4.2-6 Water Quality from MRSW-2

Parameters	10/25/2006	3/23/2007	6/15/2007	Average
Bicarbonate as HCO3, mg/L	1010	748	532	763
Carbonate as CO3, mg/L	52	22	33	36
Chloride, mg/L	9	3	2	5
Conductivity, umhos/cm	1520	1120	870	1170
Fluoride, mg/L	0.7	0.6	0.4	0.6
pH, s.u.	8.96	8.80	9.13	8.96
Solids, Total Dissolved TDS @ 180 C, mg/L	996	672	520	729
Sulfate, mg/L	1	<1.0	10	4
Gross Alpha, pci/L	3.0	1.5	0	2.25
Gross Beta, pci/L	14.0	9.7	0	11.85
Lead 210, pci/L	<1.0	<1.0	<1.0	<1.0
Polonium 210, pci/L	<1.0	<1.0	<1.0	<1.0
Radium 226, pci/L	<0.2	<0.2	<0.2	<0.2
Radium 228, pci/L	<1.0	<1.0	<1.0	<1.0
Thorium 230, pci/L	<0.2	<0.2	<0.2	<0.2
Nitrogen, Ammonia as N, mg/L	0.17	<0.05	<0.05	<0.05
Nitrogen, Nitrate+Nitrite as N, mg/L	<0.1	<0.1	<0.1	<0.1
Aluminum, mg/L		<0.1	0.1	0.1
Arsenic, mg/L	0.002	0.002	0.003	0.002
Barium, mg/L	0.8	0.5	0.1	0.5
Boron, mg/L	<0.1	<0.1	<0.1	<0.1
Cadmium, mg/L	<0.005	<0.005	<0.005	<0.005
Calcium, mg/L	18	22	11	17
Chromium, mg/L	<0.05	<0.05	<0.05	<0.05
Copper, mg/L	0.01	0.05	0.01	0.02
Iron, mg/L	0.07	0.15	0.11	0.11
Lead, mg/L	0.05	0.007	0.001	0.019
Magnesium, mg/L	43	28	20	30
Manganese, mg/L	0.01	0.02	0.01	0.02
Mercury, mg/L	<0.001	<0.001	<0.001	<0.001
Molybdenum, mg/L	<0.1	<0.1	<0.1	<0.1
Nickel, mg/L	<0.05	<0.05	<0.05	<0.05
Potassium, mg/L	14	10	7	10
Selenium, mg/L	<0.001	<0.001	<0.002	<0.002
Silica, mg/L	3.8	3.0	0.9	2.6
Sodium, mg/L	349	208	157	238
Uranium, mg/L	0.0003	0.0005	0.0006	0.000467
Vanadium, mg/L	<0.1	<0.1	<0.1	<0.1
Zinc, mg/L	0.01	0.02	0.02	0.015
Iron, TOTAL mg/L	0.07	0.04	0.36	0.157
Manganese, TOTAL mg/L	0.01	0.01	0.02	0.013
Lead 210, TOTAL pci/L	<1.0	<1.0	<1.0	<1.0
Polonium 210 suspended, pci/L	<1.0	<1.0	<1.0	<1.0
Radium 226 suspended, pci/L	<0.2	<0.2	<0.2	<0.2
Thorium 230 suspended, pci/L	<0.2	<0.2	<0.2	<0.2
Uranium suspended, pci/L	<0.0003	<0.0003	<0.0003	<0.0003

Table 3.4.2-7 Water Quality from MRSW-3

Parameters	10/25/2006	3/22/2007	6/14/2007	Average
Bicarbonate as HCO3, mg/L	358	92	33	161
Carbonate as CO3, mg/L	8	9	4	7
Chloride, mg/L	11	2	<1.0	5
Conductivity, umhos/cm	928	544	609	694
Fluoride, mg/L	0.9	0.2	0.4	0.5
pH, s.u.	8.60	9.25	9.45	9.10
Solids, Total Dissolved TDS @ 180 C, mg/L	560	5.5	414	327
Sulfate, mg/L	214	189	254	219
Gross Alpha, pci/L	12.7	7.9		10.3
Gross Beta, pci/L	13.5	9.7		11.6
Lead 210, pci/L	<1.0	<1.0	<1.0	<1.0
Polonium 210, pci/L	<1.0	<1.0	<1.0	<1.0
Radium 226, pci/L	<0.2	<0.2	<0.2	<0.2
Radium 228, pci/L	<1.0	<1.0	1.9	1.3
Thorium 230, pci/L	<0.2	<0.2	<0.2	<0.2
Nitrogen, Ammonia as N, mg/L	0.09	0.06	0.09	0.08
Nitrogen, Nitrate+Nitrite as N, mg/L	<0.1	<0.1	<0.1	<0.1
Aluminum, mg/L		<0.1	<0.1	<0.1
Arsenic, mg/L	0.002	0.002	0.003	0.002
Barium, mg/L	0.1	<0.1	<0.1	0.1
Boron, mg/L	<0.1	<0.1	<0.1	<0.1
Cadmium, mg/L	<0.005	<0.005	<0.005	<0.005
Calcium, mg/L	42	60	48	50
Chromium, mg/L	<0.05	<0.05	<0.05	<0.05
Copper, mg/L	<0.01	<0.01	<0.01	<0.01
Iron, mg/L	0.16	<0.03	0.05	0.08
Lead, mg/L	<0.05	<0.001	<0.001	<0.05
Magnesium, mg/L	18	13	18	16
Manganese, mg/L	<0.01	<0.01	<0.01	<0.01
Mercury, mg/L	<0.001	<0.001	<0.001	<0.001
Molybdenum, mg/L	<0.1	<0.1	<0.1	<0.1
Nickel, mg/L	<0.05	<0.05	<0.05	<0.05
Potassium, mg/L	8	8	4	7
Selenium, mg/L	<0.001	0.001	<0.001	0.001
Silica, mg/L	2.9	8.3	3.2	4.8
Sodium, mg/L	173	32	46	84
Uranium, mg/L	0.0130	0.0119	0.0043	0.0097
Vanadium, mg/L	<0.1	<0.1	<0.1	<0.1
Zinc, mg/L	<0.01	<0.01	<0.01	<0.01
Iron, TOTAL mg/L	0.33	0.10		0.22
Manganese, TOTAL mg/L	0.01	0.03		0.015
Lead 210, suspended pci/L	<1.0	<1.0	<1.0	<1.0
Polonium 210 suspended, pci/L	<1.0	<1.0	<1.0	<1.0
Radium 226 suspended, pci/L	<0.2	<0.2	<0.2	<0.2
Thorium 230 suspended, pci/L	<0.2	<0.2	<0.2	<0.2
Uranium suspended, pci/L	<0.0003	<0.0003	<0.003	<0.003

Table 3.4.2-8 Water Quality from MRSW-4

Parameters	10/25/2006	3/27/2007	6/14/2007	Average
Bicarbonate as HCO3, mg/L	363	156	77	199
Carbonate as CO3, mg/L	24	23	15	21
Chloride, mg/L	23	7	2	11
Conductivity, umhos/cm	1500	792	968	1087
Fluoride, mg/L	0.6	0.5	0.4	0.5
pH, s.u.	9.06	9.41	9.63	9.37
Solids, Total Dissolved TDS @ 180 C, mg/L	984	504	644	711
Sulfate, mg/L	461	230	360	350.3333
Gross Alpha, pci/L	5.6	2.5		4.05
Gross Beta, pci/L	11.9	7.6		9.75
Lead 210, pci/L	<1.0	<1.0	<1.0	1.0
Polonium 210, pci/L	<1.0	<1.0	<1.0	<1.0
Radium 226, pci/L	<0.2	<0.2	<0.2	0.2
Radium 228, pci/L	<1.0	<1.0	<1.0	1.0
Thorium 230, pci/L	<0.2	<0.2	<0.2	<0.2
Nitrogen, Ammonia as N, mg/L	0.52	0.20	0.09	0.27
Nitrogen, Nitrate+Nitrite as N, mg/L	<0.1	<0.1	<0.1	0.1
Aluminum, mg/L		<0.1	<0.1	0.1
Arsenic, mg/L	0.006	0.006	0.005	0.006
Barium, mg/L	0.2	0.1	0.1	0.1
Boron, mg/L	<0.1	<0.1	<0.1	0.1
Cadmium, mg/L	<0.005	<0.005	<0.005	<0.005
Calcium, mg/L	24	26	27	26
Chromium, mg/L	<0.05	<0.05	<0.05	<0.05
Copper, mg/L	<0.01	<0.01	<0.01	0.01
Iron, mg/L	0.32	0.03	0.03	0.13
Lead, mg/L	<0.05	<0.001	<0.001	0.050
Magnesium, mg/L	25	18	24	22
Manganese, mg/L	0.02	0.02	0.02	0.02
Mercury, mg/L	<0.001	<0.001	<0.001	<0.001
Molybdenum, mg/L	<0.1	<0.1	<0.1	<0.1
Nickel, mg/L	<0.05	<0.05	<0.05	<0.05
Potassium, mg/L	10	8	7	8
Selenium, mg/L	<0.001	<0.001	<0.001	0.001
Silica, mg/L	3.8	12.8	3.7	6.8
Sodium, mg/L	320	114	133	189
Uranium, mg/L	0.0069	0.0034	0.0028	0.0044
Vanadium, mg/L	<0.1	<0.1	<0.1	<0.1
Zinc, mg/L	<0.01	<0.01	<0.01	0.010
Iron, TOTAL mg/L	0.40	0.07		0.16
Manganese, TOTAL mg/L	0.02	0.12		0.05
Lead 210, suspended pci/L	<1.0	<1.0	<1.0	<1.0
Polonium 210 suspended, pci/L	<1.0	<1.0	<1.0	<1.0
Radium 226 suspended, pci/L	<0.2	<0.2	<0.2	<0.2
Thorium 230 suspended, pci/L	<0.2	<0.2	<0.2	<0.2
Uranium suspended, pci/L	<0.0003	<0.0003	<0.0003	<0.0003

Table 3.4.2-9 Water Quality from MRSW 5

Parameters	11/3/2006	3/22/2007	6/15/2007	Average
Bicarbonate as HCO3, mg/L	1410	924	858	1064
Carbonate as CO3, mg/L	155	24	11	63
Chloride, mg/L	6	7	10	8
Conductivity, umhos/cm	2560	1450	1520	1843
Fluoride, mg/L	1.2	0.5	0.4	0.7
pH, s.u.	9.29	8.66	8.46	8.80
Solids, Total Dissolved TDS @ 180 C, mg/L	1590	890	998	1159
Sulfate, mg/L	9	20	157	62
Gross Alpha, pci/L	11.0	2.4		6.7
Gross Beta, pci/L	32.7	11.0		21.85
Lead 210, pci/L	9.9	<1.0	<1.0	4.0
Polonium 210, pci/L	<1.0	<1.0	<1.0	<1.0
Radium 226, pci/L	0.2	1.5	2.3	1.3
Radium 228, pci/L	<.1	<1.0	<1.0	<1.0
Thorium 230, pci/L	<.2	<0.2	<0.2	<0.2
Nitrogen, Ammonia as N, mg/L	0.27	0.15	0.19	0.20
Nitrogen, Nitrate+Nitrite as N, mg/L	0.9	<0.1	<0.1	0.4
Aluminum, mg/L		<0.1	<0.1	<0.1
Arsenic, mg/L	0.008	0.003	0.004	0.005
Barium, mg/L	0.5	0.5	0.3	0.2
Boron, mg/L	0.1	<0.1	<0.1	0.1
Cadmium, mg/L	<0.005	<0.005	<0.005	<0.005
Calcium, mg/L	9	45	41	32
Chromium, mg/L	<0.05	<0.05	<0.05	<0.05
Copper, mg/L	<0.01	<0.01	<0.01	<0.01
Iron, mg/L	0.92	0.05	0.08	0.35
Lead, mg/L	<0.05	<0.001	<0.001	<0.05
Magnesium, mg/L	73	39	50	54
Manganese, mg/L	0.02	<0.01	0.03	0.03
Mercury, mg/L	<0.001	<0.001	<0.001	<0.001
Molybdenum, mg/L	<0.1	<0.1	<0.1	<0.1
Nickel, mg/L	<0.05	<0.05	<0.05	<0.05
Potassium, mg/L	22	12	13	16
Selenium, mg/L	<0.001	<0.001	0.004	0.002
Silica, mg/L	9.3	5.2	8.1	7.5
Sodium, mg/L	559	255	230	348
Uranium, mg/L	0.0010	0.0029	0.0027	0.0022
Vanadium, mg/L	<0.1	<0.1	<0.1	<0.1
Zinc, mg/L	<0.01	<0.01	0.01	0.01
Iron, TOTAL mg/L	1.11	0.11	0.12	0.45
Manganese, TOTAL mg/L	0.05	0.01	0.06	0.04
Lead 210, suspended pci/L	<2.0	<1.0	<1.0	<1.0
Polonium 210 suspended, pci/L	<2.0	<1.0	<1.0	<1.0
Radium 226 suspended, pci/L	<0.4	<0.2	2.3	0.97
Thorium 230 suspended, pci/L	<0.4	<0.2	<0.2	<0.2
Uranium suspended, pci/L	<0.0003	<0.0003	<0.0003	<0.0003

Table 3.4.2-10 Water Quality from MRSW-6

Parameters	3/22/2007	6/15/2007	Average
Bicarbonate as HCO3, mg/L	351	563	457
Carbonate as CO3, mg/L	7	114	61
Chloride, mg/L	2	3	3
Conductivity, umhos/cm	538	1140	839
Fluoride, mg/L	0.3	0.7	0.5
pH, s.u.	8.52	9.64	9
Solids, Total Dissolved TDS @ 180 C, mg/L	326	754	540
Sulfate, mg/L	10	2	6
Gross Alpha, pci/L	1.1		1.1
Gross Beta, pci/L	6.9		6.9
Lead 210, pci/L	<1.0	<1.0	<1.0
Polonium 210, pci/L	<1.0	<1.0	<1.0
Radium 226, pci/L	<0.2	1.5	0.9
Radium 228, pci/L	<1.0	<1.0	<1.0
Thorium 230, pci/L	<0.2	<0.2	<0.2
Nitrogen, Ammonia as N, mg/L	0.13	0.15	0.14
Nitrogen, Nitrate+Nitrite as N, mg/L	<0.1	<0.1	<0.1
Aluminum, mg/L	0.4	1	0.7
Arsenic, mg/L	0.002	0.006	0.004
Barium, mg/L	0.4	0.2	0.3
Boron, mg/L	<0.1	<0.1	<0.1
Cadmium, mg/L	<0.005	<0.005	<0.005
Calcium, mg/L	26	9	18
Chromium, mg/L	<0.05	<0.05	<0.05
Copper, mg/L	<0.01	<0.01	<0.01
Iron, mg/L	0.21	0.44	0.33
Lead, mg/L	<0.001	0.001	0.001
Magnesium, mg/L	10	15	13
Manganese, mg/L	<0.01	0.02	0.02
Mercury, mg/L	<0.001	<0.001	<0.001
Molybdenum, mg/L	<0.1	<0.1	<0.1
Nickel, mg/L	<0.05	<0.05	<0.05
Potassium, mg/L	7	6	7
Selenium, mg/L	<0.001	<0.002	<0.002
Silica, mg/L	9.5	5.6	7.6
Sodium, mg/L	77	232	155
Uranium, mg/L	<0.0003	0.0003	0.0003
Vanadium, mg/L	<0.1	<0.1	<0.1
Zinc, mg/L	0.01	0.01	0.01
Iron, TOTAL mg/L	0.51	0.72	0.62
Manganese, TOTAL mg/L	0.02	0.04	0.03
Lead 210, suspended pci/L	<1.0	<1.0	<1.0
Polonium 210 suspended, pci/L	<1.0	<1.0	<1.0
Radium 226 suspended, pci/L	<0.2	0.4	0.3
Thorium 230 suspended, pci/L	<0.2	<0.2	<0.2
Uranium suspended, pci/L	<0.0003	<0.0003	<0.0003

Table 3.4.2-11 Water Quality from MRSW-7

Parameters	10/25/2006	6/14/2007	Average
Bicarbonate as HCO3, mg/L	809	520	665
Carbonate as CO3, mg/L	12	22	17
Chloride, mg/L	9	2	6
Conductivity, umhos/cm	1120	837	979
Fluoride, mg/L	0.5	0.5	0.5
pH, s.u.	8.42	8.96	9
Solids, Total Dissolved TDS @ 180 C, mg/L	706	586	646
Sulfate, mg/L	23	3	13
Gross Alpha, pci/L	5.4		5.4
Gross Beta, pci/L	13.1		13.1
Lead 210, pci/L	<1.0	<1.0	<1.0
Polonium 210, pci/L	<1.0	<1.0	<1.0
Radium 226, pci/L	<0.2	<0.2	<0.2
Radium 228, pci/L	<1.0	<1.0	<1.0
Thorium 230, pci/L	<0.2	<0.2	<0.2
Nitrogen, Ammonia as N, mg/L	0.10	0.08	0.09
Nitrogen, Nitrate+Nitrite as N, mg/L	<0.1	<0.1	<0.1
Aluminum, mg/L		0.5	0.3
Arsenic, mg/L	0.003	0.004	0.004
Barium, mg/L	0.5	0.3	0.4
Boron, mg/L	<0.1	<1.0	<1.0
Cadmium, mg/L	<0.005	<0.005	<0.005
Calcium, mg/L	27	15	21
Chromium, mg/L	<0.05	<0.05	<0.05
Copper, mg/L	<0.01	<0.01	<0.01
Iron, mg/L	0.70	0.59	0.65
Lead, mg/L	<0.05	<0.001	<0.001
Magnesium, mg/L	18	10	14
Manganese, mg/L	0.02	0.01	0.02
Mercury, mg/L	<0.001	<0.001	<0.001
Molybdenum, mg/L	<0.1	<0.1	<0.1
Nickel, mg/L	<0.05	<0.05	<0.05
Potassium, mg/L	10	7	9
Selenium, mg/L	<0.001	<0.001	<0.001
Silica, mg/L	8.4	7.5	8.0
Sodium, mg/L	263	173	218
Uranium, mg/L	0.0006	0.0004	0.0005
Vanadium, mg/L	<0.1	<0.1	<0.1
Zinc, mg/L	<0.01	<0.01	<0.01
Iron, TOTAL mg/L	0.64	0.73	0.69
Manganese, TOTAL mg/L	<0.01	0.04	0.03
Lead 210, suspended pci/L	<1.0	<1.0	<1.0
Polonium 210 suspended, pci/L	<1.0	<1.0	<1.0
Radium 226 suspended, pci/L	<0.2	<0.2	<0.2
Thorium 230 suspended, pci/L	<0.2	<0.2	<0.2
Uranium suspended, pci/L	0.0007	<0.0003	<0.0003

Table 3.4.2-12 Water Quality from MRSW-8

Parameters	10/25/2006	3/23/2007	6/14/2007	Average
Bicarbonate as HCO3, mg/L	420	458	327	402
Carbonate as CO3, mg/L	1670	44	26	580
Chloride, mg/L	21	2	<1.0	8
Conductivity, umhos/cm	3220	796.0	569.0	1528
Fluoride, mg/L	2.2	0.6	0.4	1.1
pH, s.u.	9.65	9.32	9.23	9.40
Solids, Total Dissolved TDS @ 180 C, mg/L	2190	508	354	1017
Sulfate, mg/L	10	<1.0	14	8
Gross Alpha, pci/L	4.3	2.4		3.35
Gross Beta, pci/L	20.9	10.1		15.5
Lead 210, pci/L	<1.0	<1.0	<1.0	<1.0
Polonium 210, pci/L	<1.0	<1.0	<1.0	<1.0
Radium 226, pci/L	<0.2	<0.2	<0.2	<0.2
Radium 228, pci/L	<1.0	<1.0	<1.0	<1.0
Thorium 230, pci/L	<0.2	<0.2	<0.2	<0.2
Nitrogen, Ammonia as N, mg/L	0.86	0.09	<0.05	0.33
Nitrogen, Nitrate+Nitrite as N, mg/L	<0.1	<0.1	<0.1	<0.1
Aluminum, mg/L		0.1	0.2	0.1
Arsenic, mg/L	0.025	0.005	0.004	0.011
Barium, mg/L	0.6	0.1	0.1	0.3
Boron, mg/L	0.1	<0.1	<0.1	0.1
Cadmium, mg/L	<0.005	<0.005	<0.005	<0.005
Calcium, mg/L	6	13	11	10
Chromium, mg/L	<0.05	<0.05	<0.05	<0.05
Copper, mg/L	<0.01	<0.01	<0.01	<0.01
Iron, mg/L	0.48	0.09	0.39	0.32
Lead, mg/L	<0.05	<0.001	<0.001	<0.05
Magnesium, mg/L	53	15	11	26
Manganese, mg/L	0.02	<0.01	<0.01	0.01
Mercury, mg/L	<0.001	<0.001	<0.001	<0.001
Molybdenum, mg/L	<0.1	<0.1	<0.1	<0.1
Nickel, mg/L	<0.05	<0.05	<0.05	<0.05
Potassium, mg/L	19	10	7	12
Selenium, mg/L	0.002	0.001	0.001	0.0013
Silica, mg/L	6.1	7.1	3.7	5.6
Sodium, mg/L	842	158	106	369
Uranium, mg/L	0.0040	0.0009	0.001	0.0020
Vanadium, mg/L	<0.1	<0.1	<0.1	<0.1
Zinc, mg/L	<0.01	<0.01	<0.01	<0.01
Iron, TOTAL mg/L	0.20	0.86	0.063	0.374
Manganese, TOTAL mg/L	<0.01	0.01	0.02	0.01
Lead 210, suspended pci/L	6.3	<1.0	<1.0	<1.0
Polonium 210 suspended, pci/L	<1.0	<1.0	<1.0	<1.0
Radium 226 suspended, pci/L	<0.2	<0.2	<0.2	<0.2
Thorium 230 suspended, pci/L	<0.2	<0.2	<0.2	<0.2
Uranium suspended, pci/L	0.0004	<0.0003	<0.003	<0.003

Table 3.4.2-13 Water Quality from MRSW-9

Parameters	3/21/2007	6/14/2007	Average
Bicarbonate as HCO3, mg/L	131	67	99
Carbonate as CO3, mg/L	15	12	14
Chloride, mg/L	2.79	<1.0	2
Conductivity, umhos/cm	259	148	204
Fluoride, mg/L	0.2	0.2	0.2
pH, s.u.	9.32	9.16	9
Solids, Total Dissolved TDS @ 180 C, mg/L	148	96	122
Sulfate, mg/L	2	5	4
Gross Alpha, pci/L	1.7		1
Gross Beta, pci/L	3.9		2
Lead 210, pci/L	8.6	<1.0	4.8
Polonium 210, pci/L	<1.0	<1.0	<1.0
Radium 226, pci/L	<0.2	<0.2	<0.2
Radium 228, pci/L	<1.0	<1.0	<1.0
Thorium 230, pci/L	<0.2	<0.2	<0.2
Nitrogen, Ammonia as N, mg/L	<0.05	<0.05	<0.05
Nitrogen, Nitrate+Nitrite as N, mg/L	<0.1	<0.1	<0.1
Aluminum, mg/L	<0.1	0.3	0.2
Arsenic, mg/L	0.002	0.002	0.002
Barium, mg/L	<0.1	<0.1	<0.1
Boron, mg/L	<0.1	<0.1	<0.1
Cadmium, mg/L	<0.005	<0.005	<0.005
Calcium, mg/L	13	15	14
Chromium, mg/L	<0.05	<0.05	<0.05
Copper, mg/L	<0.01	<0.01	<0.01
Iron, mg/L	0.03	0.19	0.11
Lead, mg/L	<0.001	<0.001	<0.001
Magnesium, mg/L	5	4	5
Manganese, mg/L	<0.01	<0.01	<0.01
Mercury, mg/L	<0.001	<0.001	<0.001
Molybdenum, mg/L	<0.1	<0.1	<0.1
Nickel, mg/L	<0.05	<0.05	<0.05
Potassium, mg/L	6	3	5
Selenium, mg/L	<0.001	<0.001	<0.001
Silica, mg/L	6.9	3.4	5.2
Sodium, mg/L	36	8	22
Uranium, mg/L	0.0016	0.0018	0.0017
Vanadium, mg/L	<0.1	<0.1	<0.1
Zinc, mg/L	<0.01	<0.01	<0.01
Iron, TOTAL mg/L	0.08	0.19	0.14
Manganese, TOTAL mg/L	<0.01	<0.01	<0.01
Lead 210, suspended pci/L	<1.0	<1.0	<1.0
Polonium 210 suspended, pci/L	<1.0	<1.0	<1.0
Radium 226 suspended, pci/L	<0.2	<0.2	<0.2
Thorium 230 suspended, pci/L	<0.2	<0.2	<0.2
Uranium suspended, pci/L	<0.0003	<0.0003	<0.0003

Table 3.4.2-14 Water Quality Data - Surface Water - Seasonal Averages

Parameter	Fall	Late-March	Mid-June
Bicarbonate as HCO3, mg/L	787	459	374
Carbonate as CO3, mg/L	277	23	32
Chloride, mg/L	12.7	3.6	2.8
Conductivity, umhos/cm	1827	845	819
Fluoride, mg/L	0.9	0.5	0.4
pH, s.u.	8.92	9.04	9.23
Solids, Total Dissolved TDS @ 180 C, mg/L	1169	478	538
Sulfate, mg/L	108	57	90
Gross Alpha, pci/L	7.0	2.6	
Gross Beta, pci/L	18.3	8.7	
Lead 210, pci/L	2.5	2.0	1.0
Polonium 210, pci/L	<1.0	<1.0	<1.0
Radium 226, pci/L	<0.2	0.4	0.6
Radium 228, pci/L	<1.0	<1.0	1.9
Thorium 230, pci/L	<0.2	<0.2	<0.2
Nitrogen, Ammonia as N, mg/L	0.31	0.10	0.10
Nitrogen, Nitrate+Nitrite as N, mg/L	0.3	<0.1	<0.1
Aluminum, mg/L		0.1	0.4
Arsenic, mg/L	0.007	0.003	0.004
Barium, mg/L	0.5	0.3	0.2
Boron, mg/L	0.1	<0.1	<0.1
Cadmium, mg/L	<0.005	<0.005	<0.005
Calcium, mg/L	24	27	20
Chromium, mg/L	<0.05	<0.05	<0.05
Copper, mg/L	<0.01	0.015	<0.01
Iron, mg/L	0.39	0.08	0.28
Lead, mg/L	<0.05	0.002	0.001
Magnesium, mg/L	41	20	18
Manganese, mg/L	0.02	0.01	0.01
Mercury, mg/L	<0.001	<0.001	<0.001
Molybdenum, mg/L	<0.1	<0.1	<0.1
Nickel, mg/L	<0.05	<0.05	<0.05
Potassium, mg/L	14	9	7
Selenium, mg/L	0.001	0.001	0.002
Silica, mg/L	5.6	6.9	4.9
Sodium, mg/L	409	140	135
Uranium, mg/L	0.004429	0.002775	0.0016111
Vanadium, mg/L	<0.1	<0.1	<0.1
Zinc, mg/L	<0.01	0.01	0.01
Iron, TOTAL mg/L	0.43	0.27	0.50
Manganese, TOTAL mg/L	0.02	0.03	0.03
Lead 210, suspended pci/L	1.8	<1.0	<1.0
Polonium 210 suspended, pci/L	<1.0	<1.0	<1.0
Radium 226 suspended, pci/L	<0.2	<0.2	0.3
Thorium 230 suspended, pci/L	<0.2	<0.2	<0.2
Uranium suspended, pci/L	0.0004	<0.0003	<0.0003

Table 3.4.2-15 Water Quality Data - Surface Water - Average Concentrations

Parameter	Overall Average
Bicarbonate as HCO3, mg/L	523
Carbonate as CO3, mg/L	101
Chloride, mg/L	5.9
Conductivity, umhos/cm	1122
Fluoride, mg/L	0.6
pH, s.u.	9.08
Solids, Total Dissolved TDS @ 180 C, mg/L	702
Sulfate, mg/L	84
Gross Alpha, pci/L	4.6
Gross Beta, pci/L	13.1
Lead 210, pci/L	1.7
Polonium 210, pci/L	<1.0
Radium 226, pci/L	0.4
Radium 228, pci/L	1.0
Thorium 230, pci/L	<0.2
Nitrogen, Ammonia as N, mg/L	0.16
Nitrogen, Nitrate+Nitrite as N, mg/L	0.2
Aluminum, mg/L	0.3
Arsenic, mg/L	0.005
Barium, mg/L	0.3
Boron, mg/L	0.1
Cadmium, mg/L	<0.005
Calcium, mg/L	24
Chromium, mg/L	<0.05
Copper, mg/L	0.01
Iron, mg/L	0.24
Lead, mg/L	0.016
Magnesium, mg/L	26
Manganese, mg/L	0.01
Mercury, mg/L	<0.001
Molybdenum, mg/L	<0.1
Nickel, mg/L	<0.05
Potassium, mg/L	10
Selenium, mg/L	0.001
Silica, mg/L	5.8
Sodium, mg/L	217
Uranium, mg/L	0.0028
Vanadium, mg/L	<0.1
Zinc, mg/L	0.01
Iron, TOTAL mg/L	0.39
Manganese, TOTAL mg/L	0.03
Lead 210, suspended pci/L	1.2
Polonium 210 suspended, pci/L	<1.0
Radium 226 suspended, pci/L	0.2
Thorium 230 suspended, pci/L	<0.2
Uranium suspended, pci/L	<0.0003

3.4.2.4 Surface Control Structures

Several small dams and ponds exist within and downstream of the project that provide a level of control and storage of surface water. During normal runoff conditions, these ponds will contain all upgradient runoff. Many of these water features may contain higher levels of water after spring runoff or after large precipitation events but are generally reduced to small, isolated pools or are completely dry by the end of the summer. Relatively small amounts of surface discharge from coal-bed methane operations may also maintain small pools of water in these ponds during dry summer months.

Installation of Wellfield 2 monitor, injection, and production wells in main ephemeral stream channels will be avoided if possible. If it is necessary to install a well within the high water marks of a ephemeral channel, then adequate structural wellhead protection will be installed to protect the wells during potential flood conditions. Wellhead protection could include concrete berms, or reinforced steel/concrete well covers, etc. Properly sized culverts will be used for secondary access roads crossing across small drainages. Efforts will be made to construct secondary access roads to avoid crossing major drainages. However, if crossing a major drainage is required, then adequately sized culverts will be utilized and embankments will be protected from erosion using adequate best management practices (rip rap, rock, etc.) in accordance with WDEQ-LQD Rules and Regulations, Chapter 3. Culverts across significant drainages will be designed to pass the 25-year peak runoff event using head available at the entrance. The minimum culvert size of 18" will be utilized to divert drainage from roads or for crossing small drains or swayles. Crossings for major drainages will be constructed at or near right angles.

3.4.2.5 Surface Water Impacts From CBM Discharges

Currently, three Wyoming Pollutant Discharge Elimination System (WYPDES) permits exist within or adjacent to the license area. The following Table 3.4.2-16 summarizes these permits.

Table 3.4.2-16 *WYPDES Permits in or near the Moore Ranch Project*

WYPDES Permit	***Facility Name***	***Operator***
WY0040436	*East Pine Tree Unit*	*Devon Energy Production Company*
WY0051217	*Palm Tree Project*	*Bill Barrett Corporation (BBC)*
WY0055131	*BBC Pine Tree Area*	*Bill Barrett Corporation (BBC)*

Outfalls permitted under the three WYPDES permits are presented on Figure 2.7.1-2.

Table 3.4.2-17 provides the WYPDES effluent limitations for Devon's East Pine Tree Unit CBM Facility (WY0040436), Bill Barrett Corporation's (BBC) Palm Tree Project CBM Facility (WY0051217) and BBC Pine Tree Area Permit (WY0055131).

***Table 3.4.2-17** WYPDES Effluent Limitations for Permits in or near the Moore Ranch Project*

Devon – East Pine Tree Unit (Outfalls 001-002, 004-015, 017-030)[1]	
Effluent Characteristic	***Daily Maximum***
Chlorides, mg/L	*46*
Dissolved Iron, µg/L	*1000*
pH, su	*6.5 – 9.0*
Sodium Adsorption Ratio	*10*
Specific Conductance, micromhos/cm	*2000*
Total Recoverable Arsenic, µg/L	*2.4*
Total Recoverable Barium, µg/L	*1800*
Total Dissolved Solids, mg/L	*5000*
Total Flow[4], MGD	*0.68*
BBC – Palm Tree Project (Outfalls 001 - 025)[2]	
Effluent Characteristic	***Daily Maximum***
Chlorides, mg/L	*46*
Dissolved Iron, µg/L	*1000*
pH, su	*6.5 – 9.0*
Sodium Adsorption Ratio	*10*
Specific Conductance, mircromhos/cm	*2000*
Total Recoverable Arsenic, µg/L	*3.0*
Total Recoverable Barium, µg/L	*1800*
Total Flow[4], MGD	*5.3*
BBC – BBC Pine Tree Area (Outfalls 004 - 008)[3]	
Chlorides, mg/L	*46*
Dissolved Iron, µg/L	*1000*
pH, su	*6.5 – 9.0*
Sodium Adsorption Ratio	*10*
Specific Conductance, micromhos/cm	*2000*
Total Recoverable Arsenic, µg/L	*3.0*
Total Recoverable Barium, µg/L	*1800*
Total Flow[4], MGD	*1.02*

[1] Devon's East Pine Tree Unit permit (WY0040436), effective August 30, 2007.
[2] BBC's Palm Tree Project permit (WY0051217), effective February 4, 2008.
[3] BBC's BBC Pine Tree Area permit (WT0055131), effective October 4, 2007.
[4] Total flow is for all outfalls permitted under each permit number, in million gallons per day.

Table 3.4.2-18 provides a list of reservoirs permitted through the Wyoming State Engineers Office (WSEO) within the license area that may be impacted by CBNG produced water discharge. The reservoir locations are depicted on Figure 2.7.1-2.

Table 3.4.2-18 *WSEO Permitted Reservoirs with the Moore Ranch License Area*

SEO Permit No.	Qtr-Qtr	Section	Township	Range
P16543S	NWSW	1	41N	75W
P14042S	NWNE	25	42N	75W
P14041S	SESW	25	42N	75W
P14040S	SWSE	25	42N	75W
P14043S	NWNE	26	42N	75W
P14036S	SWSW	26	42N	75W
P14037S	NESE	27	42N	75W
P14038S	SWSE	35	42N	75W
P14039S	NWSE	36	42N	75W

Table 3.4.2-19 provides a list of the discharge points located within the license area. These discharge points are also presented on Figure 2.7.1-2 as are a number of others outside of the license area.

***Table 3.4.2-19** CBM WYPDES Permits and Outfall Locations Within or Upstream of the Moore Ranch Project*

Company	Permit #	Outfall #	Qtr-Qtr	Sec	Twp	Rng	Latitude	Longitude
Devon	WY0040436	001 EPTD	NWNE	25	T42N	R75W	43.59012	-105.81289
		002 EPTD	SENE	25	T42N	R75W	43.58458	-105.80856
		004 EPTD	SESE	25	T42N	R75W	43.5806	-105.8100
		005 EPTD	SWSE	25	T42N	R75W	43.5769	-105.8122
		006 EPTD	NWNE	36	T42N	R75W	43.5719	-105.8117
		007 EPTD	SWNE	36	T42N	R75W	43.5694	-105.8122
		008 EPTD	SESE	36	T42N	R75W	43.5639	-105.8008
		009 EPTD	NESW	24	T42N	R75W	43.59653	-105.81550
		010 EPTD	SWSW	31	T42N	R74W	43.5626	-105.8043
		011 EPTD	NESW	34	T42N	R75W	43.5647	-105.8586
		012 EPTD	SWSE	34	T42N	R75W	43.5647	-105.8547
		017 EPTD	NESE	27	T42N	R75W	43.5814	-105.8465
		019 EPTD	NWNW	35	T42N	R75W	43.5743	-105.8430
		020 EPTD	SENW	35	T42N	R75W	43.5688	-105.8374
		021 EPTD	NESW	35	T42N	R75W	43.5657	-105.8259
		022 EPTD	SWSE	35	T42N	R75W	43.5628	-105.8345
		023 EPTD	SWSE	35	T42N	R75W	43.5623	-105.8345
		024 EPTD	SWSE	23	T42N	R75W	43.59174	-105.83319
		025 EPTD	SESE	26	T42N	R75W	43.5775	-105.8261
		026 EPTD	SWSW	25	T42N	R75W	43.5763	-105.8227
		027 EPTD	NENW	36	T42N	R75W	43.5738	-105.8176
		030 EPTD	NENW	10	T41N	R75W	43.5442	-105.8581
BBC	WY0051217	018	NWSW	1	T41N	R75W	43.55252	-105.82161
		020	SWSE	2	T41N	R75W	43.54840	-105.83423
		021	SWSW	2	T41N	R75W	43.54722	-105.84404
BBC	WY0055131	004	NWNE	9	T41N	R75W	43.54492	-105.87229
		005	NESE	28	T42N	R75W	43.58020	-105.86910
		006	SWSW	28	T42N	R75W	43.57640	-105.88350
		007	SWSE	31	T42N	R75W	43.56395	-105.91549
		008	NESW	33	T42N	R75W	43.56641	-105.87995

**Shading indicates outfalls that are upstream of Moore Ranch License Area*

Discharge data and WYPDES permit limits for outfalls located within the license area are provided in the tables on the following pages. Data provided in response to RAI 2-5.b on the Moore Ranch Technical Report indicates that infiltration to the 72 Sand has not occurred to date.

A conservative annual declination rate of 5% is assumed for future CBM discharge based on Devon's East Pine Tree Unit (WY0040436) historic data, as presented in the following Tables 3.4.2-20 through 3.4.2-23. All three WYPDES permits will be up for renewal in early 2009 with an expiration date in 2014. Personal communications with permit holders indicates that the permits will not likely be renewed in 2014. Flow from Devon's WY0040436 outfalls is anticipated to be less than 0.006 MGD by 2013. Based on historic CBNG water discharge data within the license area, water quality will not vary significantly as CBNG water production declines.

***Table 3.4.2-20** Historic and Projected Discharge Rates at CBM Discharge Points (Devon – East Pine Tree Unit, WY0040436)*

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2012	2014
MAXIMUM FLOW (MGD)	0.1006	0.0694	0.0572	0.0302	0.0183	0.0111	0.0092	0.0120	0.0114	0.0108	0.0103	0.0093	0.0084
AVERAGE FLOW (MGD)	0.0895	0.0615	0.0388	0.0243	0.0143	0.0078	0.0078	0.0082	0.0078	0.0074	0.0070	0.0063	0.0057
ANNUAL DECLINE		36.0%	35.2%	11.1%	11.1%	17.4%	5.9%	5.9%	5.0%	5.0%	5.0%	5.0%	5.0%

***Table 3.4.2-21** BBC Pine Tree Area (WY0055131) Average Water Quality and Discharge Rates*

PARAMETER	UNIT	PERMIT LIMIT[1]	OUTFALL				
			004	005	006	007	008
Total Flow (MGD) - MAX	MGD	1.02	0.0042	0.0261	0.0146	No Dis	No Dis
Total Flow (MGD) - AVG	MGD		0.0028	0.0197	0.0124	No Dis	No Dis
Bicarbonate	mg/L		952	1293	1126	No Dis	No Dis
Dissolved Calcium	me/L		74	82	73	No Dis	No Dis
Dissolved Magnesium	me/L		26	33	34	No Dis	No Dis
Dissolved Sodium	me/L		222	305	197	No Dis	No Dis
pH	SU	6.5-9.0	7.57	7.55	7.43	No Dis	No Dis
Sodium Adsorption Ratio	Calculated	10	5.7	7.6	6.0	No Dis	No Dis
Specific Conductance	micromhos/cm	2000	1350	1686	1415	No Dis	No Dis
Total Alkalinity	mg/L as CaCO3		780	1059	922	No Dis	No Dis
Chlorides	mg/L	46	10.3	6.9	6.8	No Dis	No Dis
Dissolved Iron	ug/L	1000	160	1257	570	No Dis	No Dis
Total Recoverable Arsenic	ug/L	3	0.67	1.73	1.60	No Dis	No Dis
Total Recoverable Barium	ug/L	1800	1050	2023	1157	No Dis	No Dis
Dissolved Cadmium	ug/L		0.1	ND	N/A	No Dis	No Dis
Dissolved Manganese	ug/L		97	104.5	84.5	No Dis	No Dis
Fluorides	mg/L		0.56	0.90	0.66	No Dis	No Dis
Potassium	mg/L		9	12.3	12.4	No Dis	No Dis
Sulfates	mg/L		2.6	3	7.5	No Dis	No Dis
Total Petroleum Hydrocarbons	mg/L		1	ND	ND	No Dis	No Dis
Total Radium 226	pCi/L		0.6	1.05	0.4	No Dis	No Dis

[1] – Data is provided for outfalls within and flowing through the license area.
[2] - Permit Limit set for all outfalls discharging under Permit WY0051217 (total number outfalls is 25)
N/A - Was not monitored, No Dis – No discharge reported, ND – Reported as non-detect by laboratory

***Table 3.4.2-22** Devon East Pine Tree Unit (WY0040436) WYPDES Average Water Quality and Discharge Rates[1]*

PARAMETER	UNIT	PERMIT LIMIT[2]	OUTFALL																			
			004	005	006	007	008	010	011	012	013	017	018	019	020	021	022	023	025	026	027	030
Flow - MAX	MGD	0.68	0.0443	0.0239	0.0109	0.0213	0.0256	0.0348	0.0283	0.0290	No Dis	0.0414	No Dis	0.0183	0.0086	0.0041	0.0066	No Dis	0.0130	0.0057	0.0032	0.0175
Flow - AVG	MGD		0.0367	0.0150	0.0096	0.0206	0.0232	0.0266	0.0217	0.0135	No Dis	0.0291	No Dis	0.0158	0.0076	0.0021	0.0044	No Dis	0.0108	0.0046	0.0021	0.0139
Alkalinity	mg/L		468	615	762	670	663	572	1217	995	No Dis	997	No Dis	602	702	498	434	No Dis	796	302	407	617
Total Recoverable Arsenic	ug/L	2.4	0.8	1.4	0.9	1.6	1.3	1.4	2.6	1.4	No Dis	5.6	No Dis	0.5	2.1	2.0	0.6	No Dis	0.6	1.6	1.1	1.8
Total Recoverable Barium	ug/L	1800	628	1032	1092	902	883	486	2476	1694	No Dis	1433	No Dis	577	925	600	421	No Dis	1153	296	360	980
Bicarbonate	mg/L		660	741	921	817	804	695	1471	1190	No Dis	1211	No Dis	723	828	605	517	No Dis	960	365	496	741
Calcium	mg/L		29	42	52	51	46	36	131	103	No Dis	88	No Dis	55	54	36	28	No Dis	68	17	26	59
Chlorides	mg/L	46	10	9	9	10	9	10	8	11	No Dis	5	No Dis	5	5	7	8	No Dis	6	9	No Dis	9
Dissolved Iron	ug/L	1000	189	482	1043	1089	60	671	380	174	No Dis	353	No Dis	467	351	1060	90	No Dis	498	892	905	0
Dissolved Cadmium	ug/L		N/A	N/A	N/A	N/A	N/A	N/A	0.6	0.6	No Dis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1820
Dissolved Manganese	ug/L		109	50	66	176	50	143	117	114	No Dis	77	No Dis	48	70	61	30	No Dis	88	119	74	57
Fluorides	mg/L		0.6	0.5	0.5	0.7	1.4	0.7	0.6	0.5	No Dis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.7
Magnesium	mg/L		8	9	16	11	13	9	44	29	No Dis	32	No Dis	16	14	8	6	No Dis	16	4	5	19
pH	SU	6.5 – 9.0	7.81	7.87	7.76	7.69	7.81	7.64	7.44	7.62	No Dis	7.55	No Dis	7.51	7.34	7.05	7.60	No Dis	7.16	7.66	7.22	7.84
Potassium	mg/L		5	6	7	7	7	6	15	11	No Dis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9
Sodium	mg/L		146	215	256	221	231	199	305	274	No Dis	298	No Dis	209	232	180	160	No Dis	255	117	153	178
Sodium Adsorption Ratio	Calculated	10	7.6	7.9	8.0	7.6	7.9	8.1	5.9	6.2	No Dis	7.0	No Dis	6.4	7.2	7.1	6.9	No Dis	7.2	6.7	7.2	5.1
Specific Conductance	umhos/cm	2000	859	1093	1348	1204	1175	1008	2068	1665	No Dis	1684	No Dis	1145	1186	912	798	No Dis	1316	585	735	1076
Sulfates	mg/L		13	2	4	3	2	2	5	2	No Dis	1	No Dis	40	1	1	8	No Dis	16	9	ND	2
Total Petroleum Hydrocarbons	mg/L		0.7	1.0	1.0	0.7	1.0	0.5	1.0	1.0	No Dis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.0
Total Radium 226	pCi/L		0.5	0.3	0.5	0.3	0.3	0.3	0.8	0.6	No Dis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.5

[1] – Data is provided for outfalls within the license area.
[2] - Permit Limit set for all outfalls discharging under Permit WY0040436 (total number outfalls is 30)
N/A - Was not monitored, No Dis – No discharge reported, ND – Reported as non-detect by laboratory

Table 3.4.2-23 *BBC Palm Tree Project (WY0051217) Average Water Quality and Discharge Rates*

PARAMETER	UNIT	PERMIT LIMIT[2]	OUTFALL		
			018	020	021
Total Flow (MGD) - MAX	MGD	5.3	0.0403	0.0079	0.0083
Total Flow (MGD) - AVG	MGD		0.0147	0.0079	0.0083
Bicarbonate	mg/L		723	744	674
Dissolved Calcium	me/L		5.72	7.89	11.78
Dissolved Magnesium	me/L		1.97	2.14	2.96
Dissolved Sodium	me/L		40.30	43.88	48.96
pH	SU	6.5-9.0	8.03	8.03	7.94
Sodium Adsorption Ratio	Calculated	10	7.9	7.4	6.4
Specific Conductance	micromhos/cm	2000	880	1052	967
Total Alkalinity	mg/L as CaCO3		449	615	555
Chlorides	mg/L	46	9	8	9
Dissolved Iron	ug/L	1000	1810	1514	2020
Dissolved Manganese	ug/L		63	119	66
Sulfates	mg/L		18	1	ND
Total Recoverable Arsenic	ug/L	3	0.8	1.0	1.6
Total Recoverable Barium	ug/L	1800	608	713	832
Total Petroleum Hydrocarbons	mg/L		ND	ND	ND
Total Radium 226	pCi/L		0.36	0.47	0.23

[1] – *Data is provided for outfalls within and flowing through the license area.*
[2] - *Permit Limit set for all outfalls discharging under Permit WY0051217 (total number outfalls is 25)*
ND – Reported as non-detect by laboratory

The seasonal variability of surface water quality apparent during baseline characterization (see section 2.7.3.1) is largely due to the influence from Devon Energy's outfalls permitted under WY0040436. The lack of water at MRSW-10 and MRSW-11 indicates that Bill Barrett's discharges upstream infiltrate into the shallow alluvial system and do not directly contribute to surface hydrological features within the license area. Assessment of surface water quality in light of the contributions from CBNG water discharges present at or upstream of monitoring sites must account for the seasonal variability present in the area. Following permit renewals in late summer/early fall 2008, WYPDES permits WY0040436, WY0051217 and WY0055131 will be active into 2014.

3.4.3 Groundwater

This section describes the regional and local groundwater hydrology, including: hydrostratigraphy, groundwater flow patterns, hydraulic gradient and aquifer parameters. The discussion is based on information from investigations performed within the Powder River Basin, data presented in previous applications/reports for the Moore Ranch Site, and the geologic information presented in Section 3.3. Regional and site hydrogeology and baseline water quality conditions are discussed in the following Sections. (For ease of review the figures for this section are contained at the end of the section).

3.4.3.1 Regional Hydrogeology

The Moore Ranch site is located in the southwestern portion of the Powder River Basin, approximately 20 miles east of the north-flowing Powder River and approximately 50 miles north of Casper, Wyoming. Moore Ranch lies within the Northern Great Plains Aquifer System (USGS 1996). The Northern Great Plains Aquifer System contains overlapping aquifers in the Lower Tertiary, Upper and Lower Cretaceous, and Upper and Lower Paleozoic rocks. Figure 3.4.3-1 provides a generalized stratigraphic column of the hydrostratigraphic units of the Northern Great Plains Aquifer System. The Eocene Wasatch Formation, the stratigraphic unit that hosts the uranium mineralization of the Moore Ranch project, crops out over most of the License area (and most of the central portion of the Powder River Basin). The Oligocene White River Formation, which is commonly found in outcrop along the fringes of the Powder River Basin, has been eroded away in the Moore Ranch area. Occasional surficial deposits of the White River Formation are encountered in the vicinity of Pumpkin Buttes (north of the site), but these deposits are not a significant source of groundwater. Furthermore, Rankl and Lowry (1990) state that water from Quaternary alluvium in the Powder River Basin has not been developed extensively because better quality water occurs in the underlying Lower Tertiary and Upper Cretaceous (Wasatch-Fox Hills) sequence and large yields are generally not possible.

The Lower Tertiary aquifers are found within the Wasatch and Fort Union Formations, and the Upper Cretaceous aquifers are found within the Lance Formation and the Fox Hills Sandstone. The Lower Tertiary-Upper Cretaceous aquifer sequence (Wasatch to Fox Hills Sandstone) is about 1,350 feet thick in southeastern Montana and thickens to at least 7,000 feet in Converse County (south of the Moore Ranch Site) (Taylor 1968). The Lewis Shale is a regional aquitard that separates the Upper Cretaceous aquifers from the Lower Cretaceous aquifers.

The Lower Cretaceous aquifers include the Mesa Verde, Frontier and Cloverly Formations. Several regional aquitards are interlayered between these Cretaceous aquifers, including the Cody, Mowry and Thermopolis Shales. Figure 3.4.3-1 shows the stratigraphic relationship of the Lower Teritiary, Upper and Lower Cretaceous aquifers and the regional aquitards for the western portion of the Powder River Basin.

Historical studies have stated that regional groundwater systems (e.g., the Wasatch, Fort Union, and deeper aquifers) generally flow to the northern portion of the Powder River Basin and discharge via unknown locations in Montana (Lowry & Wilson, 1986, and Rankl & Lowry, 1990). A generalized potentiometric surface map for the Lower Tertiary units of the Northern Great Plains Aquifer system is shown in Figure 3.4.3-2. The hydraulic communication between the aquifer systems has been reported to vary from none to direct. Groundwater flow direction in sediments near outcrop areas generally has been characterized as toward the center of the Powder River Basin.

On a semi-regional scale, ground-water flow occurs to the north-northwest, and the gradient is on the order of 0.004 to 0.006 ft/ft. This ground-water flow direction is consistent with results of numerous studies (Honea, 1974; Morris & Bahr, 1975; NRC, 1978; Rose, 1971). In the vicinity of Moore Ranch, flow in the shallow groundwater system is north to northwesterly, toward the Powder River.

Regional recharge to the Lower Tertiary aquifers in the vicinity of the Moore Ranch Project generally occurs at the formation outcrops along the western and southern edges of the Powder River Basin, associated with the Casper Arch and Laramie Mountain uplifts. Some recharge to the shallower aquifer systems is also derived from localized infiltration of precipitation. As described under the section on geology, sands that contain the uranium mineralization at Moore Ranch (70 Sand) crop out within a mile to the southeast of the License Area. These outcrops are localized recharge zones for the Wasatch aquifers within the Moore Ranch License Area.

For purposes of this application, only hydrogeologic units of Lower Tertiary/Upper Cretaceous age are described with respect to general hydrologic properties and potential for groundwater supply. Units deeper than the Fox Hills Sandstone and beneath the Lewis Shale are generally too deep to economically develop for water supply or have elevated TDS concentration that renders them unusable for consumption. Exceptions to this can be found along the edges of the basin, where Lower Cretaceous and older stratigraphic units are found in outcrop. Near outcrop areas, Lower Cretaceous and Paleozoic units can provide relatively good quality water. In particular, the Mesaverde Formation, Frontier Formation, Madison Limestone and Tensleep Sandstone can produce large quantities of relatively good quality water. However those outcrop locations are tens of miles from the Moore Ranch site. In the vicinity of Moore Ranch, the Lower Cretaceous and Paleozoic rocks are separated from the Wasatch Formation by over 5,000 feet of sediments.

Units younger than Lower Tertiary are typically not present within the vicinity of Moore Ranch and therefore are of no significance with respect to groundwater supply. Hydrologic units of interest within the southwest Powder River Basin are shown on the stratigraphic column in Figure 3.4.3-1 from deepest to shallowest:

- Lewis Shale (Late Cretaceous)
- Fox Hills Sandstone (Late Cretaceous)
- Lance Formation (Late Cretaceous)
- Fort Union Formation (Paleocene)
- Wasatch Formation (Eocene)

Discussion of the regional characteristics for each of these hydrostratigraphic units is provided below.

Lewis Shale

The Lewis Shale underlies the Fox Hills Sandstone and is generally considered the major aquitard between the Upper and Lower Cretaceous aquifer systems in the Powder River Basin. This unit is described by Hodson et al. (1973) as predominately shale with sandy shale zones and lenses of fine-grained sandstone. Thickness of this unit is approximately 450 to 500 feet in the southwest part of the basin. Small quantities of water may be available from the thin sandstone beds within this unit near the margins of the basin. However most of this formation does not yield water (Hodson 1973).

Fox Hills Sandstone

The Fox Hills Sandstone is the basal aquifer unit within the Lower Tertiary/Upper Cretaceous aquifer sequence in the Powder River Basin. The Fox Hills Sandstone consists of fine to medium grained sandstone beds deposited in a marine environment. The Fox Hills Sandstone is described by Weimer (1961) as a lithogenetic unit consisting of a series of individual sands bodies, sometimes several miles wide and hundreds of miles long. The Fox Hills Sandstone has been recognized in the northwestern part of the basin, but is generally poorly developed and unmapped along the western side of the basin (Gill 1966). The Fox Hills Sandstone is approximately 700 feet thick in the west part of the basin (Horn 1955) but is often undifferentiated from the overlying Lance Formation in west and northwest parts of the basin (Hose 1955).

Because of the disconnected nature of the individual sand bodies, hydraulic head data is not sufficient to define a potentiometric surface for a specific horizon within the Fox Hills Sandstone (Rankl 1990). Wells completed in the Fox Hills Sandstone have yields that typically range from 5 to 50 gallons per minute. Locally, this formation can yield over 200 gallons per minute, although lower yields are typically available in the western portion of the basin (Hodson 1973). Flowing artesian conditions (75 gpm) were present in a well in Campbell County, completed at a depth of 2,000 feet.

Lance Formation

Overlying the Fox Hills Sandstone is the Lance Formation. The Lance Formation consists predominately of very fine-to fine-grained lenticular, clayey, calcareous sandstone. Shale, coal and lignite beds are present within the formation, which has a typical thickness of 1,000 to 3,000 feet (Conoco 1982). Wells completed in the Lance Formation generally yield less than 20 gpm and most wells are drilled in outcrop areas for domestic and stock purposes. Because few wells are completed in this formation out toward the center of the basin,

potentiometric surface data are limited. It is assumed that the direction of groundwater flow is generally to the north, similar to that of the overlying Fort Union and Wasatch Formations.

Fort Union Formation

The Paleocene Fort Union Formation is stratigraphically between the Lance Formation and the overlying Wasatch Formation, reaching a maximum thickness of approximately 3,500 feet within the Powder River Basin. The Fort Union Formation is described as continental and shallow non-marine deposits of sandstone, carbonaceous shale and coal. Outcrops of the Fort Union Formation encircle most of the basin and the beds dip basinward. This formation is a major source of coal within the Powder River Basin and the United States and is extensively exploited for coal bed methane reserves.

Water is generally produced from sandstone, jointed coal and clinker beds with maximum yields on the order of 150 gpm. Specific capacity determined from wells completed in the Fort Union Formation within the Powder River Basin are generally less than 1 gpm per foot of drawdown (Lowery 1966, and Whitcomb 1964).

The hydraulic gradient of the Fort Union and Wasatch aquifers in the vicinity of Moore Ranch is reported as 0.0014 ft/ft to the north-northwest by Conoco (1982).

Wasatch Formation

The Wasatch Formation is described as an arkosic fine- to coarse-grained sandstone with siltstone, claystone and coals. The Wasatch Formation was deposited as a mixture of alluvial, fluvial and paludal environments. The contact between the Fort Union Formation and the Wasatch Formation is gradational in the vicinity of Moore Ranch and is generally arbitrarily set at the top of the thicker coals or thick sequence of clays and silts (Conoco 1982). The boundary between the two formations was considered by Conoco to be the top of the Roland Coal. Maximum total thickness of the Wasatch Formation is greater than 1,000 feet (800 to 1,100 feet in the License Area). In the southern portion of the Powder River Basin, the Wasatch Formation generally dips to the northwest at 1.0 to 2½ degrees. The sandstones that contain the uranium mineralization are generally coarse cross-bedded arkosic sand deposited in a high-energy fluvial environment. Individual channel sand units are generally oriented northward.

There are commonly multiple water-bearing sands within the Wasatch Formation. Groundwater within the Wasatch aquifers is typically under confined (artesian) conditions, although locally unconfined conditions exist. Hodson et al (1973) reported that wells completed in the Wasatch typically yield 10 to 50 gpm in the north part of the basin but yields are generally greater in the south part of the basin with yields as high as 500 gpm possible. Specific capacities of wells completed in the Wasatch Formation are usually greater

than for wells completed in the underlying aquifers. Specific capacities of 4 to 15 gpm/ft of drawdown were reported by Hodson et al. (1973).

As reported by Rankl and Lowry, most data available to describe aquifers in the Wasatch /Fox Hills sequence are from stock and domestic wells that are generally completed in small intervals of single formations at depths of less than 500 feet. There is large topographic relief in the area and because these wells are completed in sandstone aquifers at differing depths, hydraulic head data are generally not representative of a single continuous stratigraphic horizon and are not sufficient to provide potentiometric surfaces extending over great distances. The overall groundwater flow system in the shallow aquifers in the vicinity of Moore Ranch is toward the Powder River to the north-northwest. However, the aquifer systems are often locally controlled by stratigraphy and topography and attempts to confidently extend potentiometric surface data for any significant distance is difficult.

3.4.3.2 Site Hydrogeology

Groundwater

EMC has been collecting lithologic, water level, water quality, and pump test data as part of its ongoing evaluation of hydrologic conditions at the Moore Ranch Project. In addition to recent data acquisition, historic data collected for Conoco (1982) was used to support this evaluation. Drilling and installation of borings and monitor wells is ongoing in order to provide additional data to further refine the site hydrologic conceptual model. Water level measurements, both historic and recent, provide data to assess potentiometric surface, hydraulic gradients and inferred groundwater flow directions for the aquifers of interest at the Moore Ranch Project, at least on a localized scale. Recently completed pump tests by EMC and Petrotek Engineering Corporation (PEC 2007) as well as the pump tests conducted by Conoco (1982), were used to evaluate hydrologic properties of the aquifers of interest and to assess hydraulic characteristics of the confining units.

Figure 3.4.3-3 shows the monitor wells (current and historic) that were used in the site hydrologic evaluation. Table 3.4.3-1 (at the end of this section) provides data for those wells to the extent available.

Hydrostratigraphic Units

EMC has adopted the nomenclature used by Conoco (1982) for the hydrostratigraphic units of interest within the Moore Ranch Project. Sands above the Roland Coal are numbered, increasing upward. The 40 and 50 Sands are regionally extensive sands that are considered significant aquifers. The primary Production Zone is identified as the 70 Sand. The 70 Sand is bounded above and below by areally extensive confining units with some localized exceptions, as will be discussed.. Overlying the upper confining unit is the 72 Sand. The 72 Sand is considered the overlying aquifer to the Production Zone. The 72 Sand is the shallowest occurrence of groundwater across most of the Permit Area. However, localized perched groundwater conditions have been observed in the sand that overlies the 72 Sand, designated as the 80 Sand. The 80 Sand is present in outcrop over portions of the Permit Area. Beneath the lower confining unit is the 68 Sand. Although the 68 Sand is considered the underlying aquifer to the Production Zone, it is in communication with the 70 Sand in localized areas of the License Area, most notably in a small portion of proposed Wellfield 2. The 68 Sand also appears to coalesce with the underlying 60 Sand in portions of the License Area. Figure 3.4.3-4 depicts the hydrostratigraphic relationship of these units.

Deleted: The shallowest occurrence of groundwater within the License area occurs within the 72 Sand.

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A brief description of each hydrostratigraphic unit follows, from shallowest to deepest.

80 Sand (Shallowest Occurrence of Groundwater in the Permit Area

The uppermost sand unit within the permit area is the 80 Sand. The 80 Sand is present at the surface across portions of the site, reaching a maximum thickness of nearly 100 feet. The 80 Sand pinches out toward the south-southeast. The extent of saturated conditions in the 80 Sand within the permit area appears very limited. Three monitor wells (OMW-5, OMW-6 and OMW-7B) were recently installed specifically targeting the 80 Sand interval (Figure 2). Only one of these locations, OMW-7B (located in the north central portion of proposed Wellfield 2), contains sufficient water to allow for water quality sampling or pump testing. The groundwater at location OMW-7B is present under unconfined conditions and is most likely perched above the 72 Sand.

72 Sand (Overlying Aquifer)

The 72 Sand (Overburden above the 70 Sand) consists of a 50- to 250-foot thick sequence of clays, silts, discontinuous sandstones and alluvial sediments. The alluvial sediments are limited to the low-lying areas of surface drainages. A lignite marker bed, designated the "E" coal, is present across the site below the 72 Sand. As previously described, the 72 Sands are discontinuous, and when saturated, generally represent perched water conditions. Figure 3.3-

12 is an isopach of the overburden thickness in the vicinity of the ore bodies. The 70 Sand is considered the uppermost continuous water-bearing unit within the License area.

The first potential aquifer overlying the Production Zone is the 72 Sand. The top of the 72 Sand occurs at depths of approximately 30 to 200 ft bgs within the Moore Ranch License Area. The total thickness of the sand ranges from 5 to 90 feet. This sand is discontinuous across the License area, pinching out to the west-southwest. The 72 Sand is unsaturated over the southern portion of the License Area. In areas that saturated conditions exist within the 72 Sand, this unit is considered the overlying aquifer to the Production Zone aquifer. Maximum saturated thickness observed within the Permit Area is approximately 60 feet. In some areas where the 72 sand is saturated, it is a perched aquifer system.

Upper Mudstone, E Coal and Lower Mudstone-Upper Confining Unit

Underlying the 72 Sand is a sequence of mudstone, shale and lignite. A persistent, laterally extensive lignite seam was identified by Conoco as the E Coal. The E Coal is located a few feet above the top of the 70 Sand and is a consistent marker bed for the License Area. The units above and below the E Coal were designated by Conoco as the Upper and Lower Mudstone, respectively. The sequence of Upper Mudstone, E Coal and Lower Mudstone are collectively considered the Upper Confining Unit to the Production Zone. Although the E Coal has some intrinsic permeability, its limited thickness (typically 3 feet or less) and limited extent of saturation precludes its use as a source of groundwater supply.

In some instances, saturated conditions have been found to exist in wells completed in shallower sands above areas where the upper portion of the 70 Sand is unsaturated indicating that, at least locally, perched water is present above the 70 Sand.

70 Sand (Production Zone Aquifer)

The 70 Sand contains uranium mineralization and is the Production Zone at the Moore Ranch Project. The total thickness of the 70 Sand ranges from 40 to 120 feet, but is typically 60 to 80 feet, (Figure 3.3-9). The top of the 70 Sand ranges from approximately 100 to 330 ft bgs within the Moore Ranch License Area. This hydrostratigraphic unit is areally extensive (except to the south where it crops out) and dips to the northwest at less than one degree. The 70 Sand is present in outcrop or under a thin veneer of alluvium and topsoil just south of the License area over large portions of section 11 and 12 of T41N and R75W and Sections 6 and 7 of T41N and R74W. The area of 70 Sand outcrop is a recharge zone for the Production zone aquifer. Water entering the 70 Sand in this recharge area would flow north-northwest across the License Area.

Groundwater occurs in the 70 Sand under both confined and unconfined conditions. Data indicate that the potentiometric surface in the 70 Sand is close to the top of the sand itself (approximately 100 to 150 feet below ground surface). Confined conditions predominate in the northern portion of the Permit Area becoming unconfined to the south. Groundwater flow direction, based on the potentiometric data, is generally to the north. There is adequate hydrostratigraphic confinement between the production sand and/or the overlying/underlying sands over most of the site. However, lack of hydrostratigraphic confinement between the 70 Sand and the underlying 68 Sand occurs in the eastern/northeastern part of Wellfield #2. Additional mine-unit scale testing will provide data necessary to validate the approach for mining and monitoring this section of Wellfield #2. In the south part of the License Area, the

Deleted: The 70 Sand aquifer occurs generally under unconfined conditions in the MRPA. The 70 Sand aquifer in Wellfields #1 and #3 occurs mostly under unconfined conditions and has adequate hydrostratigraphic confinement between the production sand and/or the overlying/underlying sands. In Wellfield #2, the 70 Sand aquifer occurs under unconfined conditions and for the most part has adequate hydrostratigraphic confinement between the 70 Sand and overlying/underlying sands.

70 Sand is the shallowest occurrence of groundwater (although perched conditions may exist locally in some of the overlying sands and coals). The underlying aquifer to the 70 Sand is the 68 Sand.

Lower Confining Unit

Beneath the 70 Sand is a sequence of clays and silts ranging from 0 to 50 feet thick. The clay/silt sequence is absent in the area of monitor well UMW-2 where the 70 and 68 Sands coalesce.

68 Sand (Underlying Aquifer)

The first sand underlying the 70 Sand is identified as the 68 Sand. This unit is typically 40 to 60 feet thick but can reach over 75 feet in thickness (Figure 3.3-8).. The 68 Sand appears to be laterally extensive across the permit area but coalesces with the 70 Sand at some locations, most importantly within portions of proposed Wellfield 2. Water levels in the 68 Sand monitor wells indicate this unit is under confining conditions across the site.

Deleted: The 68 Sand is present beneath the Lower Confining Unit and in some areas in contact with the 70 Sand. The 68 Sand is typically 40 to 60 feet thick but can reach over 75 feet in thickness (Figure 3.3-8).

Unnamed Shale Unit

The unnamed shale at the base of the 68 Sand has not yet been fully characterized. This unit is generally 5 to 30 feet thick.

60 Sand

The 60 Sand is generally the first sand unit underlying the 68 Sand. In areas where the 70 and 68 Sand coalesce as one aquifer, the 60 Sand is 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 75 feet of shale or mudstone with some interspersed sandstone lenses. Additional borings are being drilled to evaluate the geologic and hydrologic characteristics of this hydrostratigraphic unit.

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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 Appendix D-5 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 Permit application. Monitor wells have been completed within the 58, 50 and 40 Sands along the southern portion of the Permit 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). Table 3.4.3-2 (at the end of this section) lists water level data recorded for the site monitor wells.

The potentiometric surface for the production zone is shown on Figures 3.4.3-*5a through 3.4.3-5e. 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 3.4.3-5c), indicates a depression at baseline 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 (Figures 3.4.3-5f and 3.4.3-5g). 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 3.4.3-5h). The results of the mapping indicate that the depression around MW8 is localized and does not impact the other baseline wells. Water level data used to develop the potentiometric surface maps and the hydrographs are included in Table 3.4.3-2.* 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).

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 3.4.3-6a). Water level data used to develop the hydrographs are included in Table 3.4.3-2. 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 3.4.3-6b through 3.4.3-6f). 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) 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).

Potentiometric surface maps for the 68 Sand are attached (Figures 3.4.3-7a through 3.4.3-7e). 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. Hydrographs have been prepared for the baseline monitor wells showing water level changes over time for each well (Figure 3.4.3-7f). With the exception of well UMW3, water levels remain relatively stable during the period of measurement (February 2007 through March 2008). Comparisons of water levels in each of the nested well groups (MW1/UMW1 through MW4/UMW4) are shown on Figures 3.4.3-7g through 3.4.3-7j respectively. Water levels between the MW1/UMW1 and MW2/UMW2 well groups are very similar and no clear vertical hydraulic gradient predominates. The data are consistent with isopach data that indicate the absence of the underlying shale between the 70 and 68 Sands in the eastern 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. 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, as described later in this section. Water level data used to develop the potentiometric surface maps and the hydrographs are included in Table 3.4.3-2. 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.

Vertical hydraulic gradients were determined by measuring water levels in closely grouped wells completed in different hydrostratigraphic units. Figure 3.4.3-8 shows the location of the well groups used for the assessment of vertical hydraulic gradients. Table 3.4.3-3 summarizes the calculated vertical gradients between the 72, 70 and 68 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.

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. 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 seem 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 3.4.3-7k). In addition to the decline in water levels that was previously noted in the License Application (from February 2007 until August 2007) a large decrease in water level occurred in the well in October 2007. The decrease in water levels 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. 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. Discounting the equipment malfunction (which was identified when hand measurements indicated an error in the transducer measurement) the water level in UMW3 has been relatively stable since February 2008. The cause of the earlier declining trend in the well is unknown and was not replicated in other wells. EMC will continue periodic monitoring of well UMW-3 to identify continuing trends and potential causes of those trends in the well. Additionally, the underlying aquifer in the vicinity of UMW-3 will be closely monitoring during production of the 70 Sand in that area.

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.

Deleted: the Wellfield 1 and Wellfield 22 ore bodies.

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

Historic Pump Tests

A series of aquifer tests were conducted on the Moore Ranch project from 1977 through 1980 to assess hydraulic characteristics of the Production Zone as well as overlying and underlying hydrostratigraphic units. Initial testing was performed by Wyoming Water Resources Research Institute (WWRI). Dames & Moore's assessment of the initial testing was that the results were unsatisfactory because of improperly developed wells, inadequate water level measurements and inappropriate analysis methods (Dames & Moore, 1978). Conoco redeveloped the wells using airlift pumping. Data collected during development of the wells were analyzed by Conoco to determine aquifer characteristics; additional pump tests also were conducted and analyzed by Conoco. A summary of the Conoco tests that were conducted to assess conditions within the ore bodies at Moore Ranch is presented below *(See Appendix B5 for Historic hydrologic analysis by Conoco)*. Information on the pumping wells and observation wells utilized in the pump tests are provided in Table 3.4.3-1 and the locations of the wells are shown on Figure 3.4.3-9.

- A pumping test was conducted on 8/17/77 at well 885 with wells 886, 887 and 888 as observation wells. These wells are located within the 34 orebody. Well 885 was pumped for 1 day (1440 minutes) at a rate of 3.4 gallons per minute (gpm). Observation wells 886, 887 and 888 were located 64, 115 and 50 feet, respectively, from the pumping well. Drawdown in the observation wells at end of test for 886, 887 and 888 were 0.74, 0.76 and 1.94 feet, respectively. All wells are completed within the 70 Sand except for well 887, which is completed in the 68 Sand. The response of well 887 during the pumping test indicates the possibility that there is hydraulic communication between the 70 and 68 Sands in the vicinity of the 34 orebody. The Conoco Mine License Application states that the seal between the sands in well 887 was questionable.

  Deleted: Wellfield 1

  Deleted: Wellfield 1

- The previously described wells were redeveloped using airlift methods. Recovery following redevelopment was recorded at wells 886 and 887. The effective pumping rate was 2 gpm for 886 and 0.1 gpm for 887 with 0.7 and 12 feet of drawdown, respectively.

- A pumping test was conducted within the 35N orebody on 6/25/78. Well 1 was pumped at 3.5 gpm for 140 minutes. Observation wells 1805 and 1806, located 36 and 73 feet, respectively from the pumping well, had measured drawdown of 0.71 and 0.54 feet at the end of the test. The pumping well and the observation wells are all completed within the 70 Sand.

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- A second pumping test was conducted at Well 1 on 6/25/78 to evaluate hydraulic communication with the 68 Sand within the 35N orebody. Well 1 was pumped at 2.5 gpm for 170 minutes. Observation well 1807 is located 111 feet from pumping well and completed within the 68 Sand. Drawdown of 0.37 feet was measured at well 1807 at the conclusion of the pumping test. The test results indicate that there may be hydraulic communication between the 70 and 68 Sand within the Wellfield 2 orebody. However, the Conoco Mine License Application indicates the results are inconclusive based on concerns regarding the integrity of the well completion in 1807.

  Deleted: Wellfield 2

- Well 1814, located within the 35S orebody, was pumped at 19 gpm for 1140 minutes beginning on 12/1/78. A maximum drawdown of 1.87 feet was measured at well 1816, located 55 feet from pumping well. Both the pumping and observation wells are completed within the 70 Sand.

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- Well 1823 was pumped for 70 minutes at 1.7 gpm on 5/22/80. Well 1823 is located within the 35S orebody and is completed in the 68 Sand. Over 6 feet of drawdown was measured in that well during the test. Water levels were also measured in observation well 1816 during the test. Well 1816 is located 70 feet from 1823 and completed in the 70 Sand. Water levels in well 1816 showed a slight increase during the pumping test, indicating a possible lack of hydraulic communication in that area between the 68 and 70 Sands.

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- Well 1814, located in the 35S orebody, was pumped at an average rate of 16.8 gpm over 3,100 minutes, beginning on 8/13/80. Maximum drawdown at the pumping well was 32 feet. The maximum drawdown in the well occurred approximately 1170 minutes into test. The pumping rate gradually decreased after that time (from 17.1 gpm to 15.8 gpm) and the water levels showed slight recovery during the latter portion of the test. Water levels were recorded during the test at observation wells 1816, 1815, 1817, and 1823, located 34.5, 89, 228 and 75 feet from the pumping well, respectively. All of the wells are completed in the 70 Sand except for 1823, which is completed in the 68 Sand. Maximum drawdown measured in the 70 Sand observation wells was 2.87 feet (1816), 1.3 feet (1815) and 0.2 ft (1817). Water levels in well 1823 did not show any drawdown, again indicating hydraulic separation between the 68 and 70 Sand in the vicinity of Wellfield 3 orebody.

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Results of the tests were variable with the highest transmissivity and hydraulic conductivity values determined for the 35S orebody. The results from the aquifer tests are summarized in Table 3.4.3-4. Based on internal review of the data by PEC, representative values are presented in the table along with the range.

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Table 3.4.3-4 Summary of Conoco Pump Test Results – 68 and 70 Sand Moore Ranch Project

	Range of Values	*Representative Value*
34-Orebody		
Transmissivity (T; ft^2/d)	23 to 240	110
Hydraulic Conductivity (k; ft/day)	0.38 to 4.0	1.9
Net Sand Thickness (h; ft)	60	60
Storativity (S)	5.3×10^{-6} to 2.9×10^{-3}	9.8×10^{-4}
35N-Orebody		
Transmissivity (T; ft^2/d)	112 to 297	165
Hydraulic Conductivity (k; ft/day)	0.95 to 1.52	1.4 ft/d
Net Sand Thickness (h; ft)	80	80
Storativity (S)	8.0×10^{-5} to 5.2×10^{-4}	2.5×10^{-4}
35S-Orebody		
Transmissivity (T; ft^2/d)	374 to 735 ft^2/d	555
Hydraulic Conductivity (k; ft/day)	9.35 to 18.3	13.8
Net Sand Thickness (h; ft)	40	40
Storativity (S)	3.2×10^{-4} to 4.3×10^{-3}	1.4×10^{-3}
Specific Yield	0.01 to 0.058	0.032

Note: The 70 Sand is only partially saturated in the vicinity of the 35N and 35 S ore-bodies

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Additional testing was performed by Conoco in an area to the southeast that was selected as a potential site for evaporation ponds. The purpose of that testing was primarily to assess hydraulic characteristics of the near-surface soils with respect to suitability for pond placement.

Limited data (e.g., laboratory analyses or detailed pump test data) regarding the vertical hydraulic conductivity of the confining units are available for the Moore Ranch Project Area. However, the data from other ISR operations in the Powder River Basin (COGEMA Mining Corporation and Power Resources Inc) appear to be reasonably analogous to Moore Ranch. In this regard, the COGEMA and PRI data indicate the vertical hydraulic conductivity of clays/shales in the Wasatch is on the order of 10^{-7} to 10^{-11} cm/sec (10^{-4} to 10^{-7} ft/d).

EMC did not analyze the data from the Conoco pump tests and only reported the results of the analyses performed by Conoco. The raw data from the Conoco pump tests were unavailable for additional analysis.

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.

Deleted: In February 2007, EMC and PEC initiated a pump test designed to accomplish the following objectives:¶
¶
<#>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 MRPA; and,¶
<#>Demonstrate sufficient confinement between the Production Zone and the Overlying and Underlying Sands for the purposes of ISR mining.¶

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 3.4.3-1 provides basic well information for the pumping wells and observation wells used in the tests. Table 3.4.3-5 summarizes the pump test parameters. The location of pumping wells and observation wells are provided in Figure 3.4.3.10. Details regarding the pump test procedures and results are provided in Appendix A1.

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.

In the test at well PW1, drawdown was observed at observation well MW1 located approximately 109 feet from the pumping well. However, that test was not run under a constant rate, making analysis of the data collected during the test more qualitative than quantitative.

During the MW2 pump test, drawdown was observed at well 1805, completed within the 70 Sand at a distance of 346 feet from the pumping well. That well was analyzed using the Neuman method of analysis that is suitable for delayed yield response typical of unconfined aquifers. Results of the unconfined analysis of well 1805 are included in Figure D6.3-13.

The pump test that was performed at well MW3 resulted in no discernible drawdown at any of the monitor locations. The closest 70 Sand monitor well to the pumping well was more than 1,300 feet away.

Table 3.4.3-5 Summary of Moore Ranch 2007 Pump Test Parameters

Test No.	*Pumping Well*	*Duration (minutes)*	*Duration (days)*	*Flow Rate (gpm)*	*Comments*
1	PW-1	13,275	9.2	16.5	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

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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). The 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 2007 pump tests and the results are discussed in Appendix A1. Table 3.4.3-6 provides a summary of the aquifer properties estimated from the recent pump test results.

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Table 3.4.3-6 Summary of Production Zone (70 Sand) Aquifer Properties Estimated From 2007 Pump Test Results

Pump Test	Representative Value
Central Location Between Wellfields 1 and 2 (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)	-
Transmissivity (T; ft2/d)	329
Hydraulic Conductivity (k; ft/day)	4.6
Net Sand Thickness (h; ft)	72
Wellfield 2 Test (MW-2)	-
Transmissivity (T; ft2/d)	640
Hydraulic Conductivity (k; ft/day)	8.2
Net Sand Thickness (h; ft)	78

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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.

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 A1, 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 initial decline is not known; however, long-term monitoring data clearly indicate that the decline was not a result of the MW-3 pump test and has not had an impact on water levels in MW-3.

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 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 may need to incorporate larger-diameter (e.g., 6- or 8-inch) completions to accommodate a 6-inch pump or may require multiple tests.

- 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;

- 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,

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

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Deleted: 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 3.4.3-11a through 3.4.3-11d). Water level data used to develop the hydrographs are included in Table 3.4.3-2. 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.¶
¶
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.

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2008 Pump Test Results

EMC and PEC conducted a pump test in 2008 designed to replicate operational conditions for the 70 Sand. A 5-Spot well pattern was installed within proposed Wellfield 2. The test included a central extraction well, four injectors spaced 100 feet apart, and several additional observation wells at distances of 10, 30, 40 and 70 feet from the extraction well. Boring logs and water level data confirmed that the wells included in the 5 Spot Pump Test were all within the unconfined portion of the 70 Sand. The initial phase of the test included only pumping from the extraction well. The well was pumped at a rate of 22.3 gpm for nearly 4 days. Drawdown in the extraction well at the end of the test was approximately 21 ft. Drawdown at the four corner injection wells (without injection) was between 3.7 and 4.1 ft. After completion of the first phase of the test, water levels were allowed to recover to near static conditions and then an injection/extraction phase was conducted where water pumped from the extraction well was injected into the injection wells. The extraction rate was 20 gpm. The extracted water was equally partitioned between the 4 injection wells (5 gpm per well) for a period of 2 days. Then, two of the wells were shut-in and the 20 gpm of extracted water was injected equally into only two wells (10 gpm each). After 1 day, a third injection well was shut-in and all of the extracted water was injected into a single well for a period of 1 day. The single injection well was able to accept all 20 gpm of the extracted groundwater.

The pumping, injection and observation wells were instrumented to allow continuous monitoring during all phases of the test. The data collected from the test was analyzed using a variety of analytical methods including Theis (1935), Cooper-Jacob (1946), Neuman (delayed yield) (1972) and Theis (1935) recovery. Results of the analyses indicate that the Neuman method (developed for delayed yield responses typical of unconfined conditions) provided the best fit to the data. Furthermore, analytical results using the Neuman method were typically only 60 to 70 percent of the value determined using the standard Theis method. Data and analysis from the test are provided in Appendix A2 (Technical Memorandum "5 Spot Pump Test, Results, Analysis and Modeling, Moore Ranch Uranium Project" (Petrotek 2008a)) that is attached. The analytical results reported in that report are considered the most representative of site conditions and provide the basis for additional calculations and modeling pertaining to production and restoration operations. Adjustments to aquifer property data and calculations dependent on those aquifer properties will be made as that data becomes available throughout the project.

Recently acquired field data from a 5 Spot Pump Test provides reliable and representative aquifer characterization of the 70 Sand. Data and analysis from the test are provided in Appendix A2. The results of the pump test were used to construct and validate numerical models that will be used to design future pumps tests that will adequately demonstrate hydraulic communication within the production zone. Results of the modeling indicate that multiple pumping tests will be required to demonstrate hydraulic communication across the

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EMC conducted three pump tests in 2007 to evaluate aquifer properties of the 70 Sand. 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.¶
In the test at well PW1, drawdown was observed at observation well MW1 located approximately 109 feet from the pumping well. However, that test was not run under a constant rate, making analysis of the data collected during the test more qualitative than quantitative.¶
During the MW2 pump test, drawdown was observed at well 1805, completed within the 70 Sand at a distance of 346 feet from the pumping well. That well has been re-analyzed using the Neuman method of analysis that is suitable for delayed yield response typical of unconfined aquifers. Results of the unconfined analysis of 1805 are attached (Figure 3.4.3-12). ¶
The pump test that was performed at well MW3 resulted in no discernible drawdown at any of the monitor locations. The closest 70 Sand monitor well to the pumping well was over 1300 feet away. ¶

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production zone. A preliminary simulation of such a pump test and full description of the model development and model simulations is provided in the Appendix A4 report "Numerical Modeling of Groundwater Conditions Related to Insitu Recovery at the Moore Ranch Uranium Project, Wyoming" (Petrotek 2008b).

The recently completed 5-Spot Pump Test provided sufficient information to adequately characterize the 70 Sand aquifer system in an area where it is predominately under unconfined conditions. The aquifer characterization data has been incorporated into numerical models that will be used to assist in the design of wellfield development, production and restoration. The 5 Spot Pump Test demonstrated that the aquifer is very responsive to pumping. For example, during the first phase of the 5-Spot Pump Test with pumping occurring at a single extraction well at a rate of 21.7 gpm, drawdown of over 2 feet occurred at all wells within the test area within 1 day. The maximum distance from the pumping wells to the wells on the exterior of the pattern was 71 feet. Using parameters determined from the 5-Spot test (transmissivity of 300 ft2/d, and a specific yield of 0.028), the calculated drawdown at a distance of 500 feet from the pumping well would be approximately 0.5 feet after 10 days of pumping at 22 gpm (Figure 3.4.3-13). The data indicate that a cone of influence could rapidly extended out to a monitor well ring 500 feet from the mined ore zone and that an excursion could be reversed within a relatively short period of time. Additional model simulations will be performed to further refine the methods that would be employed to recover an excursion and to determine the time frame that recovery could be accomplished.

Also, an additional pump test was performed on the historic Conoco well 885 in the summer of 2008. In 1977, Conoco pumped well 885 at a rate of 3.4 gpm for a period of 1 day (a total of 4,900 gallons). During the test, Conoco reported drawdown in an underlying monitoring well (887) of 0.76 feet. The underlying well was reported to be a distance of 119 feet from the pumping well. Conoco stated in its report that the well seal was suspect. Drawdown was also measured at two other 70 Sand monitor wells, 886 and 888, reported to be 64 and 50 ft, respectively from the pumping well. The drawdown in those wells was reported as 0.74 and 1.95 ft, respectively. Note that the well locations reported in the Conoco Permit to Mine Application indicate that the distance from the pumping well to 887, 886 and 885 are actually 159, 161 and 12 feet respectively.

In an attempt to verify the hydraulic communication reported by Conoco, EMC conducted a pump test at well 885 on 6/4/08. Well 885 was pumped at a rate of approximately 15.6 gpm for a period of 20 hours (18,600 gallons). This test provided a significantly larger hydraulic stress to the 70 Sand than the Conoco test. The underlying monitor well (887) showed no response due to pumping of the production zone well (885). There was an unexplained and abrupt shift in the water level at well 887 halfway into the test. However, the shift does not appear to be related to the pumping test because it was a sharp instantaneous rise in water level of 0.1 feet approximately 11 hours into the test. No drawdown was observed during the

duration of the test. Drawdown in well 885 was 17.4 feet at the end of the test. Drawdown at 70 Sand monitor well 888 at the end of the test was 2.6 ft. There was no drawdown indicated at location 886 during the test. A map showing the location of the pumping well and monitor wells and plots of the water level data collected during the test are attached. Based on the results of the test, EMC has demonstrated there is no communication between the 70 Sand and 68 Sand in the vicinity of the 885 monitor well. Results of this test can be found in Appendix A3 and the historic testing performed by Conoco can be found in Appendix A5.

3.4.3.3 Groundwater Quality

Information regarding site water quality is primarily derived from studies conducted by Conoco (1982) and from ongoing exploration and delineation of the Moore Ranch Project by EMC. Conoco began a baseline groundwater monitoring program in 1978 as part of its Mine License Application for the Sand Rock Project. EMC has initiated a baseline groundwater monitoring program to collect data required for the License Permit to Mine and NRC License Applications for the Moore Ranch Uranium Project.

Regional Water Quality

Water quality within the Powder River Basin ranges from very poor to excellent. Groundwater in the near surface, more permeable aquifers is generally of better quality than groundwater in deeper and less permeable aquifers. However, significant regional aquifers are present at depth that can provide relatively good quality water. In particular, the Mesaverde Formation, Frontier Formation, Madison Limestone and Tensleep Sandstone can produce large quantities of acceptable quality water. But overall, water quality tends to degrade moving into the deeper portions of the Powder River Basin.

Sources of water quality data include the historic USGS WATSTOR data system (now replaced by the National Water Information System), the Wyoming Water Resources Research Institute (WWRI) data system (WRDS) and compilations by various authors including Hodson (1971 and 1974), Larson and Daddow (1984), Crawford (1941), Crawford and Davis (1962) and Wells (1979).

Water quality from the Madison Limestone illustrates the downgradient, basinward increase in TDS levels. Springs from Madison outcrops along the west side of the basin generally yield calcium bicarbonate type water containing less than 500 mg/l TDS. Further into the basin, groundwater within the Madison aquifer becomes progressively more saline with TDS values rapidly exceeding 3,000 mg/l. Groundwater transitions to a sodium sulfate, sodium-

chloride water type with distance from recharge areas. TDS concentrations rapidly increase in Western Converse County, possibly related to the structural complexity along the north flank of the Laramie Mountains (Feathers 1981).

Similarly, in the western half of the Powder River Basin, water quality from outcrop areas of the Tensleep Formation is generally below 500 mg/l TDS. Low TDS waters tend to be predominately magnesium to calcium-bicarbonate type. Higher TDS samples generally are associated with higher sodium sulfate or sodium chloride levels. (Feathers 1981)

A study conducted by Lowry et al (1986) that included the Powder River Basin as well as upstream parts of the Belle Fourche and Cheyenne River basins, reported that 84 percent of wells and springs reviewed exceeded the USEPA secondary drinking water standard for TDS (500 mg/l) and approximately 55 percent of the samples exceeded 1,000 mg/l. The sample set included 693 wells and springs. The average TDS concentration (in mg/l) reported in the study by formation is shown in Table 3.4.3-7.

Table 3.4.3-7 Total Dissolved Concentration by Formation, Powder River Basin (after Lowry et al 1986)

Formation	Average	Min	Max	No of Samples
Alluvium	2,128	106	6,610	38
Wasatch Formation	1,298	227	8,200	191
Fort Union Formation	1,464	209	5,620	257
Fox Hills/Hells Creek Formations	1,100	340	5,450	73
Lance Formation	1,218	251	2,850	31
Tensleep Sandstone*	874	230	6,820	15
Madison Group	1,503	65	3,240	25

* Most of the Tensleep Sandstone samples were collected from springs and near formation outcrop areas

The study noted that the dominant factor affecting TDS concentration within an aquifer is most likely the length of the flow path from recharge to discharge. Wells close to recharge areas generally have the lowest TDS levels and wells farthest from the recharge areas tend to have the highest TDS levels. Only 8 percent of the samples exceeded 3,000 mg/l.

Total dissolved solids levels within the Fox Hills Sandstone are generally higher in the western side of the basin than the eastern side, ranging between 1,000 and 2,000 mg/l. No water type is prevalent. TDS values from the Lance Formation range from about 200 to more than 2,000 mg/l but are typically between 500 and 1,500 mg/l (Hodson 1973).

Water quality for the Fort Union aquifer is described by Hodson (1973) as having TDS values ranging from 200 to more than 3,000 mg/l, but typically is between 500 and 1,500 mg/l. Water type for the Fort Union is predominately sodium bicarbonate to sodium sulfate.

Within the Wasatch, TDS ranges from less than 200 to more than 8,000 mg/l but typically ranges between 500 and 1500 mg/l. Sodium sulfate and sodium bicarbonate are the dominant water types for the Wasatch aquifer system.

The study by Lowry (1986) indicated that manganese levels exceeded the USEPA secondary drinking water standard (SDWS) of 50 µg/l in 43 percent of the 257 samples reviewed. Iron concentrations exceeded the USEPA SDWS (0.3 mg/l) in over 15 percent of the 366 samples reviewed. Selenium levels exceeded USEPA Maximum Contaminant Level (MCL) of 0.05 mg/l, in a small percentage of the wells (2.5 percent). Lead levels exceeded the MCL of 0.015 mg/l in 3.6 percent of the samples. There was no breakdown of the sample groups by formation reported in the study.

Radionuclide data for the Powder River Basin are sparse outside of the uranium mining areas. Feathers and others (1981) reported uranium ranging from 0.5 to over 10,000 µg/l for 96 samples collected from mine monitor wells completed in the Wasatch Formation. Radium-226 samples from the same sample group ranged from 0.2 to 173 pCi/l. Samples from five non-mining locations indicated uranium levels at or below 0.6 µg/l and radium-226 levels at or below 0.8 pCi/l.

Uranium levels from 31 samples from mine monitor wells completed in the Fort Union Formation ranged from 5 to 3,550 µg/l (Feathers 1981). The radium-226 concentration in those same wells ranged from 3.7 to 954 pCi/l. Samples from non-mine wells completed in the Fort Union Formation were generally low in uranium and radium-226 concentration. Samples from Lance and Fox Hills wells were much lower than those completed in the Wasatch and Fort Union mine wells but were similar to the non-mine wells for those formations.

Near Moore Ranch, hydrostratigraphic units deeper than the Fox Hills Sandstone are generally too deep to be economically developed for water supply or have elevated TDS concentrations that renders them unusable for consumption. At Moore Ranch, the Lower Cretaceous and Paleozoic aquifers are separated from the Wasatch aquifer by over 5,000 feet of sediments.

Site Baseline Water Quality

Information regarding site water quality is primarily derived from studies conducted by Conoco (1982) and from baseline monitoring of the Moore Ranch Project by EMC. Conoco began a baseline groundwater monitoring program in 1978 as part of its Mine License Application for the Sand Rock Project. EMC has initiated a baseline groundwater monitoring program in 2007 to collect data required for the Permit to Mine and NRC License Applications for the Moore Ranch Uranium Project. Some of the historic Conoco baseline wells were either completed across multiple sands or are of questionable well construction/integrity. Those wells of questionable construction or that are completed across multiple sands are not considered as part of the baseline water quality for purposes of obtaining a Permit to Mine. Data from those wells are included for discussion of background water quality for informational purposes only.

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Groundwater Monitoring Network and Parameters

Historic Network/Parameters

Conoco installed monitor wells within the License Area that were completed in the Production Zone aquifer (70 Sand), the underlying aquifer (68 Sand), the 40-50 Sand, and the Roland Coal. The locations of the Conoco monitor wells that were sampled for water quality are shown on Figure 3.4.3.-11. Table 3.4.3-8 provides construction details for the Conoco monitor wells used in the initial baseline analysis for the area. The parameters included in the Conoco Monitoring Program are listed in Table 3.4.3-9.

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Based on the data provided in the Conoco Mine License Application (1982), many of the wells were only sampled once. However, five of the wells, 1, 8-3, 893, 1808 and 1814, were sampled at least four times from November 1978 through April 1980. Two of the wells that were sampled multiple times by Conoco (1808 and 8-3) and one well (885) that was only sampled once, were also included in recent sampling rounds by EMC. The initial monitoring performed by Conoco, and the continuation of monitoring of some of the original wells, provides an extensive background record of water quality that supplements the current

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baseline sampling program. Wells 1808 and 8-3 are completed across multiple sands and are not used to establish baseline conditions for the Permit Area but are provided for informational purposes only.

Conoco also collected groundwater samples from eleven private wells within and near the License Area. Six of the wells have State Engineers Groundwater Permit Numbers, four did not and one of the locations is Pine Tree Spring. Of the six that have permit numbers, three are listed as domestic-stock wells, two are listed as stock wells and one is listed as a domestic-industrial well (Continental Oil -Permit No.12299).The locations of most of those wells are also shown on Figure 3.4.3-11. Several of the private wells are located over two miles outside the License area and are not shown on the figure. The private wells were sampled for the same parameters as the Conoco monitor wells (Table 3.4.3-9). Construction details on the private wells were generally unavailable. Therefore, the private wells are not considered for purposes of establishing baseline conditions. However, some of these private wells have also been included in the current sampling program to provide an assessment of water quality of groundwater that is being utilized in the vicinity of the Permit Area and to identify if changes in water quality at those locations may occur.

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EMC has installed a monitor well network to evaluate pre-mining baseline conditions within the License area. Four well groups were constructed, each including a completion in the Production Zone aquifer, the overlying aquifer, and the underlying aquifer. In addition to the well groups, four new wells completed in the 70 Sand are included in the baseline water quality monitoring network. Three of the original Conoco wells, 8-3, 1808, and 885, and 4 stock wells were also included in the monitoring program. 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. Table 3.4.3-10 provides a summary of well construction information. The locations of wells included in the current monitoring network are shown on Figure 3.4.3-12. The parameters included in the EMC Monitoring Program are listed in Table 3.4.3-11.¶

Table 3.4.3-9 Conoco Baseline Water Quality Monitoring Parameters

Major Ions	Trace Constituents	Radionuclides
Calcium	Aluminum	Radium-226
Magnesium	Ammonia	Uranium
Potassium	Arsenic	Polonium-210
Sodium	Barium	Lead-210
Bicarbonate	Berylium	Thorium-230
Chloride	Boron	
Carbonate	Cadmium	
Sulfate	Chromium	
Nitrate (Total)	Copper	
	Fluoride	
	Iron	
General Water Chemistry	Lead	

Table 3.4.3-9 Conoco Baseline Water Quality Monitoring Parameters

Major Ions	Trace Constituents	Radionuclides
Total Dissolved Solids	Manganese	
pH (field and laboratory measured)	Mercury	
Conductivity(field and lab measured)	Molybdenum	
Temperature (field measured)	Nickel	
	Selenium	
	Vanadium	
	Zinc	

EMC Monitoring Program

EMC has installed a monitor well network to evaluate pre-mining baseline conditions within the License area. Four well groups were constructed, each including a completion in the Production Zone aquifer, the overlying aquifer, and the underlying aquifer. In addition to the well groups, four new 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 3.4.3-10 provides a summary of well construction information. The locations of wells included in the current monitoring network are shown on Figure 3.4.3-12. The parameters included in the EMC Monitoring Program are listed in Table 3.4.3-11.

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

This baseline analysis is intended to evaluate the overall quality of groundwater that is moving beneath the License Area under normal pre-mining conditions and does not provide the final basis for establishing restoration criteria for the individual mine units. The mine

unit baseline water quality assessment and restoration goals will be provided to the WDEQ with the first Mine Unit Wellfield Data Package.

Four rounds of water sampling have been completed in the baseline monitor well for the Production Zone aquifer (70 Sand), the overlying aquifer (72 Sand) and the underlying aquifer (68 Sand). An initial water sampling round has been completed in the 80, 60, 58, 50, and 40 sand monitor wells in May 2009. Additional sampling events are planned for those wells in order to fully assess seasonal and other potential impacts to groundwater quality.

Four stock wells located within the License Area were also sampled by EMC to establish pre-mining groundwater quality. Three of the wells (T-1, P'-9, and P'-11) were previously sampled under the Conoco monitoring program (1978-1980). The locations of the four wells are shown on Figure 3.4.3-12. EMC recently replaced the pumps in those wells and was able to gather the following information.

- Stock Well #1 (formerly referred to as T-1). Pump is set 180' below surface in steel casing. Water right associated with this well is License No. 12299. Well may be completed within the 70 Sand based on depth of pump.
- Stock Well #2 (formerly referred to as P'11). Pump is set 260' below surface in steel casing. Well is most likely completed in the 68 sand.
- Stock Well #3 (formerly referred to as P'9). Pump is set 120' below surface in steel casing. Well is most likely completed in the 70 Sand.
- Stock Well #4 (formerly referred to as P'26). Pump is set 141' below surface in steel casing. Total depth of the well is 158 ft. Water right associated with well is License No. 14682. Well is likely completed above the 70 Sand, probably within the 72 sand.

Again, because of the uncertainty in the completion intervals in these wells, the water samples collected from these private stock wells do not represent baseline water quality for the Permit to Mine Application and are only provided for informational purposes and to assess possible changes in water quality during ISR operations.

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Deleted: Two rounds of water sampling have been completed in the newly installed monitor well network as of August 2007.

Deleted: However, as described in following sections, with the exception of a few wells, water quality is generally consistent between the two sampling rounds. Also, data collected from the previous baseline monitoring program conducted by Conoco provide additional information to assess temporal variability in water quality. Current data collected from wells included in the previous baseline monitoring by Conoco show relatively consistent results with the previous data showing consistent water quality for the past 25 years. 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 is representative of site groundwater quality

Table 3.4.3-11 EMC Baseline Water Quality Monitoring Parameters

Major Ions	**Trace Constituents**	**Radionuclides**
Calcium (dissolved)	Aluminum (dissolved)	Gross Alpha (dissolved)
Magnesium (dissolved)	Ammonia (as N)	Gross Beta (dissolved)
Potassium (dissolved)	Arsenic (dissolved)	Lead-210 (dissolved and suspended)
Sodium (dissolved)	Barium (dissolved)	Polonium-210 (dissolved and suspended)
Bicarbonate (total)	Beryllium (dissolved)	Radium-226 (dissolved and suspended)
Chloride (total)	Boron (dissolved)	Radium-228 (dissolved and suspended)
Carbonate (total)	Cadmium (dissolved)	
Sulfate (total)	Chromium (dissolved)	Thorium-230 (dissolved land suspended)
Nitrate + Nitrite (as N) (total)	Copper (dissolved)	Uranium (dissolved and suspended)
Silica (dissolved)	Fluoride	
	Iron (dissolved and total)	
	Lead (dissolved)	
General Water Chemistry	Manganese (dissolved and total)	
Total Dissolved Solids (@180 F)	Mercury (dissolved)	
pH (field and laboratory measured)	Molybdenum (dissolved)	
Conductivity(field and lab measured)	Nickel (dissolved)	
Temperature (field measured)	Selenium (dissolved)	
	Vanadium (dissolved)	
	Zinc (dissolved)	

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Groundwater Quality Sampling Results

Results of the Conoco baseline monitoring programs are summarized in Tables 3.4.3-12 and 3.4.3-13. Results of the EMC baseline monitoring program (72, 70, and 68 Sands) are summarized in Table 3.4.3-14a. 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 3.4.3-14b. 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 3.4.3-13a 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. Figure 3.4.3-13a is a Piper diagram of the average ion concentration for each of the non-baseline monitor wells included in the EMC groundwater monitoring program (deeper Wasatch sands, the 80 Sand, private wells and wells with unknown or multiple horizon completions).

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Figure 3.4.3-14 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 baseline sampling program. Historic data from the wells completed in the 40-50 Sand and the Roland Coal (wells 1822 and 1821 respectively) are also included on the diagram for reference. The water types for these two deeper aquifers show progressively decreasing sulfate and increasing bicarbonate and sodium with depth. 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 3.4.3-15)

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 3.4.3-15a compares the analytical results of the those 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 3.4.3-13). 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 8-3 are much higher in the recent sampling events than when the well was first sampled by Conoco in 1979 (Table 3.4.3-15a). 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 chart recorder and float for continuous water level measurement, which protected the well from the weather. However, evidence that small mammals had fallen down the well was observed when the old recording equipment was removed for sampling. Decay of the organic material in the well is a possible cause of the anomalous values detected during monitoring. While several casing volumes were removed during sampling, this well should be flushed by air lifting or increased purging prior to the next sampling round. This anomaly will be evaluated further with additional sampling events. Water quality in the other two wells, 885 and 1808, did not change significantly between the earlier and current sampling events.

Table 3.4.3-15b 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 complete as for the monitor wells listed in Table 3.4.3-15a because not all of the parameters were sampled by Conoco. However, the parameters that were monitored show good consistency over time, an indication of the relatively stable long term aquifer conditions in the area. Future background monitoring is anticipated to show a continuation of this long term stability.

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Table 3.4.3-16 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 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 exceedences occurring in samples from the Production Zone aquifer. Figure 3.4.3-16 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

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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

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Well 8-3, which is not included in the table because it is completed across both the Production Zone and the underlying aquifers, had an average TDS value of 2,380 mg/l over the two recent sampling events.

Similarly, almost half of the Production Zone samples exceeded the WDEQ Class I standard for sulfate of 250 mg/l (Figure 3.4.3-17). 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. The highest sulfate value was found in well 8-3 (1,430 mg/l) which, again, was not included in the table because the well is completed across both the Production Zone and underlying aquifer.

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Ammonia, iron, manganese, and selenium were the only trace minerals to exceed standards in the baseline wells. 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) and at well 8-3. Iron ranged from below detection to 3.34 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 (0.05 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.

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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 68 Sand (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 3.4.3-18 shows the distribution of uranium within the three aquifers. Uranium ranged from below detection (<0.0003) to 0.864 mg/l. Radium 226 distribution is shown in Figure 3.4.3-19. 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.

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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

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combined 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.

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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. In addition to TDS and sulfate groundwater quality standards, many of the monitor wells fail to meet Class I (Drinking), II (Agricultural) or III (Livestock) WDEQ classification standards for radium, gross alpha and selenium as well as USEPA Drinking water standards for uranium. The projected class of use, based on water quality is shown in following table.

Deleted: Underlying wells UMW-1 and UMW-3 had limited water above the J-collar (top of screen liner) available for sampling and the J-collar prevents lowering a pump into the screen. As a result, adequate purging these wells has proven to be difficult and will pose a difficulty in future sampling, which renders the water quality data for these wells questionable and data from wells UMW-4 and UMW-2 are more likely to be representative of water quality in the underlying 68 Sand. EMC will continue sampling efforts in these wells and evaluate any changes in water quality, and water quality of the underlying aquifer will be evaluated extensively during wellfield specific pre-mining baseline hydrologic testing activities.¶

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Table 3.4.3.17 Projected Class of Use Based on Monitor Well Water Quality Moore Ranch License Area

		STANDARDS EXCEEDED				Projected Class of Use
	Completion Interval	WDEQ Class I	WDEQ Class II	WDEQ Class III	USEPA MCL	
Well ID						
UMW-9	60 Sand	Se, g. alpha	Se, g. alpha	Se, g. alpha	Se, g. alpha, U	Class VI
UMW-10	60 Sand	Se, pH	Se, pH	Se	Se, U	Class VI
UMW-11	60 Sand	SO4, TDS, pH, Se, g. alpha	SO4, Se, g. alpha	Se, g. alpha	Se, g. alpha, U	Class VI
UMW-1	68 Sand	pH	pH	pH	None	Class VI
UMW-2	68 Sand	pH, Se, Ra	pH, Se, Ra	pH, Se, Ra	Se, Ra	Class VI
UMW-3	68 Sand	TDS, Ra	Ra	Ra	Ra	Class VI
UMW-4	68 Sand	Se	Se	Se	Se, U	Class VI
MW-2	70 Sand	SO4, TDS, Ra	SO4, Ra	Ra	Ra, U	Class VI
MW-3	70 Sand	TDS, g. alpha, Ra	G. alpha, Ra	G. alpha, Ra	G. alpha, Ra, U	Class VI
MW-4	70 Sand	SO4, TDS, g. alpha, Ra	G. alpha, Ra	G. alpha, Ra	G. alpha, Ra, U	Class VI
MW-6	70 Sand	None	None	None	None	Class I
MW-7	70 Sand	Se, g alpha	Se, g. alpha	Se, g. alpha	Se, g. alpha, U	Class VI
MW-9	70 Sand	SO4, TDS, Se, g alpha, Ra	SO4, Se, g alpha, Ra	Se, g alpha, Ra	Se, g alpha, Ra, U	Class VI
MW-11	70 Sand	SO4, TDS, Fe, g. alpha, Ra	SO4, g. alpha, Ra	g. alpha, Ra	g. alpha, Ra U	Class VI
PW-1	70 Sand	SO4, TDS, Fe, g. alpha, Ra	SO4, g. alpha, Ra	g. alpha, Ra	g. alpha, Ra U	Class VI
885	70 Sand	SO4, TDS, Mn, g. alpha, Ra	SO4, g. alpha, Ra	g. alpha, Ra	g. alpha, Ra U	Class VI

Table 3.4.3.17 Projected Class of Use Based on Monitor Well Water Quality
Moore Ranch License Area

		STANDARDS EXCEEDED				Projected Class of Use
	Completion Interval	WDEQ Class I	WDEQ Class II	WDEQ Class III	USEPA MCL	
Well ID						
1808	68-70 Sand	SO4, TDS, Mn, Ra	SO4, Ra	Ra	Ra	Class VI
8-3	68-70 Sand	SO4, TDS, Fe, Mn	SO4, TDS,	None	None	Class III
OMW-1	72 Sand	pH	None	pH	None	Class II
OMW-2	72 Sand	SO4, TDS, Mn	SO4	None	None	Class III
OMW-3	72 Sand	None	None	None	None	Class I
OMW-4	72 Sand	SO4, TDS, Fe, Mn	SO4, Mn	None	None	Class III
OMW-7B	80 Sand	TDS, g. alpha	g. alpha	g. alpha	g. alpha	Class VI
Stockwell #1	70?	SO4, TDS, Fe, Mn	SO4, Mn	None	None	Class III
Stockwell #2	68?	SO4, TDS, Fe, Mn	SO4, Mn	None	None	Class III
Stockwell #3	70?	SO4, TDS, Fe, Mn, g. alpha	SO4, TDS, Mn, g. alpha	g. alpha	g. alpha	Class VI
Stockwell #4	72?	None	None	None	None	Class I

A set of figures has been prepared that identifies the projected WDEQ class of use (from Table 3.4.3.17) for the 60 through 80 Sands within the project area, based on the available monitor well water quality data (Figure 3.4.3-20a through 2d). A separate figure is presented that indicates the projected class of use of four private un-permitted stock wells within the Permit Area that have been sampled by EMC Figure 3.4.3-20e. The completion zones for these wells are estimated from pump depths and projection from site cross sections. Also included on the figure is the projected class of use for two Conoco monitor wells that are completed across multiple aquifers.

The only permitted domestic well within the Permit Area is identified as an industrial, domestic well for the Rio Algom Mining Corp (P12299W). That well is projected as being completed in the 58 or 60 Sand interval. There are no occupied residences within the Permit Area. The nearest other permitted domestic wells are located approximately two miles to the east of the Permit Area. These wells are hydraulically upgradient or cross-gradient to the Permit Area.

There are numerous permitted and un-permitted stock wells located within the Permit Area. Water quality data are unavailable from SEO records for any of the permitted stock wells

Deleted: 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 on 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 previous baseline monitoring by Conoco show relatively consistent results with the previous data showing 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).

within the two-mile radius of the Moore Ranch Permit Area. EMC collected water quality from four stock wells within the Permit Area that are not permitted. Water quality data from those wells indicate that one of the wells meets all WDEQ Class I and USEPA MCL standards for general chemistry, inorganics and radionuclides (Table CR 3.4.3.3-3, previous comment response). Two of the wells meet Class III standards (but not Class I) making them suitable for livestock purposes, consistent with their current use. The fourth stock well exceeds the WDEQ Class III standard for gross alpha, making the Wyoming groundwater classification of this well as Class VI, unsuitable for drinking water, agricultural or livestock uses. EMC has no control over the use of these private wells and can only inform the well owner that the water quality is unsuitable for the wells intended use.

As shown in Table CR3.4.3.3-3, the all but one of the 60, 68 and 70 Sand monitor wells exceed Class I, II and III standards for gross alpha and radium and the USEPA MCL for uranium. Many of those wells also exceed selenium standards for Class I, II and III water. All of the 72 sand monitor wells meet the Class III water quality standards. These water quality trends are consistent with the presence of uranium mineralization beneath the 72 Sands within the Moore Ranch Permit Area.

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3.4.3.4 Groundwater Impacts from CBM Discharge

Between 1979 and 1981 Conoco installed 35 piezometers in section 35, T42N, R75W and section 1, T41N, R75W as part of an evaluation of proposed mine tailings and evaporation pond sites. The piezometers were installed in discrete lithologic units (silts, sands, coals and alluvium) contained in the 72 sand aquifer. Two of these piezometers were completed near OMW-2 in sandy sections of the aquifer. The measured water elevations for both wells are similar to the elevations measured currently in the 72 sand. Data from the piezometers and monitor well OMW-2 are presented in Table 3.4.3-22. While saturated thickness levels are below those currently measured in OMW-2, this is likely a relict of completion methods versus quantity of water in the formation. Of the 35 piezometers completed for Conoco's Appendix D-6, only two lacked groundwater. EMC believes the presence of water in the 72 sand in 1979-1980 (some 21 years prior to CBNG development) indicates that the aquifer has been historically present in the area and is not the result of CBNG development. Additionally, Stockwell #4P14682P, located in the SENW quarter of section 26, T42N, R75W and completed in the 72 sand aquifer has been a source of livestock water since the early sixties.

Table 3.4.3-22 *Shallow Tailings Area Piezometer Characteristics*

Well/Piezometer I.D.	*Total Depth*	*Depth to Water (Ft)*	*Saturated Thickness*	*Static Water Elevation*	*Water Level Date*

			(Ft)	*(Ft. AMSL)*	
OMW-2	***78***	***67.62***	***10.38***	***5244.88***	***2/9/2007***
35N-6	***90***	***86.87***	***3.13***	***5236.5***	***5/15/1980***
35N-7C	***84***	***82.09***	***1.91***	***5229.3***	***5/15/1980***

As noted previously in this section, the groundwater within the 72 sands is of the calcium-sulfate type. Shallow groundwater monitoring associated with CBNG water storage facilities in the area also indicates calcium-sulfate type water under baseline conditions (WDEQ-WQD, Sheridan Office, 2008). Groundwater quality data from three monitor wells installed by methane producers in sections 4, 15 and 22 of T42N, R75W, are also of the calcium-sulfate type (MW4-2, MW23-15 and MW22-1). These three wells are under water table conditions and have not received any infiltration from water produced during coal-bed development because they were installed prior to the discharge of CBNG produced water. Based on elevation relationships, it is highly likely that the wells in sections 15 and 22 are installed in the 72 sand aquifer. Similarly, the groundwater encountered in piezometers 35N-6 and 35N-7C (Conoco, 1981) is of the calcium-sulfate type. Both of these piezometers were completed in sandy portions of the 72 sand aquifer.

Shallow aquifer systems which have received CBNG water typically display an evolution from calcium-sulfate to sodium-bicarbonate type (WDEQ-WQD, Sheridan Office, 2008). CBNG water within this area is of the sodium-bicarbonate type. Data from a monitor well (MWAL21-20-1) installed in a shallow alluvial system located in the NENW of section 20, T43N, R77W have been included on the Piper diagrams (Figures 3.4.3-10). These data show the influence from infiltration of CBNG water as sodium and bicarbonate become the dominant ions in the shallow groundwater. The evolution from a calcium-sulfate based water type to sodium-bicarbonate occurred along with a decrease in total dissolved solids. Although groundwater in OMW-3 is somewhat atypical because of the significant presence of the bicarbonate ion, bicarbonate concentrations are far below those observed from nearby CBNG outfalls and the dominant cation remains calcium versus the prevalent sodium from CBNG discharges.

Comparison of the ambient water quality measured in the 72 sand to data from a system being altered by infiltration indicates that the 72 sand has not received infiltration from nearby discharges. The potential for the water quality of the 72 sand to be impacted by infiltrating CBNG discharges was evaluated through a basic linear velocity analysis using conservative estimates to delineate; 1) minimum travel time for CBNG produced water to infiltrate from the surface through the overlying silts and clays to the top of the sandy portion of the 72 aquifer, and 2) minimum travel time between infiltration into the sandstone (either underlying an impoundment or recharge directly into a sandstone outcrop) to the closest monitoring point. The basic assumptions that were made lead to exceedingly conservative velocities and travel times (see Table 3.4.3-23). Fundamentally, utilizing conservative values for thickness, hydraulic conductivity and porosity it is theoretically possible for the 72 sand

to receive water during the lifespan of the Moore Ranch Project. Infiltration into outcrops or subcrops of the 72 sand to where it could potentially reach monitoring locations is less likely, with travel times on the order of tens to hundreds of thousands of years.

Anecdotal evidence provided by the WDEQ-WQD for surface water facilities permitted to receive CBNG produced water provides few instances in which water infiltrating from the facilities has adversely impacted groundwater resources. Groundwater quality has been adversely affected and class of use has changed at only 16 out of 109 permitted impoundments due to infiltration from overlying reservoirs/infiltration pits. Typically, the class of use has changed due to increases in the concentrations of selenium, TDS or sulfate. These data represent nearly four years of data collection from 259 monitor wells installed at sites across the Powder River Basin. Based on the lack of change in groundwater chemistry in the 72 sand aquifer from 1980 to the present, there is no evidence to suggest that this aquifer is impacted.

Table 3.4.3-23 Estimated Linear Travel Times to the 72 Sand Aquifer System

Unit	Thickness (ft)		Thickness (cm)	K (cm/sec)	Porosity (unitless)	(dh/dl)	Average Linear Velocity (cm/sec)	Average Linear Velocity (ft/day)	Travel Time (days)	Travel Time (years)
Overburden Siltstone	Minimum	30	914	1.0E-04	0.35	1	2.9E-04	0.810	37	0.1
		30	914	1.0E-05	0.35	1	2.9E-05	0.081	370	1.0
		30	914	1.0E-06	0.35	1	2.9E-06	0.008	3704	10.1
	Average	115	3505	1.0E-04	0.35	1	2.9E-04	0.810	142	0.4
		115	3505	1.0E-05	0.35	1	2.9E-05	0.081	1420	3.9
		115	3505	1.0E-06	0.35	1	2.9E-06	0.008	14199	38.9
	Maximum	200	6096	1.0E-04	0.35	1	2.9E-04	0.810	247	0.7
		200	6096	1.0E-05	0.35	1	2.9E-05	0.081	2469	6.8
		200	6096	1.0E-06	0.35	1	2.9E-06	0.008	24694	67.7

Unit	Distance to monitoring point (ft)	Distance (cm)	K (cm/sec)	Porosity (unitless)	(dh/dl)	Average Linear Velocity (cm/sec)	Average Linear Velocity (ft/day)	Travel Time (days)	Travel Time (years)
72 Sand	9151	2.8E+05	1.0E-06	0.25	0.004	1.6E-08	4.4E-05	2.1E+08	5.7E+05
	851	2.6E+04	1.0E-06	0.25	0.004	1.6E-08	4.4E-05	1.9E+07	5.3E+04

Indicates most conservative travel time and velocity estimate (thinnest overburden, highest K)
Indicates measured variables used in calculations. Values are from Conoco, 1981 and EMC, 2007
Distance is measured from approximate sandstone outcrop on South Fork Ninemile Creek (NESE, S10, T41N, R75W) to monitor well OMW-4
Distance is measured from outfall 020 EPTD to OMW-2 (area where overburden siltstone is thinnest)

Addendum 3.4-A

Ground Water Rights within a 2-Mile Radius

Addendum Table 3.4.A. Water Well Rights Within Two Miles of the Moore Ranch Permit Area (Revised June 2009)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Type_Permit_No	Priority	Status	T	Dir_NS	R	Dir_EW	Sec	Qtrqtr	Applicant	Facility_Name	Uses	Yld_Act	Well Depth	Static Depth	Top Completion	Bottom Completion
2	**Domestic**																
3	P17302P	31-Jul-64	GST	41	N	74	W	4	NESE	PINE TREE RANCH CO.	PINE TREE #2	DOM,STO	40	165	90	Unknown	Unknown
4	P17304P	31-Aug-46	GST	41	N	74	W	4	SENE	PINE TREE RANCH CO.	PINE TREE #3	DOM,STO	25	137	80	Unknown	Unknown
5																	
6	Industrial																
7	P12299W	04-Jan-72	ADJ	42	N	75	W	33	NWSE	RIO ALGOM MINING CORP.	UM 1575 2 33 42 75	IND,DOM	15	440	60	348	440
8	P60162W	21-May-80	GST	42	N	75	W	35	NENW	POWER RESOURCES INC	CONOCO 1821	IND,MIS	40	1200	342	1120	1200
9	P60163W	21-May-80	GST	42	N	75	W	35	NENW	POWER RESOURCES INC	CONOCO 1822	IND,MIS	45	740	249	560	720
10																	
11	Irrigation, Misc																
12	P174003W	28-Mar-06	GSI	42	N	74	W	28	SESE	NINE MILE LAND CO	MOORE #20	IRR,MIS					
13																	
14	**Miscellaneous**																
15	P78584W	14-Nov-88		41	N	74	W	7	NESE	W. A. MONCRIEF, JR.	LUCKY PINE #7 1	MIS	50	960	200	870	960
16	P161053W	22-Jul-04	GSI	41	N	74	W	7	NESE	Diamond T LLC	LUCKY PINE #7-1	MIS					
17	P177243W	11-Sep-06	GST	42	N	74	W	18	SWSW	YATES PETROLEUM CORPORATION	ENL. PRATHER CS #5	MIS					
18	P183672W	14-Nov-07	GSI	42	N	75	W	35	SWSE	ENERGY METALS CORPORATION	EMC MRWW#1	MIS				470-590	
19																	
20	**Monitor Wells**																
21	P39655W	15-Aug-77	GST	41	N	75	W	2	NWNE	KERR-MCGEE NUCLEAR CORPORATION	MOORE RANCH PROJECT D(41-75)2-0B6	MON	0	165	99	87	Unknown
22	P39656W	15-Aug-77	GST	41	N	75	W	3	NWNE	KERR-MCGEE NUCLEAR CORPORATION	MOORE RANCH PROJECT D(41-75)3-OB7	MON	0	175	70	105	Unknown
23	41/5/416W	10-Apr-09	UNA	41	N	75	W	2	NWNE	ENERGY METALS CORP	UMW-6	MON					
24	41/6/416W	10-Apr-09	UNA	41	N	75	W	2	NENW	ENERGY METALS CORP	UMW-7	MON					
25	41/7/416W	10-Apr-09	UNA	41	N	75	W	3	NENE	ENERGY METALS CORP	UMW-8	MON					
26	41/8/416W	10-Apr-09	UNA	41	N	75	W	3	NENW	ENERGY METALS CORP	UMW-9	MON					
27	P177581W	18-Oct-06	GSI	42	N	75	W	27	SWSE	ENERGY METALS CORP	EMC MW11	MON					
28	P177571W	18-Oct-06	GSI	42	N	75	W	34	SENW	ENERGY METALS CORP	EMC MW1	MON					
29	P177573W	18-Oct-06	GSI	42	N	75	W	34	NWNE	ENERGY METALS CORP	EMC MW3	MON					
30	P177574W	18-Oct-06	GSI	42	N	75	W	34	NWSE	ENERGY METALS CORP	EMC MW4	MON					
31	P177578W	18-Oct-06	GSI	42	N	75	W	34	SWNE	ENERGY METALS CORP	EMC MW8	MON					
32	P177579W	18-Oct-06	GSI	42	N	75	W	34	NENW	ENERGY METALS CORP	EMC MW9	MON					
33	P177580W	18-Oct-06	GSI	42	N	75	W	34	NENE	ENERGY METALS CORP	EMC MW10	MON					
34	P177584W	18-Oct-06	GSI	42	N	75	W	34	NWNE	ENERGY METALS CORP	EMC OMW3	MON					
35	P177585W	18-Oct-06	GSI	42	N	75	W	34	NWSE	ENERGY METALS CORP	EMC OMW4	MON					
36	P177588W	18-Oct-06	GSI	42	N	75	W	34	NWNE	ENERGY METALS CORP	EMC UMW3	MON					
37	P177589W	18-Oct-06	GSI	42	N	75	W	34	NWSE	ENERGY METALS CORP	EMC UMW4	MON					
38	P177570W	18-Oct-06	GSI	42	N	75	W	35	SWNE	ENERGY METALS CORP	EMC PW1	MON					
39	P177572W	18-Oct-06	GSI	42	N	75	W	35	SENW	ENERGY METALS CORP	EMC MW2	MON					
40	P177575W	18-Oct-06	GSI	42	N	75	W	35	NWSW	ENERGY METALS CORP	EMC MW5	MON					
41	P177576W	18-Oct-06	GSI	42	N	75	W	35	SWNE	ENERGY METALS CORP	EMC MW6	MON					
42	P177577W	18-Oct-06	GSI	42	N	75	W	35	NESW	ENERGY METALS CORP	EMC MW7	MON					
43	P177582W	18-Oct-06	GSI	42	N	75	W	35	SWNE	ENERGY METALS CORP	EMC OMW1	MON					
44	P177583W	18-Oct-06	GSI	42	N	75	W	35	SENW	ENERGY METALS CORP	EMC OMW2	MON					
45	P177586W	18-Oct-06	GSI	42	N	75	W	35	SWNE	ENERGY METALS CORP	EMC UMW1	MON					
46	P177587W	18-Oct-06	GSI	42	N	75	W	35	SENW	ENERGY METALS CORP	EMC UMW2	MON					
47	P39648W	15-Aug-77	GST	42	N	75	W	34	SWNE	POWER RESOURCES INC	MOORE RANCH PROJECT D (42 75) 43 P	MON	0	240	182	160	Unknown

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	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Type_Permit_No	Priority	Status	T	Dir_NS	R	Dir_EW	Sec.	Qtrqtr.	Applicant	Facility_Name	Uses	Yld_Act	Well Depth	Static Depth	Top Completion	Bottom Completion
48	P39653W	15-Aug-77	GST	42	N	75	W	34	SWNW	POWER RESOURCES INC	MOORE RANCH PROJECT D (42 75) 34 OB4	MON	0	260	164	185	220
49	P39654W	15-Aug-77	GST	42	N	75	W	34	NWNE	POWER RESOURCES INC	MOORE RANCH PROJECT D (42 75) 34 OB5	MON	0	330	163	247	320
50	P75097W	05-Mar-87	GST	42	N	75	W	34	SWNE	POWER RESOURCES INC	MOORE RANCH #886	MON	0	240	186	Unknown	Unknown
51	P75098W	05-Mar-87	GST	42	N	75	W	34	SWNE	POWER RESOURCES INC	MOORE RANCH #887	MON	0	320	177.2	Unknown	Unknown
52	P75099W	05-Mar-87	GST	42	N	75	W	34	SWNE	POWER RESOURCES INC	MOORE RANCH #888	MON	0	250	177.3	Unknown	Unknown
53	P75100W	05-Mar-87	GST	42	N	75	W	34	SWNE	POWER RESOURCES INC	MOORE RANCH #893	MON	0	240	173.19	Unknown	Unknown
54	P39649W	15-Aug-77	GST	42	N	75	W	35	SENW	POWER RESOURCES INC	MOORE RANCH PROJECT D (42 75) 34 P	MON	0	240	160	120	Unknown
55	P39650W	15-Aug-77	GST	42	N	75	W	35	SWNW	POWER RESOURCES INC	MOORE RACNCH PROJEACT D (42 75) 35 OB1	MON	0	263	208	185	257
56	P39651W	15-Aug-77	GST	42	N	75	W	35	NENW	POWER RESOURCES INC	MOORE RANCH PROJECT D (42 75) 35 OB2	MON	0	275	144	188	0
57	P39652W	15-Aug-77	GST	42	N	75	W	35	SENE	POWER RESOURCES INC	MOORE RANCH PROJECT D (42 75) 35 OB3	MON	0	227	189	135	225
58	P75101W	05-Mar-87	GST	42	N	75	W	35	SWNE	POWER RESOURCES INC	MOORE RANCH #1805	MON	0	240	154.1	Unknown	Unknown
59	P75102W	05-Mar-87	GST	42	N	75	W	35	SWNE	POWER RESOURCES INC	MOORE RANCH #1806	MON	0	220	146	Unknown	Unknown
60	P75103W	05-Mar-87	GST	42	N	75	W	35	SWNE	POWER RESOURCES INC	MOORE RANCH #1807	MON	0	290	160.5	Unknown	Unknown
61	P75104W	05-Mar-87	GST	42	N	75	W	35	SWSW	POWER RESOURCES INC	MOORE RANCH #1814	MON	0	207	157.1	Unknown	Unknown
62	P75105W	05-Mar-87	GST	42	N	75	W	35	SWSW	POWER RESOURCES INC	MOORE RANCH #1815	MON	0	208	159.6	Unknown	Unknown
63	P75106W	05-Mar-87	GST	42	N	75	W	35	SWSW	POWER RESOURCES INC	MOORE RANCH #1816	MON	0	207	155.1	Unknown	Unknown
64	P75107W	05-Mar-87	GST	42	N	75	W	35	NWSW	POWER RESOURCES INC	MOORE RANCH #1817	MON	0	233	162.9	Unknown	Unknown
65	P75108W	05-Mar-87	GST	42	N	75	W	35	SWSW	POWER RESOURCES INC	MOORE RANCH #1823	MON	0	240	113.1	Unknown	Unknown
66	41/8/454W	15-May-09	UNA	42	N	75	W	34	NWNE	ENERGY METALS CORP	UMW-11	MON					
67	41/1/416W	10-Apr-09	UNA	42	N	75	W	35	NESW	ENERGY METALS CORP	MW-18	MON					
68	41/10/415W	10-Apr-09	UNA	42	N	75	W	35	NESW	ENERGY METALS CORP	MW-17	MON					
69	41/2/416W	10-Apr-09	UNA	42	N	75	W	35	NESW	ENERGY METALS CORP	MW-19	MON					
70	41/3/416W	10-Apr-09	UNA	42	N	75	W	35	NESW	ENERGY METALS CORP	PMW-1	MON					
71	41/4/416W	10-Apr-09	UNA	42	N	75	W	35	NESW	ENERGY METALS CORP	UMW-5	MON					
72	41/5/415W	10-Apr-09	UNA	42	N	75	W	35	NESW	ENERGY METALS CORP	IMW-1	MON					
73	41/6/415W	10-Apr-09	UNA	42	N	75	W	35	NESW	ENERGY METALS CORP	IMW-2	MON					
74	41/7/415W	10-Apr-09	UNA	42	N	75	W	35	NESW	ENERGY METALS CORP	IMW-3	MON					
75	41/7/454W	15-May-09	UNA	42	N	75	W	35	NESW	ENERGY METALS CORP	UMW-10	MON					
76	41/8/415W	10-Apr-09	UNA	42	N	75	W	35	NESW	ENERGY METALS CORP	IMW-4	MON					
77	41/9/415W	10-Apr-09	UNA	42	N	75	W	35	NESW	ENERGY METALS CORP	MW-16	MON					
78																	
79	Stock																
80	P17301P	31-Dec-28	GST	41	N	74	W	4	NESE	PINE TREE RANCH CO.	PINE TREE #1	STO	15	130	55	Unknown	Unknown
81	P6973W	12-Oct-70	GST	41	N	74	W	5	SWNW	PINE TREE RANCH CO.	PINE TREE #9	STO	5	170	60	140	165
82	P17305P	30-Jun-43	GST	41	N	74	W	7	NENW	PINE TREE RANCH CO.	PINE TREE #6	STO	20	50	18	Unknown	Unknown
83	P14670P	31-Dec-33	GST	41	N	75	W	5	NWSE	TAYLOR RANCH CO.	TAYLOR #41 1	STO	5	22	5	Unknown	Unknown
84	P78123W	27-Sep-88	GST	41	N	75	W	13	SWSW	INC. W. I. MOORE RANCH CO.	MONA RAE #1	STO	20	200	100	150	200
85	P120985W	30-Nov-99	GST	41	N	75	W	14	SWNW	W.I. MOORE RANCH COMPANY	Frankie #1 Well	STO	7	150	30	Unknown	Unknown
86	P78124W	27-Sep-88	GST	41	N	75	W	15	SESW	INC. W. I. MOORE RANCH CO.	V B #1	STO	5	100	75	40	90
87	P22296P	31-Dec-52	GST	41	N	75	W	22	NWNW	OGALALLA ALDN & CATTLE LIMITED PARTNERSHIP	McNAUGHTIN PASTURE #1	STO	3	125	50	Unknown	Unknown
88	P120983W	30-Nov-99	GST	41	N	75	W	23	SESE	W.I. MOORE RANCH COMPANY	F C #4 Spring	STO	3	3	0	Unknown	Unknown
89	P14685P	31-Dec-39	GST	42	N	74	W	16	SWSE	TAYLOR RANCH CO.	TAYLOR #58-3	STO	5	275	150	Unknown	Unknown
90	P14686P	31-Dec-67	GST	42	N	74	W	17	NWNW	TAYLOR RANCH CO.	TAYLOR #58-4	STO	5	220	150	Unknown	Unknown
91	P85802W	12-Aug-91	GST	42	N	74	W	17	SENE	IBERLIN RANCH	PT-WW#1	STO	25	300	180	260	300
92	P14684P	30-Jun-64	GST	42	N	74	W	18	SWSW	TAYLOR RANCH CO.	TAYLOR #57-58-2	STO	4	350	235	Unknown	Unknown

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1	Type, Permit_No	Priority	Status	T	Dir_NS	R	Dir_EW	Sec.	Qtrqtr	Applicant	Facility_Name	Uses	Yld_Act	Well Depth	Static Depth	Top Completion	Bottom Completion
93	P12244P	31-Dec-67	GST	42	N	74	W	28	SESW	JOHN W. & VELMA R. MOORE	FARM #1	STO	20	200	100	Unknown	Unknown
94	P17306P	31-Dec-37	GST	42	N	74	W	29	NWSW	PINE TREE RANCH CO.	PINE TREE #7	STO	40	150	40	Unknown	Unknown
95	P37879W	16-May-77	GST	42	N	74	W	29	NESW	PINE TREE RANCH CO.**CHARLES H. ARCHIBALD	PINE TREE #5 1	STO	2	8	4	4	8
96	P14683P	31-Dec-38	GST	42	N	74	W	30	NWNW	TAYLOR RANCH CO.	TAYLOR #57-1	STO	3	275	175	Unknown	Unknown
97	P6972W	12-Oct-70	GST	42	N	74	W	33	SWSE	PINE TREE RANCH CO.	PINE TREE #8	STO	25	210	95	Unknown	Unknown
98	P35330W	12-Nov-76	GST	42	N	75	W	14	SESE	TAYLOR RANCH COMPANY LIMITED	TAYLOR BLISS #1	STO	25	500	100	380	460
99	P50880W	28-Nov-79	GST	42	N	75	W	21	SWNE	T-CHAIR LIVESTOCK CO.	T-CHAIR LIVESTOCK COMPANY #21-1	STO	25	800	130	360	620
100	P35746W	29-Dec-76	GST	42	N	75	W	22	SWNW	BROWN LAND COMPANY	WOODS #1	STO	15	660	320	Unknown	Unknown
101	P63571W	06-Apr-83	GST	42	N	75	W	22	NENW	T-CHAIR LIVESTOCK CO.	CCI #8 UPPER	STO	10	421	266	354	413
102	P63572W	06-Apr-83	GST	42	N	75	W	22	NENW	T-CHAIR LIVESTOCK CO.	CCI #8 MIDDLE	STO	10	534	259	439	531
103	P63573W	06-Apr-83	GST	42	N	75	W	22	NENW	T-CHAIR LIVESTOCK CO.	CCI #8 LOWER	STO	10	722	270	636	720
104	P14681P	31-Jul-61	GST	42	N	75	W	26	NWNW	TAYLOR RANCH CO.	TAYLOR #55-1	STO	3	158	80	Unknown	Unknown
105	P14682P	31-Aug-61	GST	42	N	75	W	26	SENW	TAYLOR RANCH CO.	TAYLOR #56-1	STO	3	158	80	Unknown	Unknown
106	P14660P	30-Apr-43	GST	42	N	75	W	28	NESE	TAYLOR RANCH CO.	TAYLOR #29-1	STO	3	355	150	Unknown	Unknown
107																	
108	Stock_CBM																
109	P140455W	23-Oct-01	GST	41	N	74	W	4	NENW	YATES PETROLEUM CORP.	DIETZ CS FEE #1	STO,CBM	200	881	810	819	877
110	P140456W	23-Oct-01	GST	41	N	74	W	4	SWNW	YATES PETROLEUM CORP.	DIETZ CS FEE #2	STO,CBM	200	953	734	890	950
111	P140457W	23-Oct-01	GST	41	N	74	W	4	NESW	YATES PETROLEUM CORP.	DIETZ CS FEE #3	STO,CBM	200	953	747	889	946
112	P140458W	23-Oct-01	GST	41	N	74	W	4	SWSW	YATES PETROLEUM CORP.	DIETZ CS FEE #4	STO,CBM	200	972	751	912	964
113	P136058W	15-Jun-01	GST	41	N	75	W	3	SWSW	DEVON ENERGY PRODUCTION COMPANY, L.P.** WY STATE BOARD OF LAND COMMISSIONERS	STATE (WALKER) 3S-13	STO,CBM	25	1142	300	1060	1108
114	P114089W	17-Feb-99	GSE	41	N	75	W	3	SWNE	DEVON ENERGY CORP.** WALKER CREEK LIVESTOCK CO.	WALKER FED 3S-7	STO,CBM					
115	P139473W	24-Sep-01	GSE	41	N	75	W	3	SWSE	DEVON ENERGY PRODUCTION COMPANY, L.P.** WALKER CREEK LIVESTOCK CO.	WALKER FEDERAL 3S-15	STO,CBM					
116	40/1/406W	17-Oct-07	UNA	41	N	75	W	3	NENW	Bill Barrett Corp.	WALKER CREEK FED 21-3-4175	STO,CBM					
117	40/2/406W	17-Oct-07	UNA	41	N	75	W	3	SWNE	Bill Barrett Corp.	WALKER CREEK FED 32-3-4175	STO,CBM					
118	40/3/406W	17-Oct-07	UNA	41	N	75	W	3	SWSE	Bill Barrett Corp.	WALKER CREEK FED 34-3-4175	STO,CBM					
119	40/3/448W	21-Nov-07	UNA	41	N	75	W	3	SWNW	Bill Barrett Corp.	WALKER CREEK FED 12-3-4175	STO,CBM					
120	40/4/406W	17-Oct-07	UNA	41	N	75	W	3	NENE	Bill Barrett Corp.	IBERLIN FED 41-3-4175	STO,CBM					
121	40/5/406W	17-Oct-07	UNA	41	N	75	W	3	NESE	Bill Barrett Corp.	WALKER CREEK FED 43-3-4175	STO,CBM					
122	41/5/97W	16-May-08	UNA	41	N	75	W	4	NENW	BILL BARRETT CORPORATION	WALKER CREEK FED 21-4-4175	STO,CBM					
123	41/6/97W	16-May-08	UNA	41	N	75	W	4	NENE	BILL BARRETT CORPORATION	WALKER CREEK FED 41-4-4175	STO,CBM					
124	41/7/262W	05-Sep-08	UNA	41	N	75	W	4	SWNE	BILL BARRETT CORPORATION	WALKER CREEK FED 32-4-4175	STO,CBM					
125	41/8/262W	05-Sep-08	UNA	41	N	75	W	4	SWNW	BILL BARRETT CORPORATION	WALKER CREEK FED 12-4-4175	STO,CBM					
126	P164238W	09-Dec-04	GSI	41	N	75	W	6	SENW	BILL BARRETT CORPORATION	IBERLIN 22-6-4175	STO,CBM					
127	P164239W	09-Dec-04	GSI	41	N	75	W	6	SWNE	BILL BARRETT CORPORATION	IBERLIN 32-6-4175	STO,CBM					
128	P167682W	09-May-05	GSI	41	N	75	W	6	NESW	BILL BARRETT CORPORATION	IBERLIN 23-6-4175	STO,CBM					

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	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Type_Permit_No	Priority	Status	T	Dir_NS	R	Dir_EW	Sec	Qtrqtr	Applicant	Facility_Name	Uses	Yld_Act	Well Depth	Static Depth	Top Completion	Bottom Completion
129	P167684W	09-May-05	GSI	41	N	75	W	6	SWSW	BILL BARRETT CORPORATION	IBERLIN 14-6-4175	STO,CBM					
130	P167689W	09-May-05	GSI	41	N	75	W	6	SWSE	BILL BARRETT CORPORATION	IBERLIN 34-6-4175	STO,CBM					
131	P169150W	22-Jul-05	GSI	41	N	75	W	6	SWNW	BILL BARRETT CORPORATION	FEDERAL 12-6-4175	STO,CBM					
132	P169151W	22-Jul-05	GSI	41	N	75	W	6	NENW	BILL BARRETT CORPORATION	FEDERAL 21-6-4175	STO,CBM					
133	P169152W	22-Jul-05	GSI	41	N	75	W	6	NENE	BILL BARRETT CORPORATION	FEDERAL 41-6-4175	STO,CBM					
134	P169153W	22-Jul-05	GSI	41	N	75	W	6	NESE	BILL BARRETT CORPORATION	FEDERAL 43-6-4175	STO,CBM					
135	P164240W	09-Dec-04	GSI	41	N	75	W	7	NENW	BILL BARRETT CORPORATION	IBERLIN 21-7-4175	STO,CBM					
136	P164241W	09-Dec-04	GSI	41	N	75	W	7	SWNE	BILL BARRETT CORPORATION	IBERLIN 32-7-4175	STO,CBM					
137	P164242W	09-Dec-04	GSI	41	N	75	W	7	NWSW	BILL BARRETT CORPORATION	IBERLIN 33-7-4175	STO,CBM					
138	P164243W	09-Dec-04	GSI	41	N	75	W	7	SWNE	BILL BARRETT CORPORATION	IBERLIN 42-7-4175	STO,CBM					
139	P164244W	09-Dec-04	GSI	41	N	75	W	7	NESE	BILL BARRETT CORPORATION	IBERLIN 43-7-4175	STO,CBM					
140	P169154W	22-Jul-05	GSI	41	N	75	W	7	SWNW	BILL BARRETT CORPORATION	FEDERAL 12-7-4175	STO,CBM					
141	P169155W	22-Jul-05	GSI	41	N	75	W	7	SWSW	BILL BARRETT CORPORATION	FEDERAL 14-7-4175	STO,CBM					
142	P169156W	22-Jul-05	GSI	41	N	75	W	7	NESW	BILL BARRETT CORPORATION	FEDERAL 23-7-4175	STO,CBM					
143	P164245W	09-Dec-04	GSI	41	N	75	W	8	SWNW	BILL BARRETT CORPORATION	IBERLIN 12-8-4175	STO,CBM					
144	P169157W	22-Jul-05	GSI	41	N	75	W	8	SWSW	BILL BARRETT CORPORATION	FEDERAL 14-8-4175	STO,CBM					
145	P169158W	22-Jul-05	GSI	41	N	75	W	8	NENW	BILL BARRETT CORPORATION	FEDERAL 21-8-4175	STO,CBM					
146	P169159W	22-Jul-05	GSI	41	N	75	W	8	NESW	BILL BARRETT CORPORATION	FEDERAL 23-8-4175	STO,CBM					
147	P169160W	22-Jul-05	GSI	41	N	75	W	8	SWSE	BILL BARRETT CORPORATION	FEDERAL 34-8-4175	STO,CBM					
148	P136043W	15-Jun-01	GST	41	N	75	W	9	SWNE	DEVON ENERGY PRODUCTION COMPANY, L.P.	WALKER 9S-7	STO,CBM	25	1050	356	977	1041
149	P136060W	15-Jun-01	GSE	41	N	75	W	9	SWSE	DEVON ENERGY PRODUCTION COMPANY, L.P.	WI MOORE 9S-15	STO,CBM					
150	P180619W	14-Mar-07	GSI	41	N	75	W	9	NENE	BILL BARRETT CORPORATION	WALKER CREEK STATE 41-9-4175	STO,CBM					
151	P180620W	14-Mar-07	GSI	41	N	75	W	9	SWSE	BILL BARRETT CORPORATION	MOORE WIRC 34-9-4175	STO,CBM					
152	40/3/495W	14-Jan-08	UNA	41	N	75	W	9	NESE	BILL BARRETT CORPORATION	WI MOORE FED 43-9-4175	STO,CBM					
153	P136046W	15-Jun-01	GST	41	N	75	W	10	NESE	DEVON ENERGY PRODUCTION COMPANY, L.P.	WI MOORE 10S-9	STO,CBM	25	971	625	893	969
154	P136049W	15-Jun-01	GST	41	N	75	W	10	SWSE	DEVON ENERGY PRODUCTION COMPANY, L.P.	WI MOORE 10S-15	STO,CBM	25	1024	700	945	1004
155	P136047W	15-Jun-01	GST	41	N	75	W	10	NESW	DEVON ENERGY PRODUCTION COMPANY, L.P.	WI MOORE 10S-11	STO,CBM	25	1032	755	948	1027
156	P136048W	15-Jun-01	GST	41	N	75	W	10	SWSW	DEVON ENERGY PRODUCTION COMPANY, L.P.	WI MOORE 10S-13	STO,CBM	25	1062	778	976	1055
157	P136061W	15-Jun-01	GST	41	N	75	W	10	SWNE	DEVON ENERGY PRODUCTION COMPANY, L.P.	WI MOORE 10S-7	STO,CBM	25	1064	390	982	1052
158	P136045W	15-Jun-01	GST	41	N	75	W	10	NENW	DEVON ENERGY PRODUCTION COMPANY, L.P.	WALKER 10S-3	STO,CBM	25	1076	746	993	1067
159	P136044W	15-Jun-01	GST	41	N	75	W	10	NENE	DEVON ENERGY PRODUCTION COMPANY, L.P.	WALKER 10S-1	STO,CBM	25	1086	839	996	1063
160	P136051W	15-Jun-01	GST	41	N	75	W	10	SWNW	DEVON ENERGY PRODUCTION COMPANY, L.P.	WALKER 10S-5	STO,CBM	25	1131	390	1046	1127
161	P161649W	20-Aug-04	GST	41	N	75	W	11	NESW	BILL BARRETT CORPORATION	WALKER CREEK 23-11-4175	STO,CBM	9	932	835	864	926
162	P161652W	20-Aug-04	GST	41	N	75	W	11	NWSE	BILL BARRETT CORPORATION	MOORE WIRC 33-11-4175	STO,CBM	14	934	817	846	928
163	P161650W	20-Aug-04	GSI	41	N	75	W	11	SWNE	BILL BARRETT CORPORATION	MOORE WIRC 32-11-4175	STO,CBM	2	957	851	875	952
164	P161651W	20-Aug-04	GSI	41	N	75	W	11	NENW	BILL BARRETT CORPORATION	WALKER CREEK 21-11-4175	STO,CBM					
165	40/4/448W	21-Nov-07	UNA	41	N	75	W	11	SWSW	Bill Barrett Corp.	WALKER CREEK FED 14-11-4175	STO,CBM					
166	40/6/406W	17-Oct-07	UNA	41	N	75	W	11	SWNW	Bill Barrett Corp.	WALKER CREEK FED12-11-4175	STO,CBM					
167	P167789W	17-May-05	GSI	41	N	75	W	14	SWSW	BILL BARRETT CORPORATION	FEDERAL 14-14-4175	STO,CBM					
168	P167790W	17-May-05	GSI	41	N	75	W	14	NESW	BILL BARRETT CORPORATION	FEDERAL 23-14-4175	STO,CBM					

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	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Type_Permit_No	Priority	Status	T	Dir_NS	R	Dir_EW	Sec	Qtrqtr	Applicant	Facility_Name	Uses	Yld_Act	Well Depth	Static Depth	Top Completion	Bottom Completion
169	P167791W	17-May-05	GSI	41	N	75	W	14	SWNE	BILL BARRETT CORPORATION	FEDERAL 32-14-4175	STO,CBM					
170	P167792W	17-May-05	GSI	41	N	75	W	14	SWSE	BILL BARRETT CORPORATION	FEDERAL 34-14-4175	STO,CBM					
171	P167793W	17-May-05	GSI	41	N	75	W	14	NENE	BILL BARRETT CORPORATION	FEDERAL 41-14-4175	STO,CBM					
172	P167794W	17-May-05	GSI	41	N	75	W	14	NESE	BILL BARRETT CORPORATION	FEDERAL 43-14-4175	STO,CBM					
173	41/5/94W	16-May-08	UNA	41	N	75	W	14	NENW	BILL BARRETT CORPORATION	W.I. MOORE FED 21-14-4175	STO,CBM					
174	41/9/262W	05-Sep-08	UNA	41	N	75	W	14	SWNW	BILL BARRETT CORPORATION	W.I. MOORE FED 12-14-4175	STO,CBM					
175	P167795W	17-May-05	GSI	41	N	75	W	15	SWSW	BILL BARRETT CORPORATION	FEDERAL 14-15-4175	STO,CBM					
176	P167796W	17-May-05	GSI	41	N	75	W	15	NESW	BILL BARRETT CORPORATION	FEDERAL 23-15-4175	STO,CBM					
177	P167797W	17-May-05	GSI	41	N	75	W	15	SWSE	BILL BARRETT CORPORATION	FEDERAL 34-15-4175	STO,CBM					
178	P167798W	17-May-05	GSI	41	N	75	W	15	NESE	BILL BARRETT CORPORATION	FEDERAL 43-15-4175	STO,CBM					
179	41/6/94W	16-May-08	UNA	41	N	75	W	15	NENW	BILL BARRETT CORPORATION	W.I. MOORE FED 21-15-4175	STO,CBM					
180	P136052W	15-Jun-01	GST	41	N	75	W	16	NENE	DEVON ENERGY PRODUCTION COMPANY, L.P.	STATE WI MOORE 16S-1	STO,CBM	25	905	264	830	888
181	P136053W	15-Jun-01	GST	41	N	75	W	16	NENW	DEVON ENERGY PRODUCTION COMPANY, L.P.** WY STATE BOARD OF LAND COMMISSIONERS	STATE WI MOORE 16S-3	STO,CBM	25	1044	941	990	1030
182	P136055W	15-Jun-01	GST	41	N	75	W	16	SWNE	DEVON ENERGY PRODUCTION COMPANY, L.P.** WY STATE BOARD OF LAND COMMISSIONERS	STATE WI MOORE 16S-7	STO,CBM	25	1107	562	1033	1101
183	P135874W	18-Jun-01	GST	41	N	75	W	16	NESE	DEVON ENERGY PRODUCTION COMPANY, L.P.** WY STATE BOARD OF LAND COMMISSIONERS	STATE WI MOORE 16S-9	STO,CBM	25	1122	486	1050	1103
184	P135873W	18-Jun-01	GST	41	N	75	W	16	SWSE	DEVON ENERGY PRODUCTION COMPANY, L.P.** WY STATE BOARD OF LAND COMMISSIONERS	STATE WI MOORE 16S-15	STO,CBM	25	1162	518	1076	1138
185	P136050W	15-Jun-01	GST	41	N	75	W	16	NESW	DEVON ENERGY PRODUCTION COMPANY, L.P.** WY STATE BOARD OF LAND COMMISSIONERS	STATE WI MOORE 16S-11	STO,CBM	25	1162	390	1139	1152
186	P136054W	15-Jun-01	GST	41	N	75	W	16	SWNW	DEVON ENERGY PRODUCTION COMPANY, L.P.** WY STATE BOARD OF LAND COMMISSIONERS	STATE WI MOORE 16S-5	STO,CBM	25	1176	329	1096	1168
187	P136057W	15-Jun-01	GST	41	N	75	W	16	SWSW	DEVON ENERGY PRODUCTION COMPANY, L.P.** WY STATE BOARD OF LAND COMMISSIONERS	STATE WI MOORE 16S-13	STO,CBM	25	1184	503	1112	1078
188	P169165W	22-Jul-05	GST	41	N	75	W	17	NENE	BILL BARRETT CORPORATION	FEDERAL 41-17-4175	STO,CBM	10	1201	337	1105	1164
189	P167687W	09-May-05	GSI	41	N	75	W	17	SWSW	BILL BARRETT CORPORATION	IBERLIN 14-17-4175	STO,CBM					
190	P167688W	09-May-05	GSI	41	N	75	W	17	SWNW	BILL BARRETT CORPORATION	IBERLIN 12-17-4175	STO,CBM					
191	P169161W	22-Jul-05	GSI	41	N	75	W	17	NENW	BILL BARRETT CORPORATION	FEDERAL 21-17-4175	STO,CBM					
192	P169162W	22-Jul-05	GSI	41	N	75	W	17	NESW	BILL BARRETT CORPORATION	FEDERAL 23-17-4175	STO,CBM					
193	P169163W	22-Jul-05	GSI	41	N	75	W	17	SWNE	BILL BARRETT CORPORATION	FEDERAL 32-17-4175	STO,CBM					
194	P169164W	22-Jul-05	GSI	41	N	75	W	17		BILL BARRETT CORPORATION	FEDERAL 34-17-4175	STO,CBM					
195	P169166W	22-Jul-05	GSI	41	N	75	W	17	NESE	BILL BARRETT CORPORATION	FEDERAL 43-17-4175	STO,CBM					
196	P167683W	09-May-05	GSI	41	N	75	W	18	NESE	BILL BARRETT CORPORATION	IBERLIN 43-18-4175	STO,CBM					
197	P167685W	09-May-05	GSI	41	N	75	W	18	SWNE	BILL BARRETT CORPORATION	IBERLIN 32-18-4175	STO,CBM					
198	P167686W	09-May-05	GSI	41	N	75	W	18	NENE	BILL BARRETT CORPORATION	IBERLIN 41-18-4175	STO,CBM					

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	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Type, Permit_No	Priority	Status	T	Dir_NS	R	Dir_EW	Sec	Qtrqtr	Applicant	Facility_Name	Uses	Yld_Act	Well Depth	Static Depth	Top Completion	Bottom Completion
199	P169167W	22-Jul-05	GSI	41	N	75	W	18	SWNW	BILL BARRETT CORPORATION	FEDERAL 12-18-4175	STO,CBM					
200	P169168W	22-Jul-05	GSI	41	N	75	W	18	SWSW	BILL BARRETT CORPORATION	FEDERAL 14-18-4175	STO,CBM					
201	P169169W	22-Jul-05	GSI	41	N	75	W	18	NENW	BILL BARRETT CORPORATION	FEDERAL 21-18-4175	STO,CBM					
202	P169170W	22-Jul-05	GSI	41	N	75	W	18	NESW	BILL BARRETT CORPORATION	FEDERAL 23-18-4175	STO,CBM					
203	P169171W	22-Jul-05	GSI	41	N	75	W	18	SWSE	BILL BARRETT CORPORATION	FEDERAL 34-18-4175	STO,CBM					
204	P166780W	04-Apr-05	GSI	41	N	75	W	20	SWSE	BILL BARRETT CORPORATION	MOORE LAND CO. 34-20-4175	STO,CBM					
205	P166781W	04-Apr-05	GSI	41	N	75	W	20	NESE	BILL BARRETT CORPORATION	OGALALLA LAND 43-20-4175	STO,CBM					
206	P169172W	22-Jul-05	GSI	41	N	75	W	20	SWNE	BILL BARRETT CORPORATION	FEDERAL 32-20-4175	STO,CBM					
207	P169173W	22-Jul-05	GSI	41	N	75	W	21	SWNE	BILL BARRETT CORPORATION	FEDERAL 32-21-4175	STO,CBM					
208	P169174W	22-Jul-05	GSI	41	N	75	W	21	SWSE	BILL BARRETT CORPORATION	FEDERAL 34-21-4175	STO,CBM					
209	P169175W	22-Jul-05	GSI	41	N	75	W	21	NENE	BILL BARRETT CORPORATION	FEDERAL 41-21-4175	STO,CBM					
210	P169176W	22-Jul-05	GSI	41	N	75	W	21	NESE	BILL BARRETT CORPORATION	FEDERAL 43-21-4175	STO,CBM					
211	P169177W	22-Jul-05	GSI	41	N	75	W	22	SWNW	BILL BARRETT CORPORATION	FEDERAL 12-22-4175	STO,CBM					
212	P169178W	22-Jul-05	GSI	41	N	75	W	22	SWSW	BILL BARRETT CORPORATION	FEDERAL 14-22-4175	STO,CBM					
213	P169179W	22-Jul-05	GSI	41	N	75	W	22	NENW	BILL BARRETT CORPORATION	FEDERAL 21-22-4175	STO,CBM					
214	P169180W	22-Jul-05	GSI	41	N	75	W	22	NESW	BILL BARRETT CORPORATION	FEDERAL 23-22-4175	STO,CBM					
215	P169181W	22-Jul-05	GSI	41	N	75	W	22	SWNE	BILL BARRETT CORPORATION	FEDERAL 32-22-4175	STO,CBM					
216	P169182W	22-Jul-05	GSI	41	N	75	W	22	SWSE	BILL BARRETT CORPORATION	FEDERAL 34-22-4175	STO,CBM					
217	P169183W	22-Jul-05	GSI	41	N	75	W	22	NENE	BILL BARRETT CORPORATION	FEDERAL 41-22-4175	STO,CBM					
218	P169184W	22-Jul-05	GSI	41	N	75	W	22	NESE	BILL BARRETT CORPORATION	FEDERAL 43-22-4175	STO,CBM					
219	P167799W	17-May-05	GSI	41	N	75	W	23	SWNW	BILL BARRETT CORPORATION	FEDERAL 12-23-4175	STO,CBM					
220	P167800W	17-May-05	GSI	41	N	75	W	23	SWSW	BILL BARRETT CORPORATION	FEDERAL 14-23-4175	STO,CBM					
221	P167801W	17-May-05	GSI	41	N	75	W	23	NENW	BILL BARRETT CORPORATION	FEDERAL 21-23-4175	STO,CBM					
222	P167802W	17-May-05	GSI	41	N	75	W	23	NESW	BILL BARRETT CORPORATION	FEDERAL 23-23-4175	STO,CBM					
223	P167803W	17-May-05	GSI	41	N	75	W	23	SWNE	BILL BARRETT CORPORATION	FEDERAL 32-23-4175	STO,CBM					
224	P167804W	17-May-05	GSI	41	N	75	W	23	SWSE	BILL BARRETT CORPORATION	FEDERAL 34-23-4175	STO,CBM					
225	P167805W	17-May-05	GSI	41	N	75	W	23	NENE	BILL BARRETT CORPORATION	FEDERAL 41-23-4175	STO,CBM					
226	P167806W	17-May-05	GSI	41	N	75	W	23	NESE	BILL BARRETT CORPORATION	FEDERAL 43-23-4175	STO,CBM					
227	P159667W	15-Jun-04	GST	42	N	74	W	17	SWSW	WILLIAMS PRODUCTION RMT COMPANY	ANCU 14-17-4274	STO,CBM	13	1093	1027	997	1072
228	P155710W	13-Nov-03	GST	42	N	74	W	17	SWSE	WILLIAMS PRODUCTION RMT COMPANY	ANCU NINE MILE LAND 34-17-4274	STO,CBM	17	1120	769	1034	1109
229	P159671W	15-Jun-04	GST	42	N	74	W	17	NENE	WILLIAMS PRODUCTION RMT COMPANY	ANCU 41-17-4274	STO,CBM	13	1125	1064	1037	1112
230	P155709W	13-Nov-03	GST	42	N	74	W	17	NESE	WILLIAMS PRODUCTION RMT COMPANY	ANCU NINE MILE LAND 43-17-4274	STO,CBM	18	1135	779	1047	1124
231	P159669W	15-Jun-04	GST	42	N	74	W	17	NESW	WILLIAMS PRODUCTION RMT COMPANY	ANCU 23-17-4274	STO,CBM	15	1160	1050	1066	1140
232	P159666W	15-Jun-04	GST	42	N	74	W	17	SWNW	WILLIAMS PRODUCTION RMT COMPANY	ANCU 12-17-4274	STO,CBM	13	1195	928	1109	1184
233	P159668W	15-Jun-04	GSI	42	N	74	W	17	NENW	WILLIAMS PRODUCTION RMT COMPANY	ANCU 21-17-4274	STO,CBM					
234	P159670W	15-Jun-04	GSI	42	N	74	W	17	SWNE	WILLIAMS PRODUCTION RMT COMPANY	ANCU 32-17-4274	STO,CBM					
235	P154205W	09-Sep-03	GST	42	N	74	W	18	SWSW	YATES PETROLEUM CORP.	PRATHER CS #3	STO,CBM	200	1185	941	1109	1174
236	P154203W	09-Sep-03	GST	42	N	74	W	18	NESE	YATES PETROLEUM CORP.	PRATHER CS #1	STO,CBM	200	1202	851	1120	1189
237	P154204W	09-Sep-03	GST	42	N	74	W	18	NESW	YATES PETROLEUM CORP.	PRATHER CS #2	STO,CBM	200	1239	1002	1164	1234
238	P177085W	28-Aug-06	GSI	42	N	74	W	18	NENE	WILLIAMS PRODUCTION RMT COMPANY	SCOTT FED 41-18-4274	STO,CBM					
239	P177086W	28-Aug-06	GSI	42	N	74	W	18	SWNE	WILLIAMS PRODUCTION RMT COMPANY	SCOTT FED 32-18-4274	STO,CBM					

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	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Type_Permit_No	Priority	Status	T	Dir_NS	R	Dir_EW	Sec.	Qtrqtr	Applicant	Facility_Name	Uses	Yld_Act	Well Depth	Static Depth	Top Completion	Bottom Completion
240	P177087W	28-Aug-06	GSI	42	N	74	W	18	NENW	WILLIAMS PRODUCTION RMT COMPANY	SCOTT FED 21-18-4274	STO,CBM					
241	P177088W	28-Aug-06	GSI	42	N	74	W	18	SWNW	WILLIAMS PRODUCTION RMT COMPANY	SCOTT FED 12-18-4274	STO,CBM					
242	P154207W	09-Sep-03	GST	42	N	74	W	19	SWNE	YATES PETROLEUM CORP.	OLSWICK CS FEE #2	STO,CBM	200	1038	877	964	1034
243	P150373W	28-Mar-03	GST	42	N	74	W	19	SWSW	YATES PETROLEUM CORPORATION	CAVALRY CS FEDERAL # 4	STO,CBM	200	1112	961	1039	1108
244	P150372W	28-Mar-03	GST	42	N	74	W	19	SWNW	YATES PETROLEUM CORPORATION	CAVALRY CS FEDERAL # 2	STO,CBM	200	1118	906	1042	1105
245	P144387W	22-Apr-02	GSI	42	N	74	W	19	SWSE	YATES PETROLEUM CORPORATION	OLSWICK CS FEE # 4	STO,CBM					
246	P140449W	23-Oct-01	GST	42	N	74	W	20	NENE	YATES PETROLEUM CORP.	STEVE CS FEE #1	STO,CBM	200	1080	770	1006	1076
247	P140450W	23-Oct-01	GSE	42	N	74	W	20	SWNE	YATES PETROLEUM CORP.	STEVE CS FEE #2	STO,CBM					
248	P159678W	15-Jun-04	GST	42	N	74	W	21	SWNW	WILLIAMS PRODUCTION RMT COMPANY	ANCU 14-21-4274	STO,CBM	9	950	750	868	942
249	P159678W	15-Jun-04	GST	42	N	74	W	21	SWNW	WILLIAMS PRODUCTION RMT COMPANY	ANCU 14-21-4274	STO,CBM	9	950	750	868	942
250	P159678W	15-Jun-04	GST	42	N	74	W	21	SWSW	WILLIAMS PRODUCTION RMT COMPANY	ANCU 14-21-4274	STO,CBM	9	950	750	868	942
251	P159678W	15-Jun-04	GST	42	N	74	W	21	SWSW	WILLIAMS PRODUCTION RMT COMPANY	ANCU 14-21-4274	STO,CBM	9	950	750	868	942
252	P159683W	15-Jun-04	GST	42	N	74	W	21	NENE	WILLIAMS PRODUCTION RMT COMPANY	ANCU 41-21-4274	STO,CBM	9	980	217	900	970
253	P159684W	15-Jun-04	GST	42	N	74	W	21	NESE	WILLIAMS PRODUCTION RMT COMPANY	ANCU 41-21-4274	STO,CBM	9	980	739	864	939
254	P159679W	15-Jun-04	GST	42	N	74	W	21	SWNE	WILLIAMS PRODUCTION RMT COMPANY	ANCU 21-21-4274	STO,CBM	8	990	772	900	973
255	P159681W	15-Jun-04	GST	42	N	74	W	21	SWNE	WILLIAMS PRODUCTION RMT COMPANY	ANCU 32-21-4274	STO,CBM	9	990	692	890	964
256	P159682W	15-Jun-04	GST	42	N	74	W	21	SWSE	WILLIAMS PRODUCTION RMT COMPANY	ANCU 34-21-4274	STO,CBM	8	1019	539	930	1004
257	P159677W	15-Jun-04	GST	42	N	74	W	21	SWNW	WILLIAMS PRODUCTION RMT COMPANY	ANCU 12-21-4274	STO,CBM	8	1024	815	940	1014
258	P159680W	15-Jun-04	GST	42	N	74	W	21	NESW	WILLIAMS PRODUCTION RMT COMPANY	ANCU 23-21-4274	STO,CBM	10	1025	771	944	1014
259	P158876W	01-Mar-04	GSI	42	N	74	W	29	SWSW	YATES PETROLEUM CORP.	BIGHORN CS FEDERAL #4	STO,CBM					
260	P137057W	16-Jul-01	GST	42	N	74	W	30	SENE	YATES PETROLEUM CORP.	MCCONNELL CS FEE #1	STO,CBM	200	1023	819	951	1014
261	P137058W	16-Jul-01	GST	42	N	74	W	30	SWNE	YATES PETROLEUM CORP.	McCONNELL CS FEE #2	STO,CBM	200	1047	944	967	1035
262	P137060W	16-Jul-01	GST	42	N	74	W	30	SWSE	YATES PETROLEUM CORP.	McCONNELL CS FEE #4	STO,CBM	200	1067	817	991	1054
263	P150093W	10-Mar-03	GST	42	N	74	W	30	SWNW	YATES PETROLEUM CORPORATION	CRITTENDON CS FEDERAL # 2	STO,CBM	200	1166	1026	1089	1159
264	P137059W	16-Jul-01	GSE	42	N	74	W	30	NESE	YATES PETROLEUM CORP.	McCONNELL CS FEE #3	STO,CBM					
265	P149130W	16-Jan-03	GSI	42	N	74	W	30	SWSW	YATES PETROLEUM CORPORATION	CRITTENDON CS FEDERAL #4	STO,CBM					
266	P137785W	02-Aug-01	GST	42	N	74	W	31	NESW	DEVON ENERGY PRODUCTION COMPANY, L.P.**CHARLES H ARCHIBALD**WILLIAM D. RAMSBOTTOM	STATE ARCHIBALD 31S-11	STO,CBM	25	1038	526	960	1036
267	P150371W	28-Mar-03	GST	42	N	74	W	31	SWSE	YATES PETROLEUM CORPORATION	SIOUX CS FEDERAL # 2	STO,CBM	200	1048	811	974	1044
268	P135573W	04-Jun-01	GST	42	N	74	W	31	SWNW	YATES PETROLEUM CORPORATION	McPARTLIN CS FEE #3	STO,CBM	200	1071	867	1001	1065
269	P135574W	04-Jun-01	GST	42	N	74	W	31	SWNE	YATES PETROLEUM CORPORATION	MCPARTLIN CS FEE #4	STO,CBM	200	1071	941	990	1060
270	P135572W	04-Jun-01	GST	42	N	74	W	31	NENW	YATES PETROLEUM CORPORATION	McPARTLIN CS FEE #2	STO,CBM	200	1084	1043	1008	1078

Addendum Table 3.4.A. Water Well Rights Within Two Miles of the Moore Ranch Permit Area (Revised June 2009)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Type_Permit_No	Priority	Status	T	Dir_NS	R	Dir_EW	Sec	Qtrqtr	Applicant	Facility_Name	Uses	Yld_Act	Well Depth	Static Depth	Top Completion	Bottom Completion
271	P135571W	04-Jun-01	GST	42	N	74	W	31	NENE	YATES PETROLEUM CORPORATION	McPARTLIN CS FEE #1	STO,CBM	200	1090	1046	1019	1088
272	P135941W	11-Jun-01	GST	42	N	74	W	32	SWNE	YATES PETROLEUM CORP.	OLSWICK CS FEE #8	STO,CBM	200	1018	838	943	1012
273	P135940W	11-Jun-01	GST	42	N	74	W	32	NWSW	YATES PETROLEUM CORP.	OLSWICK CS FEE #7	STO,CBM	200	1080	962	1003	1070
274	P135938W	11-Jun-01	GSE	42	N	74	W	32	SENE	YATES PETROLEUM CORP.	OLSWICK CS FEE #5	STO,CBM					
275	P135939W	11-Jun-01	GSE	42	N	74	W	32	NENW	YATES PETROLEUM CORP.	OLSWICK CS FEE #6	STO,CBM					
276	P152613W	20-Jun-03	GST	42	N	74	W	33	SWNW	YATES PETROLEUM CORP.	LOOK CS #1	STO,CBM	200	871	699	800	868
277	P161018W	19-Jul-04	GST	42	N	75	W	13	NESW	DEVON ENERGY PRODUCTION COMPANY, L.P.**JOHN P. & MAGGIE L. IBERLIN	IBERLIN FEDERAL 13S-11	STO,CBM	25	1218	940	1131	1211
278	P161017W	19-Jul-04	GST	42	N	75	W	13	SWSW	DEVON ENERGY PRODUCTION COMPANY, L.P.**JOHN P. & MAGGIE L. IBERLIN	IBERLIN FEDERAL 13S-13	STO,CBM	25	1222	1102	1135	1216
279	P136026W	15-Jun-01	GST	42	N	75	W	13	NESE	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN 13 S-9	STO,CBM	25	1251	902	1205	1282
280	P161020W	19-Jul-04	GST	42	N	75	W	13	NENW	DEVON ENERGY PRODUCTION COMPANY, L.P.**JOHN P. & MAGGIE L. IBERLIN	IBERLIN FEDERAL 13S-3	STO,CBM	25	1271	949	1183	1263
281	P136024W	15-Jun-01	GST	42	N	75	W	13	NENE	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN 13 S-1	STO,CBM	25	1284	849	1230	1308
282	P161019W	19-Jul-04	GST	42	N	75	W	13	SWNW	DEVON ENERGY PRODUCTION COMPANY, L.P.**JOHN P. & MAGGIE L. IBERLIN	IBERLIN FEDERAL 13S-5	STO,CBM	25	1299	1006	1213	1294
283	P136025W	15-Jun-01	GST	42	N	75	W	13	SWNE	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN 13 S-7	STO,CBM	25	1313	952	1255	1332
284	P136031W	15-Jun-01	GST	42	N	75	W	14	SWSE	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN 14S- 15	STO,CBM	25	1182	682	1122	1204
285	P161026W	19-Jul-04	GST	42	N	75	W	14	NENW	DEVON ENERGY PRODUCTION COMPANY, L.P.**JOHN P. & MAGGIE L. IBERLIN	IBERLIN FEDEAL 14S-3	STO,CBM	25	1190	786	1088	1174
286	P161028W	19-Jul-04	GST	42	N	75	W	14	SWNE	DEVON ENERGY PRODUCTION COMPANY, L.P.**JOHN P. & MAGGIE L. IBERLIN	IBERLIN FEDEAL 14S-7	STO,CBM	25	1195	804	1107	1190
287	P136029W	15-Jun-01	GST	42	N	75	W	14	NESW	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN 14 S- 11	STO,CBM	25	1203	739	1115	1199
288	P136028W	15-Jun-01	GST	42	N	75	W	14	NESE	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN 14 S- 9	STO,CBM	25	1205	755	1114	1196
289	P136030W	15-Jun-01	GST	42	N	75	W	14	SWSW	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN 14 S- 13	STO,CBM	25	1220	500	1164	1250
290	P161016W	19-Jul-04	GST	42	N	75	W	14	NENE	DEVON ENERGY PRODUCTION COMPANY, L.P.**JOHN P. & MAGGIE L. IBERLIN	IBERLIN FEDERAL 14S-1	STO,CBM	25	1251	835	1149	1236
291	P161027W	19-Jul-04	GST	42	N	75	W	14	SWNW	DEVON ENERGY PRODUCTION COMPANY, L.P.**JOHN P. & MAGGIE L. IBERLIN	IBERLIN FEDEAL 14S-5	STO,CBM	25	1260	770	1164	1252
292	40/1/378W	26-Sep-07	UNA	42	N	75	W	15	NENW	BILL BARRETT CORPORATION	T-CHAIR FED 21-15-4275	STO,CBM					
293	40/10/377W	26-Sep-07	UNA	42	N	75	W	15	SWSW	BILL BARRETT CORPORATION	T-CHAIR FED 14-15-4275	STO,CBM					
294	40/2/378W	26-Sep-07	UNA	42	N	75	W	15	NESW	BILL BARRETT CORPORATION	T-CHAIR FED 23-15-4275	STO,CBM					
295	40/3/378W	26-Sep-07	UNA	42	N	75	W	15	SWNE	BILL BARRETT CORPORATION	T-CHAIR FED 32-15-4275	STO,CBM					
296	40/4/378W	26-Sep-07	UNA	42	N	75	W	15	SWSE	BILL BARRETT CORPORATION	T-CHAIR FED 34-15-4275	STO,CBM					

Addendum Table 3.4.A. Water Well Rights Within Two Miles of the Moore Ranch Permit Area (Revised June 2009)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Type_Permit_No	Priority	Status	T	Dir_NS	R	Dir_EW	Sec	Qtrqtr	Applicant	Facility_Name	Uses	Yld_Act	Well Depth	Static Depth	Top Completion	Bottom Completion
297	40/5/378W	26-Sep-07	UNA	42	N	75	W	15	NENE	BILL BARRETT CORPORATION	T-CHAIR FED 41-15-4275	STO,CBM					
298	40/6/378W	26-Sep-07	UNA	42	N	75	W	15	NESE	BILL BARRETT CORPORATION	T-CHAIR FED 43-15-4275	STO,CBM					
299	40/9/377W	26-Sep-07	UNA	42	N	75	W	15	SWNW	BILL BARRETT CORPORATION	T-CHAIR FED 12-15-4275	STO,CBM					
300	P145923W	17-Jul-02	GSE	42	N	75	W	16	NESW	WY STATE BOARD OF LAND COMMISSIONERS** DEVON ENERGY PRODUCTION COMPANY, L.P.	STATE(T CHAIR) 16S-11	STO,CBM					
301	P180596W	14-Mar-07	GSI	42	N	75	W	17	NESE	Bill Barrett Corp.	T-CHAIR 43-17-4275	STO,CBM					
302	P180597W	14-Mar-07	GSI	42	N	75	W	17	NENE	Bill Barrett Corp.	T-CHAIR 41-17-4275	STO,CBM					
303	P180598W	14-Mar-07	GSI	42	N	75	W	17	SWNE	Bill Barrett Corp.	T-CHAIR 32-17-4275	STO,CBM					
304	P180599W	14-Mar-07	GSI	42	N	75	W	17	NESW	Bill Barrett Corp.	T-CHAIR 23-17-4275	STO,CBM					
305	41/1/96W	16-May-08	UNA	42	N	75	W	17	NENW	BILL BARRETT CORPORATION	T-CHAIR FED 21-17-4275	STO,CBM					
306	41/10/95W	16-May-08	UNA	42	N	75	W	17	SWSW	BILL BARRETT CORPORATION	T-CHAIR FED 14-17-4275	STO,CBM					
307	41/2/96W	16-May-08	UNA	42	N	75	W	17	SWSE	BILL BARRETT CORPORATION	T-CHAIR FED 34-17-4275	STO,CBM					
308	41/9/95W	16-May-08	UNA	42	N	75	W	17	SWNW	BILL BARRETT CORPORATION	T-CHAIR FED 12-17-4275	STO,CBM					
309	P180015W	27-Feb-07	GSI	42	N	75	W	19	SWNW	BILL BARRETT CORPORATION	T-CHAIR 12-19-4275	STO,CBM					
310	P180017W	27-Feb-07	GSI	42	N	75	W	19	NENW	BILL BARRETT CORPORATION	T-CHAIR 21-19-4275	STO,CBM					
311	P180020W	27-Feb-07	GSI	42	N	75	W	19	SWNE	BILL BARRETT CORPORATION	T-CHAIR 32-19-4275	STO,CBM					
312	P180024W	27-Feb-07	GSI	42	N	75	W	19	NENE	BILL BARRETT CORPORATION	T-CHAIR 41-19-4275	STO,CBM					
313	P180018W	27-Feb-07	GSI	42	N	75	W	20	NESW	BILL BARRETT CORPORATION	T-CHAIR 23-20-4275	STO,CBM					
314	P180022W	27-Feb-07	GSI	42	N	75	W	20	SWSE	BILL BARRETT CORPORATION	T-CHAIR 34-20-4275	STO,CBM					
315	41/1/98W	16-May-08	UNA	42	N	75	W	20	NENE	BILL BARRETT CORPORATION	T-CHAIR FED 41-20-4275	STO,CBM					
316	41/10/97W	16-May-08	UNA	42	N	75	W	20	SWNE	BILL BARRETT CORPORATION	T-CHAIR FED 32-20-4275	STO,CBM					
317	41/3/96W	16-May-08	UNA	42	N	75	W	20	SWNW	BILL BARRETT CORPORATION	T-CHAIR FED 12-20-4275	STO,CBM					
318	41/4/96W	16-May-08	UNA	42	N	75	W	20	SWSW	BILL BARRETT CORPORATION	T-CHAIR FED 14-20-4275	STO,CBM					
319	41/5/96W	16-May-08	UNA	42	N	75	W	20	NENW	BILL BARRETT CORPORATION	T-CHAIR FED 21-20-4275	STO,CBM					
320	41/6/96W	16-May-08	UNA	42	N	75	W	20	NESE	BILL BARRETT CORPORATION	T-CHAIR FED 43-20-4275	STO,CBM					
321	40/3/510W	22-Jan-08	UNA	42	N	75	W	21	SWNE	BILL BARRETT CORPORATION	T-CHAIR FED 32-21-4275	STO,CBM					
322	40/4/446W	21-Nov-07	UNA	42	N	75	W	21	NENE	Bill Barrett Corp.	T-CHAIR FED 41-21-4275	STO,CBM					
323	40/4/510W	22-Jan-08	UNA	42	N	75	W	21	SWSE	BILL BARRETT CORPORATION	T-CHAIR FED 34-21-4275	STO,CBM					
324	40/5/446W	21-Nov-07	UNA	42	N	75	W	21	NESE	Bill Barrett Corp.	T-CHAIR FED 43-21-4275	STO,CBM					
325	41/10/96W	16-May-08	UNA	42	N	75	W	21	NESW	BILL BARRETT CORPORATION	T-CHAIR FED 23-21-4275	STO,CBM					
326	41/7/96W	16-May-08	UNA	42	N	75	W	21	SWNW	BILL BARRETT CORPORATION	T-CHAIR FED 12-21-4275	STO,CBM					
327	41/8/96W	16-May-08	UNA	42	N	75	W	21	SWSW	BILL BARRETT CORPORATION	T-CHAIR FED 14-21-4275	STO,CBM					
328	41/9/96W	16-May-08	UNA	42	N	75	W	21	NENW	BILL BARRETT CORPORATION	T-CHAIR FED 21-21-4275	STO,CBM					
329	P180592W	14-Mar-07	GSI	42	N	75	W	22	NESE	Bill Barrett Corp.	T-CHAIR 43-22-4275	STO,CBM					
330	P180593W	14-Mar-07	GSI	42	N	75	W	22	SWSE	Bill Barrett Corp.	T-CHAIR 34-22-4275	STO,CBM					
331	P180594W	14-Mar-07	GSI	42	N	75	W	22	NESW	Bill Barrett Corp.	T-CHAIR 23-22-4275	STO,CBM					
332	P180595W	14-Mar-07	GSI	42	N	75	W	22	SWSW	Bill Barrett Corp.	T-CHAIR 14-22-4275	STO,CBM					
333	40/6/446W	21-Nov-07	UNA	42	N	75	W	22	SWNW	Bill Barrett Corp.	T-CHAIR FED 12-22-4275	STO,CBM					
334	40/7/378W	26-Sep-07	UNA	42	N	75	W	22	NENW	BILL BARRETT CORPORATION	T-CHAIR FED 21-22-4275	STO,CBM					
335	40/8/378W	26-Sep-07	UNA	42	N	75	W	22	SWNE	BILL BARRETT CORPORATION	T-CHAIR FED 32-22-4275	STO,CBM					
336	40/9/378W	26-Sep-07	UNA	42	N	75	W	22	NENE	BILL BARRETT CORPORATION	T-CHAIR FED 41-22-4275	STO,CBM					
337	P136032W	15-Jun-01	GST	42	N	75	W	23	NENE	DEVON ENERGY PRODUCTION COMPANY, L.P.	IBERLIN 23 S- 1	STO,CBM	25	1272	343	1186	1264
338	P136033W	15-Jun-01	GST	42	N	75	W	23	SWNE	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN 23 S- 7	STO,CBM	25	1280	404	1189	1275
339	P136035W	15-Jun-01	GST	42	N	75	W	23	SWSE	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN 23 S- 15	STO,CBM	25	1295	775	1209	1292

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1	Type_Permit_No	Priority	Status	T	Dir_NS	R	Dir_EW	Sec.	Qtrqtr	Applicant	Facility_Name	Uses	Yld_Act	Well Depth	Static Depth	Top Completion	Bottom Completion
340	P136034W	15-Jun-01	GST	42	N	75	W	23	NESE	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN 23 S- 9	STO,CBM	25	1346	462	1240	1320
341	P136038W	15-Jun-01	GST	42	N	75	W	24	NESE	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN 24 S- 9	STO,CBM	25	1185	716.47	1098	1173
342	P136036W	15-Jun-01	GST	42	N	75	W	24	NENE	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN 24 S- 1	STO,CBM	25	1200	731	1112	1190
343	P136039W	15-Jun-01	GST	42	N	75	W	24	SWSE	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN 24 S- 15	STO,CBM	25	1218	874	1126	1204
344	P136037W	15-Jun-01	GST	42	N	75	W	24	SWNE	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN 24S- 7	STO,CBM	25	1234	734	1195	1270
345	P114075W	17-Feb-99	GST	42	N	75	W	25	SESE	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN 25S-16	STO,CBM	25	1081	771	998	1072
346	P114082W	17-Feb-99	GST	42	N	75	W	25	SENE	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN 25S-8	STO,CBM	25	1129	188	1053	1121
347	P114083W	17-Feb-99	GST	42	N	75	W	25	NWSE	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN 25S-10	STO,CBM	25	1134	390	1053	1129
348	P114081W	17-Feb-99	GST	42	N	75	W	25	NWNE	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN 25S-2	STO,CBM	25	1174	390	1097	1169
349	P161029W	19-Jul-04	GST	42	N	75	W	25	SWNW	DEVON ENERGY PRODUCTION COMPANY, L.P.**JOHN P. & MAGGIE L. IBERLIN	IBERLIN FEDEAL 25S-5	STO,CBM	25	1178	1017	1037	1174
350	P114374W	03-Mar-99	GSE	42	N	75	W	25	NENW	1) DEVON ENERGY CORP 2) MR. MARK IBERLIN, IBERLIN RANCH PARTNERSHIP	IBERLIN FED 25S-3	STO,CBM					
351	P114375W	03-Mar-99	GSE	42	N	75	W	25	SWNW	1) DEVON ENERGY CORP 2) MR. MARK IBERLIN, IBERLIN RANCH PARTNERSHIP	IBERLIN FED 25S-5	STO,CBM					
352	P114376W	03-Mar-99	GSE	42	N	75	W	25	NESW	1) DEVON ENERGY CORP 2) MR. MARK IBERLIN, IBERLIN RANCH PARTNERSHIP	IBERLIN FED 25S-11	STO,CBM					
353	P114377W	03-Mar-99	GSE	42	N	75	W	25	SWSW	1) DEVON ENERGY CORP 2) MR. MARK IBERLIN, IBERLIN RANCH PARTNERSHIP	IBERLIN FED 25S-13	STO,CBM					
354	P114076W	17-Feb-99	GST	42	N	75	W	26	SESE	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN 26S-16	STO,CBM	25	1171	390	1079	1161
355	P136040W	15-Jun-01	GST	42	N	75	W	26	NENE	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN 26S- 1	STO,CBM	25	1255	1073	1188	1248
356	P136042W	15-Jun-01	GST	42	N	75	W	26	SWSE	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN 26 S- 15	STO,CBM	25	1260	800	1170	1249
357	P136041W	15-Jun-01	GST	42	N	75	W	26	SWNE	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN 26 S- 7	STO,CBM	25	1280	390	1222	1260
358	P114378W	03-Mar-99	GST	42	N	75	W	26	NENW	1) DEVON ENERGY CORP 2) MR. MARK IBERLIN, IBERLIN RANCH PARTNERSHIP	IBERLIN FED 26S-3	STO,CBM	25	1318	1288	1233	1314
359	P114380W	03-Mar-99	GSE	42	N	75	W	26	NESW	1) DEVON ENERGY CORP 2) MR. MARK IBERLIN, IBERLIN RANCH PARTNERSHIP	IBERLIN FED 26S-11	STO,CBM					
360	P114381W	03-Mar-99	GSE	42	N	75	W	26	SWSW	1) DEVON ENERGY CORP 2) MR. MARK IBERLIN, IBERLIN RANCH PARTNERSHIP	IBERLIN FED 26S-13	STO,CBM					

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1	Type_Permit_No	Priority	Status	T	Dir_NS	R	Dir_EW	Sec.	Qtrqtr	Applicant	Facility_Name	Uses	Yld_Act	Well Depth	Static Depth	Top Completion	Bottom Completion
361	P114372W	03-Mar-99	GST	42	N	75	W	27	NESE	1) DEVON ENERGY CORP 2) MR. MARK IBERLIN, IBERLIN RANCH PARTNERSHIP	IBERLIN FED 27S-9	STO,CBM	25	1198	1123	1100	1198
362	P161030W	19-Jul-04	GST	42	N	75	W	27	NENE	DEVON ENERGY PRODUCTION COMPANY, L.P.**JOHN P. & MAGGIE L. IBERLIN	IBERLIN FEDEAL 27S-1	STO,CBM	25	1231	775	1164	1206
363	P114382W	03-Mar-99	GSE	42	N	75	W	27	NENE	1) DEVON ENERGY CORP 2) MR. MARK IBERLIN, IBERLIN RANCH PARTNERSHIP	IBERLIN FED 27S-1	STO,CBM					
364	P180590W	14-Mar-07	GSI	42	N	75	W	28	NESE	Bill Barrett Corp.	IBERLIN 43-28-4275	STO,CBM					
365	P180591W	14-Mar-07	GSI	42	N	75	W	28	NESW	Bill Barrett Corp.	IBERLIN 23-28-4275	STO,CBM					
366	41/1/97W	16-May-08	UNA	42	N	75	W	28	SWNW	BILL BARRETT CORPORATION	IBERLIN FED 12-28-4275	STO,CBM					
367	41/2/97W	16-May-08	UNA	42	N	75	W	28	SWNE	BILL BARRETT CORPORATION	IBERLIN FED 32-28-4275	STO,CBM					
368	41/2/98W	16-May-08	UNA	42	N	75	W	28	NENW	BILL BARRETT CORPORATION	IBERLIN FED 21-28-4275	STO,CBM					
369	41/3/97W	16-May-08	UNA	42	N	75	W	28	NENE	BILL BARRETT CORPORATION	IBERLIN FED 41-28-4275	STO,CBM					
370	41/3/98W	16-May-08	UNA	42	N	75	W	29	SWNE	BILL BARRETT CORPORATION	IBERLIN FED 32-29-4275	STO,CBM					
371	41/4/97W	16-May-08	UNA	42	N	75	W	29	NENE	BILL BARRETT CORPORATION	T-CHAIR FED 41-29-4275	STO,CBM					
372	41/4/98W	16-May-08	UNA	42	N	75	W	29	SWSE	BILL BARRETT CORPORATION	IBERLIN FED 34-29-4275	STO,CBM					
373	41/5/98W	16-May-08	UNA	42	N	75	W	29	NESE	BILL BARRETT CORPORATION	IBERLIN FED 43-29-4275	STO,CBM					
374	P180587W	14-Mar-07	GSI	42	N	75	W	32	NESE	Bill Barrett Corp.	IBERLIN 43-32-4275	STO,CBM					
375	P180588W	14-Mar-07	GSI	42	N	75	W	32	NENE	Bill Barrett Corp.	IBERLIN 41-32-4175	STO,CBM					
376	P180589W	14-Mar-07	GSI	42	N	75	W	32	SWSE	Bill Barrett Corp.	IBERLIN 34-32-4275	STO,CBM					
377	40/1/447W	21-Nov-07	UNA	42	N	75	W	33	NESE	Bill Barrett Corp.	WALKER CREEK FED 43-33-4275	STO,CBM					
378	40/10/446W	21-Nov-07	UNA	42	N	75	W	33	NENE	Bill Barrett Corp.	WALKER CREEK FED 41-33-4275	STO,CBM					
379	40/5/510W	22-Jan-08	UNA	42	N	75	W	33	SWSW	BILL BARRETT CORPORATION	WALKER CREEK FED 14-33-4275	STO,CBM					
380	40/7/446W	21-Nov-07	UNA	42	N	75	W	33	SWNW	Bill Barrett Corp.	WALKER CREEK FED 12-33-4275	STO,CBM					
381	40/7/554W	13-Feb-08	UNA	42	N	75	W	33	NESW	BILL BARRETT CORPORATION	WALKER CREEK FED 23-33-4275	STO,CBM					
382	40/8/446W	21-Nov-07	UNA	42	N	75	W	33	NENW	Bill Barrett Corp.	IBERLIN FED 21-33-4275	STO,CBM					
383	40/8/554W	13-Feb-08	UNA	42	N	75	W	33	SWSE	BILL BARRETT CORPORATION	WALKER CREEK FED 34-33-4275	STO,CBM					
384	40/9/446W	21-Nov-07	UNA	42	N	75	W	33	SWNE	Bill Barrett Corp.	WALKER CREEK FED 32-33-4275	STO,CBM					
385	41/6/98W	16-May-08	UNA	42	N	75	W	33	SWSE	BILL BARRETT CORPORATION	WALKER CREED FED 34-33-4275	STO,CBM					
386	P137787W	02-Aug-01	GST	42	N	75	W	34	SWSE	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN 34S-15	STO,CBM	25	1146	598	1058	1139
387	P137788W	02-Aug-01	GST	42	N	75	W	34	SWSW	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN 34S-13	STO,CBM	25	1161	408.92	1098	1184
388	P137786W	02-Aug-01	GST	42	N	75	W	34	NESE	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN 34S-9	STO,CBM	25	1188	390	1036	1060
389	P137789W	02-Aug-01	GST	42	N	75	W	34	NESW	IBERLIN RANCH PARTNERSHIP** DEVON ENERGY PRODUCTION COMPANY, L.P.	IBERLIN 34S-11	STO,CBM	25	1215	673	1118	1204
390	P114077W	17-Feb-99	GST	42	N	75	W	34	NENE	DEVON ENERGY CORP.** WALKER CREEK LIVESTOCK CO.	WALKER CREEK 34S-1	STO,CBM	25	1245	696	1138	1218
391	P114102W	17-Feb-99	GSE	42	N	75	W	34	SWNE	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN FED 34S-7	STO,CBM					

Addendum Table 3.4.A. Water Well Rights Within Two Miles of the Moore Ranch Permit Area (Revised June 2009)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Type_Permit_No	Priority	Status	T	Dir_NS	R	Dir_EW	Sec	Qtrqtr	Applicant	Facility_Name	Uses	Yld_Act	Well Depth	Static Depth	Top Completion	Bottom Completion
392	40/2/447W	21-Nov-07	UNA	42	N	75	W	34	SWNW	Bill Barrett Corp.	IBERLIN FED 12-34-4275	STO,CBM					
393	40/3/447W	21-Nov-07	UNA	42	N	75	W	34	NENW	Bill Barrett Corp.	IBERLIN FED 21-34-4275	STO,CBM					
394	P114070W	17-Feb-99	GST	42	N	75	W	35	NWSW	DEVON ENERGY CORP.** WALKER CREEK LIVESTOCK CO.	WALKER CREEK 35S-12	STO,CBM	25	1044	392	980	1038
395	P114085W	17-Feb-99	GST	42	N	75	W	35	SWSW	DEVON ENERGY CORP.** WALKER CREEK LIVESTOCK CO.	WALKER CREEK 35S-13	STO,CBM	25	1107	356	979	1006
396	P114067W	17-Feb-99	GST	42	N	75	W	35	SWNW	DEVON ENERGY CORP.** WALKER CREEK LIVESTOCK CO.	WALKER CREEK 35S-5	STO,CBM	25	1108	380	1027	1087
397	P114069W	17-Feb-99	GST	42	N	75	W	35	NESW	DEVON ENERGY CORP.** WALKER CREEK LIVESTOCK CO.	WALKER CREEK 35S-11	STO,CBM	25	1131	395	1059	1131
398	P114068W	17-Feb-99	GST	42	N	75	W	35	SENW	DEVON ENERGY CORP.** WALKER CREEK LIVESTOCK CO.	WALKER CREEK 35S-6	STO,CBM	25	1146	390	1053	1132
399	P114078W	17-Feb-99	GST	42	N	75	W	35	SWSE	WYO BOARD OF LAND COMMISSIONERS** DEVON ENERGY CORP.	WALKER CREEK ST 35S-15	STO,CBM	25	1151	750	1031	1110
400	P114084W	17-Feb-99	GST	42	N	75	W	35	NWNW	DEVON ENERGY CORP.** WALKER CREEK LIVESTOCK CO.	WALKER CREEK 35S-4	STO,CBM	25	1180	400	1085	1172
401	P114387W	03-Mar-99	GSE	42	N	75	W	35	SWNE	1) DEVON ENERGY CORP 2) WALKER CREEK LIVESTOCK	WALKER CREEK FED 35S-7	STO,CBM					
402	P114391W	03-Mar-99	GSE	42	N	75	W	35	NENE	1) DEVON ENERGY CORP 2) WALKER CREEK LIVESTOCK	WALKER CREEK FED 35S-1	STO,CBM					
403	P114080W	17-Feb-99	GST	42	N	75	W	36	SESW	WYO BOARD OF LAND COMMISSIONERS** DEVON ENERGY CORP.	WALKER CREEK ST 36S-14	STO,CBM	25	1032	390	995	1071
404	P114086W	17-Feb-99	GST	42	N	75	W	36	NWNE	WYO BOARD OF LAND COMMISSIONERS** DEVON ENERGY CORP.	WALKER CREEK ST 36S-2	STO,CBM	25	1052	390	989	1061
405	P114079W	17-Feb-99	GST	42	N	75	W	36	SENE	WYO BOARD OF LAND COMMISSIONERS** DEVON ENERGY CORP.	WALKER CREEK ST 36S-8	STO,CBM	25	1074	390	987	1053
406	P113642W	21-Jan-99	GSE	42	N	75	W	36	NESE	WYO BOARD OF LAND COMMISSIONERS** YATES PETROLEUM CORPORATION	PINE TREE DRAW CS STATE #1	STO,CBM	100	1075	773	1004	1066
407	P114071W	17-Feb-99	GST	42	N	75	W	36	NENW	WYO BOARD OF LAND COMMISSIONERS** DEVON ENERGY CORP.	WALKER CREEK ST 35S-3	STO,CBM	25	1079	400	992	1069
408	P114074W	17-Feb-99	GST	42	N	75	W	36	SENW	WYO BOARD OF LAND COMMISSIONERS** DEVON ENERGY CORP.	WALKER CREEK ST 36S-6	STO,CBM	25	1108	390	1023	1101
409	P114072W	17-Feb-99	GST	42	N	75	W	36	NWNW	WYO BOARD OF LAND COMMISSIONERS** DEVON ENERGY CORP.	WALKER CREEK ST 36S-4	STO,CBM	25	1140	400	1060	1140
410	P114073W	17-Feb-99	GST	42	N	75	W	36	SWNW	WYO BOARD OF LAND COMMISSIONERS** DEVON ENERGY CORP.	WALKER CREEK ST 36S-5	STO,CBM	25	1148	380	1070	1135
411	P114087W	17-Feb-99	GST	42	N	75	W	36	NWSW	WYO BOARD OF LAND COMMISSIONERS** DEVON ENERGY CORP.	WALKER CREEK ST 36S-12X	STO,CBM	25	1148	1037	1059	1137
412																	
413	CBM																
414	P156398W	12-Jan-04	GST	41	N	74	W	4	NESE	BILL BARRETT CORPORATION	FEDERAL 43-4-4174	CBM	21	824	523	759	915

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	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Type_Permit_No	Priority	Status	T	Dir_NS	R	Dir_EW	Sec.	Qtrqtr	Applicant	Facility_Name	Uses	Yld_Act	Well Depth	Static Depth	Top Completion	Bottom Completion
415	P156395W	12-Jan-04	GST	41	N	74	W	4	SWNE	BILL BARRETT CORPORATION	FEDERAL 32-4-4174	CBM	16	858	483	793	846
416	P156396W	12-Jan-04	GST	41	N	74	W	4	SWSE	BILL BARRETT CORPORATION	FEDERAL 34-4-4174	CBM	18	873	549	805	855
417	P156397W	12-Jan-04	GST	41	N	74	W	4	NENE	BILL BARRETT CORPORATION	FEDERAL 41-4-4174	CBM	15	883	493	807	874
418	P156400W	12-Jan-04	GST	41	N	74	W	5	NENE	BILL BARRETT CORPORATION	FEDERAL 41-5-4174	CBM	20	955	622	881	943
419	P153683W	18-Aug-03	GST	41	N	74	W	5	SWNW	BILL BARRETT CORPORATION	DIAMOND T 12-5-4174	CBM	18	991	823	916	991
420	P154747W	15-Oct-03	GST	41	N	74	W	5	SENW	BILL BARRETT CORPORATION	DIAMOND T 22-5-4174	CBM	18	1015	679	943	1011
421	P156307W	04-Dec-03	GST	41	N	74	W	5	NWSW	BILL BARRETT CORPORATION	DIAMOND T 13-5-4174	CBM	17	1019	705	945	1008
422	P153685W	18-Aug-03	GST	41	N	74	W	5	SWSE	BILL BARRETT CORPORATION	DIAMOND T 34-5-4174	CBM	16	1030	980	965	1027
423	P153684W	18-Aug-03	GST	41	N	74	W	5	NESW	BILL BARRETT CORPORATION	DIAMOND T 23-5-4174	CBM	17	1037	684	957	1008
424	P156399W	12-Jan-04	GST	41	N	74	W	5	SWNE	BILL BARRETT CORPORATION	FEDERAL 32-5-4174	CBM	15	1042	705	961	1029
425	P153686W	18-Aug-03	GST	41	N	74	W	5	NESE	BILL BARRETT CORPORATION	DIAMOND T 43-5-4174	CBM	15	1062	1018	994	1055
426	P155742W	19-Nov-03	GST	41	N	74	W	6	NWSE	BILL BARRETT CORPORATION	DIAMOND T 33-6-4174	CBM	15	961	709	885	957
427	P156402W	12-Jan-04	GST	41	N	74	W	6	NESW	BILL BARRETT CORPORATION	FEDERAL 23-6-4174	CBM	19	967	846	896	967
428	P153688W	18-Aug-03	GST	41	N	74	W	6	SWNE	BILL BARRETT CORPORATION	DIAMOND T 32-6-4174	CBM	17	982	699	907	979
429	P153687W	18-Aug-03	GST	41	N	74	W	6	NENW	BILL BARRETT CORPORATION	DIAMOND T 21-6-4174	CBM	16	986	740	911	983
430	P156401W	12-Jan-04	GST	41	N	74	W	6	SWSW	BILL BARRETT CORPORATION	FEDERAL 14-6-4174	CBM	15	990	734	904	982
431	P153927W	27-Aug-03	GST	41	N	74	W	6	SWNW	BILL BARRETT CORPORATION	DIAMOND T 12-6-4174	CBM	9	999	681	927	991
432	P153689W	18-Aug-03	GST	41	N	74	W	6	NESE	BILL BARRETT CORPORATION	DIAMOND T 43-6-4174	CBM	10	1012	762	949	1000
433	P155743W	19-Nov-03	GST	41	N	74	W	6	SENE	BILL BARRETT CORPORATION	DIAMOND T 42-6-4174	CBM	14	1020	764	951	1020
434	P153692W	18-Aug-03	GST	41	N	74	W	7	SWSE	BILL BARRETT CORPORATION	DIAMOND T 34-7-4174	CBM	19	848	449	781	840
435	P153693W	18-Aug-03	GST	41	N	74	W	7	NESE	BILL BARRETT CORPORATION	DIAMOND T 43-7-4174	CBM	22	901	574	825	887
436	P156403W	12-Jan-04	GST	41	N	74	W	7	NENW	BILL BARRETT CORPORATION	FEDERAL 21-7-4174	CBM	8	930	820	840	908
437	P153691W	18-Aug-03	GST	41	N	74	W	7	NESW	BILL BARRETT CORPORATION	DIAMOND T 23-7-4174	CBM	20	947	580	862	925
438	P153690W	18-Aug-03	GST	41	N	74	W	7	SWSW	BILL BARRETT CORPORATION	DIAMOND T 14-7-4174	CBM	20	958	6247	900	946
439	P156404W	12-Jan-04	GST	41	N	74	W	7	NENE	BILL BARRETT CORPORATION	FEDERAL 41-7-4174	CBM	9	990	841	907	968
440	P156410W	12-Jan-04	GST	41	N	74	W	8	SWSE	BILL BARRETT CORPORATION	FEDERAL 34-8-4174	CBM	12	841	513	788	830
441	P156406W	12-Jan-04	GST	41	N	74	W	8	SWSW	BILL BARRETT CORPORATION	FEDERAL 14-8-4174	CBM	11	897	587	832	893
442	P156408W	12-Jan-04	GST	41	N	74	W	8	NESW	BILL BARRETT CORPORATION	FEDERAL 23-8-4174	CBM	9	952	598	885	942
443	P156412W	12-Jan-04	GST	41	N	74	W	8	NESE	BILL BARRETT CORPORATION	FEDERAL 43-8-4174	CBM	10	963	595	899	953
444	P156405W	12-Jan-04	GST	41	N	74	W	8	SWNW	BILL BARRETT CORPORATION	FEDERAL 12-8-4174	CBM	16	1000	706	932	996
445	P156409W	12-Jan-04	GST	41	N	74	W	8	SWNE	BILL BARRETT CORPORATION	FEDERAL 32-8-4174	CBM	11	1011	668	938	1000
446	P156407W	12-Jan-04	GST	41	N	74	W	8	NENW	BILL BARRETT CORPORATION	FEDERAL 21-8-4174	CBM	10	1018	771	948	1010
447	P156411W	12-Jan-04	GST	41	N	74	W	8	NENE	BILL BARRETT CORPORATION	FEDERAL 41-8-4174	CBM	11	1062	728	994	1056
448	P156417W	12-Jan-04	GST	41	N	74	W	9	SWNE	BILL BARRETT CORPORATION	FEDERAL 32-9-4174	CBM	12	871	573	818	858
449	P156414W	12-Jan-04	GST	41	N	74	W	9	SWSW	BILL BARRETT CORPORATION	FEDERAL 14-9-4174	CBM	14	909	579	850	900
450	P156415W	12-Jan-04	GST	41	N	74	W	9	NENW	BILL BARRETT CORPORATION	FEDERAL 21-9-4174	CBM	13	911	591	848	911
451	P156413W	12-Jan-04	GST	41	N	74	W	9	SWNW	BILL BARRETT CORPORATION	FEDERAL 12-9-4174	CBM	13	985	704	920	978
452	P156418W	12-Jan-04	GST	41	N	74	W	9	SWSE	BILL BARRETT CORPORATION	FEDERAL 34-9-4174	CBM	16	997	610	934	975
453	P156416W	12-Jan-04	GST	41	N	74	W	9	NESW	BILL BARRETT CORPORATION	FEDERAL 23-9-4174	CBM	16	1022	641	953	1022
454	P156419W	12-Jan-04	GSI	41	N	74	W	9	NENE	BILL BARRETT CORPORATION	FEDERAL 41-9-4174	CBM					
455	P156420W	12-Jan-04	GSI	41	N	74	W	9	NESE	BILL BARRETT CORPORATION	FEDERAL 43-9-4174	CBM					
456	P153696W	18-Aug-03	GST	41	N	74	W	18	SWNW	BILL BARRETT CORPORATION	DIAMOND T 12-18-4174	CBM	13	721	486	677	721
457	P153699W	18-Aug-03	GST	41	N	74	W	18	SWSE	BILL BARRETT CORPORATION	NINE MILE 34-18-4174	CBM	22	791	460	745	780
458	P148712W	31-Oct-02	GST	41	N	74	W	18	NESE	BILL BARRETT CORPORATION	PALM 43-18-4174	CBM	7	821	358	758	821
459	P153698W	18-Aug-03	GST	41	N	74	W	18	NESW	BILL BARRETT CORPORATION	NINE MILE 23-18-4174	CBM	15	852	552	777	828
460	P153697W	18-Aug-03	GST	41	N	74	W	18	NENW	BILL BARRETT CORPORATION	DIAMOND T 21-18-4174	CBM	15	881	503	809	871
461	P156440W	12-Jan-04	GST	41	N	75	W	1	NENE	BILL BARRETT CORPORATION	FEDERAL 41-1-4175	CBM	17	1013	821	936	1006
462	P156435W	12-Jan-04	GST	41	N	75	W	1	SWNW	BILL BARRETT CORPORATION	FEDERAL 12-1-4175	CBM	15	1028	783	952	1024
463	P155689W	18-Nov-03	GST	41	N	75	W	1	SWSW	BILL BARRETT CORPORATION	WALKER CREEK 14-1-4175	CBM	13	1031	706	944	1011
464	P156437W	12-Jan-04	GST	41	N	75	W	1	NESW	BILL BARRETT CORPORATION	FEDERAL 23-1-4175	CBM	18	1044	764	962	1036

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	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Type_Permit_No	Priority	Status	T	Dir_NS	R	Dir_EW	Sec.	Qtrqtr	Applicant	Facility_Name	Uses	Yld_Act	Well Depth	Static Depth	Top Completion	Bottom Completion
465	P156438W	12-Jan-04	GST	41	N	75	W	1	SWNE	BILL BARRETT CORPORATION	FEDERAL 32-1-4175	CBM	17	1052	695	976	1048
466	P156439W	12-Jan-04	GST	41	N	75	W	1	SWSE	BILL BARRETT CORPORATION	FEDERAL 34-1-4175	CBM	17	1052	730	980	1052
467	P156436W	12-Jan-04	GST	41	N	75	W	1	NENW	BILL BARRETT CORPORATION	FEDERAL 21-1-4175	CBM	16	1063	866	980	1052
468	P156441W	12-Jan-04	GST	41	N	75	W	1	NESE	BILL BARRETT CORPORATION	FEDERAL 43-1-4175	CBM	15	1074	762	966	1068
469	P155688W	18-Nov-03	GST	41	N	75	W	2	SWSE	BILL BARRETT CORPORATION	WALKER CREEK 34-2-4175	CBM	17	1011	711	934	1011
470	P156443W	12-Jan-04	GST	41	N	75	W	2	SWSW	BILL BARRETT CORPORATION	FEDERAL 14-2-4175	CBM	17	1034	834	946	1023
471	P156577W	29-Jan-04	GST	41	N	75	W	2	SESE	BILL BARRETT CORPORATION	WALKER CREEK 44-2-4175	CBM	18	1037	737	955	1028
472	P156446W	12-Jan-04	GST	41	N	75	W	2	SWNE	BILL BARRETT CORPORATION	FEDERAL 32-2-4175	CBM	17	1040	757	962	1040
473	P156447W	12-Jan-04	GST	41	N	75	W	2	NENE	BILL BARRETT CORPORATION	FEDERAL 41-2-4175	CBM	6	1102	887	1035	1102
474	P156442W	12-Jan-04	GST	41	N	75	W	2	SWNW	BILL BARRETT CORPORATION	FEDERAL 12-2-4175	CBM	15	1122	810	1049	1118
475	P156445W	12-Jan-04	GST	41	N	75	W	2	NESW	BILL BARRETT CORPORATION	FEDERAL 23-2-4175	CBM	17	1122	800	998	1074
476	P156444W	12-Jan-04	GST	41	N	75	W	2	NENW	BILL BARRETT CORPORATION	FEDERAL 21-2-4175	CBM	14	1139	836	1050	1128
477	P139469W	24-Sep-01	GSE	41	N	75	W	3	NENW	DEVON ENERGY PRODUCTION COMPANY, L.P.** WALKER CREEK LIVESTOCK CO.	WALKER FEDERAL 3S-3	CBM					
478	P139470W	24-Sep-01	GSE	41	N	75	W	3	SWNW	DEVON ENERGY PRODUCTION COMPANY, L.P.** WALKER CREEK LIVESTOCK CO.	WALKER FEDERAL 3S-5	CBM					
479	P139471W	24-Sep-01	GSE	41	N	75	W	3	NESE	DEVON ENERGY PRODUCTION COMPANY, L.P.** WALKER CREEK LIVESTOCK CO.	WALKER FEDERAL 3S-9	CBM					
480	P139472W	24-Sep-01	GSE	41	N	75	W	3	NESW	DEVON ENERGY PRODUCTION COMPANY, L.P.** WALKER CREEK LIVESTOCK CO.	WALKER FEDERAL 3S-11	CBM					
481	P139474W	24-Sep-01	GSE	41	N	75	W	4	NENE	DEVON ENERGY PRODUCTION COMPANY, L.P.** WALKER CREEK LIVESTOCK CO.	WALKER FEDERAL 4S-1	CBM					
482	P171197W	20-Oct-05	GSI	41	N	75	W	9	SWNE	DEVON ENERGY PRODUCTION COMPANY, L.P.** WALKER CREEK LIVESTOCK CO.	WALKER 9S-7X	CBM					
483	P154592W	24-Sep-03	GST	41	N	75	W	11	NESE	BILL BARRETT CORPORATION	MOORE WIRC 43-11-4175	CBM	18	941	650	858	934
484	P155690W	18-Nov-03	GST	41	N	75	W	11	NENE	BILL BARRETT CORPORATION	WALKER CREEK 41-11-4175	CBM	19	1021	745	932	1008
485	P154594W	24-Sep-03	GST	41	N	75	W	12	SWSW	BILL BARRETT CORPORATION	MOORE WIRC 14-12-4175	CBM	14	914	589	843	904
486	P156451W	12-Jan-04	GST	41	N	75	W	12	SWSE	BILL BARRETT CORPORATION	FEDERAL 34-12-4175	CBM	19	963	679	889	963
487	P156449W	12-Jan-04	GST	41	N	75	W	12	NESW	BILL BARRETT CORPORATION	FEDERAL 23-12-4175	CBM	18	977	631	888	966
488	P154593W	24-Sep-03	GST	41	N	75	W	12	SWNW	BILL BARRETT CORPORATION	MOORE WIRC 12-12-4175	CBM	18	994	688	909	985
489	P156453W	12-Jan-04	GST	41	N	75	W	12	NESE	BILL BARRETT CORPORATION	FEDERAL 43-12-4175	CBM	10	995	710	911	980
490	P156448W	12-Jan-04	GST	41	N	75	W	12	NENW	BILL BARRETT CORPORATION	FEDERAL 21-12-4175	CBM	15	1018	676	942	1010
491	P156450W	12-Jan-04	GST	41	N	75	W	12	SWNE	BILL BARRETT CORPORATION	FEDERAL 32-12-4175	CBM	20	1030	715	950	1024
492	P156452W	12-Jan-04	GST	41	N	75	W	12	NENE	BILL BARRETT CORPORATION	FEDERAL 41-12-4175	CBM	17	1032	811	952	1028
493	P154596W	24-Sep-03	GST	41	N	75	W	13	SWNE	BILL BARRETT CORPORATION	MOORE WIRC 32-13-4175	CBM	20	859	554	771	845
494	P155744W	19-Nov-03	GST	41	N	75	W	13	SENE	BILL BARRETT CORPORATION	DIAMOND T 42-13-4175	CBM	12	876	495	802	863
495	P156457W	12-Jan-04	GST	41	N	75	W	13	NESE	BILL BARRETT CORPORATION	FEDERAL 43-13-4175	CBM	7	883	656	794	883
496	P154591W	24-Sep-03	GST	41	N	75	W	13	NENW	BILL BARRETT CORPORATION	MOORE WIRC 21-13-4175	CBM	19	887	578	799	860
497	P156456W	12-Jan-04	GST	41	N	75	W	13	SWSE	BILL BARRETT CORPORATION	FEDERAL 34-13-4175	CBM	13	903	569	822	890
498	P156454W	12-Jan-04	GST	41	N	75	W	13	SWSW	BILL BARRETT CORPORATION	FEDERAL 14-13-4175	CBM	23	912	624	833	896
499	P156455W	12-Jan-04	GST	41	N	75	W	13	NESW	BILL BARRETT CORPORATION	FEDERAL 23-13-4175	CBM	19	931	642	852	912
500	P154595W	24-Sep-03	GST	41	N	75	W	13	SWNW	BILL BARRETT CORPORATION	MOORE WIRC 12-13-4175	CBM	18	955	664	867	933
501	P147628W	04-Oct-02	GST	42	N	74	W	16	SWSW	WY STATE BOARD OF LAND COMMISSIONERS** WILLIAMS PRODUCTION RMT COMPANY	STATE 14-16-4274	CBM	15	1017	657	937	1009

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	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Type_Permit_No	Priority	Status	T	Dir_NS	R	Dir_EW	Sec.	Qtrqtr	Applicant	Facility_Name	Uses	Yld_Act	Well Depth	Static Depth	Top Completion	Bottom Completion
502	P147632W	04-Oct-02	GST	42	N	74	W	16	SWSE	WY STATE BOARD OF LAND COMMISSIONERS** WILLIAMS PRODUCTION RMT COMPANY	STATE 34-16-4274	CBM	10	1051	660	972	1047
503	P147630W	04-Oct-02	GST	42	N	74	W	16	NESW	WILLIAMS PRODUCTION RMT COMPANY	STATE 23-16-4274	CBM	18	1074	692	991	1068
504	P147633W	04-Oct-02	GST	42	N	74	W	16	NENE	WY STATE BOARD OF LAND COMMISSIONERS** WILLIAMS PRODUCTION RMT COMPANY	STATE 41-16-4274	CBM	17	1076	672	997	1069
505	P147634W	04-Oct-02	GST	42	N	74	W	16	NESE	WY STATE BOARD OF LAND COMMISSIONERS** WILLIAMS PRODUCTION RMT COMPANY	STATE 43-16-4274	CBM	13	1079	915	992	1065
506	P147631W	04-Oct-02	GST	42	N	74	W	16	SWNE	WY STATE BOARD OF LAND COMMISSIONERS** WILLIAMS PRODUCTION RMT COMPANY	STATE 32-16-4274	CBM	14	1106	699	1019	1093
507	P147627W	04-Oct-02	GST	42	N	74	W	16	SWNW	WY STATE BOARD OF LAND COMMISSIONERS** WILLIAMS PRODUCTION RMT COMPANY	STATE 12-16-4274	CBM	18	1130	802	1048	1124
508	P147629W	04-Oct-02	GST	42	N	74	W	16	NENW	WY STATE BOARD OF LAND COMMISSIONERS** WILLIAMS PRODUCTION RMT COMPANY	STATE 21-16-4274	CBM	18	1138	641	1054	1127
509	P160346W	28-Jun-04	GST	42	N	74	W	18	SWSE	YATES PETROLEUM CORPORATION	PRATHER CS #4	CBM,RES	200	1179	801	1100	1167
510	P175091W	25-May-06	GSI	42	N	74	W	18	SWSW	YATES PETROLEUM CORP	PRATHER CS #5	CBM					
511	P158880W	01-Mar-04	GST	42	N	74	W	20	SWSW	YATES PETROLEUM CORP.	CUSTER CS FEDERAL #5	CBM,RES	200	1025	723	949	1014
512	P158879W	01-Mar-04	GST	42	N	74	W	20	NESE	YATES PETROLEUM CORP.	CUSTER CS FEDERAL #3	CBM,RES	200	1031	697	953	1019
513	P160348W	28-Jun-04	GST	42	N	74	W	20	NENW	YATES PETROLEUM CORPORATION	CUSTER CS FEDERAL #1	CBM,RES	200	1050	753	971	1040
514	P171763W	05-Apr-05	GSI	42	N	74	W	20	SWNE	YATES PETROLEUM CORP.	STEVE CS #02	CBM,MIS					
515	P158878W	01-Mar-04	GSI	42	N	74	W	20	SWNW	YATES PETROLEUM CORP.	CUSTER CS FEDERAL #2	CBM,RES					
516	P163652W	18-Oct-04	GST	42	N	74	W	28	SWSE	YATES PETROLEUM CORP.	BIGHORN CS FEDERAL #8	CBM,MIS	200	838	682	773	828
517	P158883W	01-Mar-04	GST	42	N	74	W	28	SWSW	YATES PETROLEUM CORP.	BIGHORN CS FEDERAL #1	CBM,RES	200	881	591	805	866
518	P161979W	30-Aug-04	GST	42	N	74	W	28	NESE	YATES PETROLEUM CORP.	BIGHORN CS FED #06	CBM,RES	200	893	754	816	893
519	P163653W	18-Oct-04	GST	42	N	74	W	28	SWSE	YATES PETROLEUM CORP.	BIGHORN CS FEDERAL #11	CBM,MIS	200	918	664	847	910
520	P161978W	30-Aug-04	GST	42	N	74	W	28	NENW	YATES PETROLEUM CORP.	CUSTER CS FEDERAL #13	CBM,RES	200	956	633	886	948
521	P161977W	30-Aug-04	GST	42	N	74	W	28	NENE	YATES PETROLEUM CORP.	CUSTER CS FEDERAL #12	CBM,RES	200	1016	686	Unknown	Unknown
522	P158881W	01-Mar-04	GST	42	N	74	W	29	NENE	YATES PETROLEUM CORP.	CUSTER CS FEDERAL #8	CBM,RES	200	948	608	870	942
523	P158877W	01-Mar-04	GST	42	N	74	W	29	SWSE	YATES PETROLEUM CORP.	BIGHORN CS FEDERAL #5	CBM,RES	200	974	669	904	964
524	P158882W	01-Mar-04	GST	42	N	74	W	29	SWNW	YATES PETROLEUM CORP.	CUSTER CS FEDERAL #10	CBM,RES	200	992	727	914	982
525	P130611W	31-Oct-00	GST	42	N	74	W	31	SWSW	DEVON ENERGY PROD. CO., L.P. 2** WY STATE BOARD OF LAND COMMISSIONERS	STATE ARCHIBALD 31S-13	CBM	25	984	600	904	980
526	P167696W	05-May-05	GSI	42	N	74	W	31	NESE	YATES PETROLEUM CORP.	SIOUX CS FEDERAL #01	CBM,MIS,RES					
527	P160347W	28-Jun-04	GST	42	N	74	W	32	NESE	YATES PETROLEUM CORPORATION	BIGHORN CS FEDERAL #9	CBM,RES	200	981	863	904	972
528	P156463W	12-Jan-04	GST	42	N	74	W	32	SWSE	BILL BARRETT CORPORATION	FEDERAL 34-32-4274	CBM	2	1026	728	945	1021
529	P156462W	12-Jan-04	GST	42	N	74	W	32	NESW	BILL BARRETT CORPORATION	FEDERAL 23-32-4274	CBM	15	1027	726	949	1023
530	P156461W	12-Jan-04	GST	42	N	74	W	32	SWSW	BILL BARRETT CORPORATION	FEDERAL 14-32-4274	CBM	14	1071	780	997	1061
531	P156617W	26-Jan-04	GST	42	N	74	W	33	NENE	BILL BARRETT CORPORATION	NINEMILE 41-33-4274	CBM	7	830	667	752	822
532	P156615W	26-Jan-04	GST	42	N	74	W	33	NENW	BILL BARRETT CORPORATION	NINEMILE 21-33-4274	CBM	8	842	733	766	834
533	P163654W	18-Oct-04	GST	42	N	74	W	33	SWSE	YATES PETROLEUM CORP.	BIGHORN CS FEDERAL #13	CBM,MIS	200	861	495	795	852
534	P156616W	26-Jan-04	GST	42	N	74	W	33	SWNE	BILL BARRETT CORPORATION	NINEMILE 32-33-4274	CBM	8	871	722	798	860
535	P161980W	30-Aug-04	GST	42	N	74	W	33	NESE	YATES PETROLEUM CORP.	BIGHORN CS FED #10	CBM,MIS	200	873	602	797	854
536	P162026W	09-Aug-04	GSI	42	N	74	W	33	SWSW	YATES PETROLEUM CORP.	BIGHORN CS FEDERAL #12	CBM,RES	200	929	770	856	921
537	P158296W	27-Apr-04	GSI	42	N	75	W	16	SWSE	DEVON ENERGY PRODUCTION COMPANY, L.P.	STATE (T-CHAIR) 16S-15	CBM					

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	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Type_Permit_No	Priority	Status	T	Dir_NS	R	Dir_EW	Sec.	Qtrqtr	Applicant	Facility_Name	Uses	Yld_Act	Well Depth	Static Depth	Top Completion	Bottom Completion
538	P158297W	27-Apr-04	GSI	42	N	75	W	16	SWSW	DEVON ENERGY PRODUCTION COMPANY, L.P.	STATE (T-CHAIR) 16S-13	CBM					
539	P158298W	27-Apr-04	GSI	42	N	75	W	16	SWNW	DEVON ENERGY PRODUCTION COMPANY, L.P.	STATE (T-CHAIR) 16S-5	CBM					
540	P158299W	27-Apr-04	GSI	42	N	75	W	16	NENW	DEVON ENERGY PRODUCTION COMPANY, L.P.	STATE (T-CHAIR) 16S-3	CBM					
541	P158667W	29-Apr-04	GSI	42	N	75	W	16	SWNE	DEVON ENERGY PRODUCTION COMPANY, L.P.	STATE (T CHAIR) 16S-7	CBM					
542	P158668W	29-Apr-04	GSI	42	N	75	W	16	NENE	DEVON ENERGY PRODUCTION COMPANY, L.P.	STATE (T CHAIR) 16S-1	CBM					
543	P165993W	02-Mar-05	GSI	42	N	75	W	16	NWSE	DEVON ENERGY PRODUCTION COMPANY, L.P.** WY STATE BOARD OF LAND COMMISSIONERS	STATE (T CHAIR) 16S-10	CBM					
544	P139124W	17-Sep-01	GST	42	N	75	W	23	NENW	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN FEDERAL 23S-3	CBM	25	1297	937	1192	1280
545	P139125W	17-Sep-01	GST	42	N	75	W	23	SWNW	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN FEDERAL 23S-5	CBM	25	1351	890	1256	1338
546	P139127W	17-Sep-01	GST	42	N	75	W	23	SWSW	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN FEDERAL 23S-13	CBM	25	1378	1024	1281	1370
547	P139126W	17-Sep-01	GST	42	N	75	W	23	NESW	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN FEDERAL 23S-11	CBM	25	1386	1007	1290	1376
548	P139129W	17-Sep-01	GST	42	N	75	W	24	SWNW	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN FEDERAL 24S-5	CBM	25	1252	1193	1168	1249
549	P139131W	17-Sep-01	GST	42	N	75	W	24	SWSW	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN FEDERAL 24S-13	CBM	25	1289	1179	1190	1282
550	P139128W	17-Sep-01	GSE	42	N	75	W	24	NENW	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN FEDERAL 24S-3	CBM					
551	P139130W	17-Sep-01	GSE	42	N	75	W	24	NESW	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN FEDERAL 24S-11	CBM					
552	P166070W	16-Mar-05	GSE	42	N	75	W	25	NENW	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN FEDERAL 25S-3	CBM					
553	P114379W	03-Mar-99	GST	42	N	75	W	26	NWSW	1) DEVON ENERGY CORP 2) MR. MARK IBERLIN, IBERLIN RANCH PARTNERSHIP	IBERLIN FED 26S-5	CBM	25	1281	840	1182	1270
554	P139273W	17-Sep-01	GST	42	N	75	W	27	SWNE	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN FEDERAL 27S-7	CBM	25	1131	483	1056	1110
555	P158671W	29-Apr-04	GST	42	N	75	W	27	SWSW	DEVON ENERGY PRODUCTION COMPANY, L.P.	IBERLIN 27S-13	CBM	25	1224	676	1127	1202
556	P158672W	29-Apr-04	GST	42	N	75	W	27	NESW	DEVON ENERGY PRODUCTION COMPANY, L.P.	IBERLIN 27S-11	CBM	25	1358	910	1270	1358
557	P158674W	29-Apr-04	GST	42	N	75	W	27	NENW	DEVON ENERGY PRODUCTION COMPANY, L.P.	IBERLIN 27S-3	CBM	25	1365	629	1269	1360
558	P139133W	17-Sep-01	GSE	42	N	75	W	27	SWNW	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN 27S-5	CBM					

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	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Type_Permit_No	Priority	Status	T	Dir_NS	R	Dir_EW	Sec	Qtrqtr	Applicant	Facility_Name	Uses	Yld_Act	Well Depth	Static Depth	Top Completion	Bottom Completion
559	P139274W	17-Sep-01	GSE	42	N	75	W	27	SWSE	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN FEDERAL 27S-15	CBM					
560	P139134W	17-Sep-01	GSI	42	N	75	W	27	NESW	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN 27S-11	CBM					
561	P158673W	29-Apr-04	GSI	42	N	75	W	27	SWNW	DEVON ENERGY PRODUCTION COMPANY, L.P.** Iberlin Ranch Ltd. Partnership	IBERLIN 27S-5	CBM					
562	P158669W	29-Apr-04	GST	42	N	75	W	28	SWSE	DEVON ENERGY PRODUCTION COMPANY, L.P.	IBERLIN 28S-15	CBM	25	1165	705	1086	1156
563	P158304W	27-Apr-04	GST	42	N	75	W	28	SWSW	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN 28S-13	CBM	25	1410	451	1310	1401
564	P139479W	24-Sep-01	GSE	42	N	75	W	28	NENE	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN FEDERAL 28S-1	CBM					
565	P139480W	24-Sep-01	GSE	42	N	75	W	28	NESE	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN 28S-9	CBM					
566	P158295W	27-Apr-04	GSE	42	N	75	W	28	NESW	IBERLIN RANCH PARTNERSHIP** DEVON ENERGY PRODUCTION COMPANY, L.P.	IBERLIN 28S-11	CBM					
567	P158670W	29-Apr-04	GSE	42	N	75	W	28	NESE	DEVON ENERGY PRODUCTION COMPANY, L.P.** Iberlin Ranch Ltd. Partnership	IBERLIN 28S-9	CBM					
568	P158302W	27-Apr-04	GST	42	N	75	W	32	SWNE	DEVON ENERGY PRODUCTION COMPANY, L.P.	IBERLIN 32S-7	CBM	25	1319	454	1266	1310
569	P158300W	27-Apr-04	GSE	42	N	75	W	32	SWSE	DEVON ENERGY PRODUCTION COMPANY, L.P.** Iberlin Ranch Ltd. Partnership	IBERLIN 32S-15	CBM					
570	P158301W	27-Apr-04	GSE	42	N	75	W	32	NESE	DEVON ENERGY PRODUCTION COMPANY, L.P.** Iberlin Ranch Ltd. Partnership	IBERLIN 32S-9	CBM					
571	P158303W	27-Apr-04	GSE	42	N	75	W	32	NENE	DEVON ENERGY PRODUCTION COMPANY, L.P.** Iberlin Ranch Ltd. Partnership	IBERLIN 32S-1	CBM					
572	P139475W	24-Sep-01	GSE	42	N	75	W	33	NENE	DEVON ENERGY PRODUCTION COMPANY, L.P.** WALKER CREEK LIVESTOCK CO.	WALKER CEEEK FEDERAL 33S-1	CBM					
573	P139476W	24-Sep-01	GSE	42	N	75	W	33	SWNE	DEVON ENERGY PRODUCTION COMPANY, L.P.** WALKER CREEK LIVESTOCK CO.	WALKER CEEEK FEDERAL 33S-7	CBM					
574	P139477W	24-Sep-01	GSE	42	N	75	W	33	NESE	DEVON ENERGY PRODUCTION COMPANY, L.P.** WALKER CREEK LIVESTOCK CO.	WALKER CEEEK FEDERAL 33S-9	CBM					
575	P139478W	24-Sep-01	GSI	42	N	75	W	33	SWSE	DEVON ENERGY PRODUCTION COMPANY, L.P.** WALKER CREEK LIVESTOCK CO.	WALKER CEEEK FEDERAL 33S-15	CBM					
576																	
577	Abandoned, Canceled or Rejected																
578	P54205W	29-Oct-80	A&C	42	N	74	W	18	NESE	WYOMING STATE HIGHWAY DEPARTMENT	PINE TREE #1	MIS	0	320	-1	Unknown	Unknown
579	P44481W	31-Jul-78	ABA	42	N	74	W	17	NWNW	WYOMING STATE HIGHWAY DEPARTMENT	PINE TREE #3	IND	0	400	-1	Unknown	Unknown
580	P44480W	31-Jul-78	ABA	42	N	75	W	26	NENE	WYOMING STATE HIGHWAY DEPARTMENT	PINE TREE #2	IND	0	400	-1	Unknown	Unknown

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1	Type_Permit_No	Priority	Status	T	Dir_NS	R	Dir_EW	Sec.	Qtrqtr.	Applicant	Facility_Name	Uses	Yld_Act	Well Depth	Static Depth	Top Completion	Bottom Completion
581	P44479W	31-Jul-78	ABA	42	N	75	W	33	SWNW	WYOMING STATE HIGHWAY DEPARTMENT	PINETREE #1	IND	0	400	-1	Unknown	Unknown
582	P9934W	09-Aug-71	ABA	42	N	75	W	33	NWSE	CONTINENTAL OIL CO.	UM-1575 1-33-42-75	DOM		-1	-1	185	205
583	P139462W	24-Sep-01	CAN	41	N	75	W	2	NENE	DEVON ENERGY PRODUCTION COMPANY, L.P.** WALKER CREEK LIVESTOCK CO.	WALKER FEDERAL 2S-1	CBM					
584	P139463W	24-Sep-01	CAN	41	N	75	W	2	NENW	DEVON ENERGY PRODUCTION COMPANY, L.P.** WALKER CREEK LIVESTOCK CO.	WALKER FEDERAL 2S-3	CBM					
585	P139464W	24-Sep-01	CAN	41	N	75	W	2	SWNW	DEVON ENERGY PRODUCTION COMPANY, L.P.** WALKER CREEK LIVESTOCK CO.	WALKER FEDERAL 2S-5	CBM					
586	P139465W	24-Sep-01	CAN	41	N	75	W	2	SWNE	DEVON ENERGY PRODUCTION COMPANY, L.P.** WALKER CREEK LIVESTOCK CO.	WALKER FEDERAL 2S-7	CBM					
587	P139466W	24-Sep-01	CAN	41	N	75	W	2	NESE	DEVON ENERGY PRODUCTION COMPANY, L.P.** WALKER CREEK LIVESTOCK CO.	WALKER FEDERAL 2S-9	CBM					
588	P139467W	24-Sep-01	CAN	41	N	75	W	2	NESW	DEVON ENERGY PRODUCTION COMPANY, L.P.** WALKER CREEK LIVESTOCK CO.	WALKER FEDERAL 2S-11	CBM					
589	P139468W	24-Sep-01	CAN	41	N	75	W	2	SWSW	DEVON ENERGY PRODUCTION COMPANY, L.P.** WALKER CREEK LIVESTOCK CO.	WALKER FEDERAL 2S-13	CBM					
590	P60168W	21-May-80	CAN	41	N	75	W	2	NWNE	CONOCO INC.	CONOCO SR 5	IND,MIS					
591	P60169W	21-May-80	CAN	41	N	75	W	2	NESE	CONOCO INC.	CONOCO SR 6	IND,MIS					
592	P60170W	21-May-80	CAN	41	N	75	W	2	NWSE	CONOCO INC.	CONOCO SR 7	IND,MIS					
593	P114088W	17-Feb-99	CAN	41	N	75	W	3	NENE	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN RANCH FED 3S-1	STO,CBM					
594	P114388W	03-Mar-99	CAN	41	N	75	W	3	NWNE	1) DEVON ENERGY CORP 2) WALKER CREEK LIVESTOCK	WALKER FED 3S-2	STO,CBM					
595	P114393W	03-Mar-99	CAN	41	N	75	W	3	SENE	1) DEVON ENERGY CORP 2) WALKER CREEK LIVESTOCK	WALKER FED 3S-8	STO,CBM					
596	P60171W	21-May-80	CAN	41	N	75	W	3	NESE	CONOCO INC.	CONOCO SR 8	IND,MIS					
597	P59810W	09-Nov-81	CAN	41	N	75	W	4	SESW	WOODS PETROLEUM CORPORATION**USDI, BLM	PINE TREE UNIT #4-40	MIS	100	1500	170	Unknown	Unknown
598	P58663W	22-Sep-81	CAN	41	N	75	W	5	SWNE	WOODS PETROLEUM CORPORATION**USDI, BLM	PINE TREE UNIT #5-31	MIS					
599	P115381W	22-Apr-99	CAN	41	N	75	W	6	SWNW	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN FEDERAL 6S-5	STO,CBM					
600	P115389W	22-Apr-99	CAN	41	N	75	W	6	NENW	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN RANCH FEDERAL 6S-3	STO,CBM					
601	P59277W	31-Jul-81	CAN	41	N	75	W	8	SWNW	LTD TAYLOR RANCH CO	PINE TREE UNIT #8 18	STO	25	800	85	Unknown	Unknown
602	P59330W	06-Jan-82	CAN	41	N	75	W	9	NWSW	BILL MOORE	PINE TREE UNIT #9-42	STO					
603	P56841W	19-Mar-81	CAN	41	N	75	W	12	NWSE	DAVIS OIL COMPANY** W. I. MOORE RANCH	MARION HARRIS #2	MIS					
604	P52841W	30-Jun-80	CAN	41	N	75	W	13	NESE	DAVIS OIL COMPANY	MARION HARRIS #1	MIS	100	635	10	420	605
605	P66437W	06-Feb-84	CAN	41	N	75	W	13	NESE	NINE MILE LAND CO.	MOORE #1	STO					
606	P30534W	17-Jul-75	CAN	41	N	75	W	14	NESW	WOODS PETROLEUM CORPORATION	CROSSROAD UNIT II WELL #1	TEM,IND,DRI					
607	P59809W	06-Nov-81	CAN	41	N	75	W	16	SWNW	WY BOARD OF LAND COMMISSIONERS**WOODS PETROLEUM CORPORATION	PINE TREE UNIT #16 43	MIS					
608	P59811W	09-Nov-81	CAN	41	N	75	W	16	SESW	WY BOARD OF LAND COMMISSIONERS**WOODS PETROLEUM CORPORATION	PINE TREE UNIT #16-44	MIS	140	860	170	Unknown	Unknown

Addendum Table 3.4.A. Water Well Rights Within Two Miles of the Moore Ranch Permit Area (Revised June 2009)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Type_Permit_No	Priority	Status	T	Dir_NS	R	Dir_EW	Sec.	Qtrqtr	Applicant	Facility_Name	Uses	Yld_Act	Well Depth	Static Depth	Top Completion	Bottom Completion
609	P136056W	15-Jun-01	CAN	41	N	75	W	21	NENE	DEVON ENERGY PRODUCTION COMPANY, L.P.	STATE WI MOORE 16S-9	STO,CBM					
610	P136059W	15-Jun-01	CAN	41	N	75	W	21	NENE	DEVON ENERGY PRODUCTION COMPANY, L.P.** WY STATE BOARD OF LAND COMMISSIONERS	STATE WI MOORE 16S-16	STO,CBM					
611	P33971W	11-Jun-76	CAN	41	N	75	W	21	NWSE	WOODS PETROLEUM CORPORATION	WOODS PINE TREE UNIT #21-2	TEM,MIS,DRI	60	700	200	460	700
612	P48349W	04-Jun-79	CAN	41	N	75	W	21	NWSE	WOODS PETROLEUM CORPORATION	PINE TREE UNIT #28 7	MIS	60	700	200	460	700
613	P67892W	28-Jun-84	CAN	41	N	75	W	21	NWSE	WOODS PETROLEUM CORPORATION** OGALLALA LAND COMPANY	PINE TREE UNIT #21 2	MIS	60	700	200	460	700
614	P30522W	11-Jul-75	CAN	41	N	75	W	23	NWNW	WOODS PETROLEUM CORPORATION	RALPH FRYE GOVT. #1	TEM,IND,DRI					
615	P115960W	17-May-99	CAN	42	N	74	W	17	NWNW	THUNDER CREEK LLC	PINE TREE WELL #1	MIS					
616	P54508W	29-Jul-80	CAN	42	N	74	W	19	NENE	THE CLEVELAND-CLIFFS IRON COMPANY	DW - 9U	MON	0	368	223	332	368
617	P54509W	29-Jul-80	CAN	42	N	74	W	19	NENE	THE CLEVELAND-CLIFFS IRON COMPANY	DW - 9M	MON	0	530	246	410	529
618	P54510W	29-Jul-80	CAN	42	N	74	W	19	NENE	THE CLEVELAND-CLIFFS IRON COMPANY	DW - 9L	MON	0	640	238	550	641
619	P63583W	06-Apr-83	CAN	42	N	74	W	19	NENE	2-BAR RANCH COMPANY	PINE TREE 9 LOWER	STO					
620	P63584W	06-Apr-83	CAN	42	N	74	W	19	NENE	2-BAR RANCH COMPANY	PINE TREE 9 MIDDLE	STO					
621	P63585W	06-Apr-83	CAN	42	N	74	W	19	NENE	2-BAR RANCH COMPANY	PINETREE 9 UPPER	STO					
622	P130610W	31-Oct-00	CAN	42	N	74	W	31	NESW	DEVON ENERGY PROD. CO., L.P. 2** WY STATE BOARD OF LAND COMMISSIONERS	STATE ARCHIBALD 31S-11	CBM					
623	P28590W	18-Oct-74	CAN	42	N	74	W	33	SWSE	PINE TREE RANCH CO.	ENL PINE TREE #8	IND	100	210	95	Unknown	Unknown
624	P31473W	19-Nov-75	CAN	42	N	75	W	14	SESE	WOODS PETROLEUM CORPORATION**INC. TAYLOR RANCH COMPANY	TAYLOR BLISS #1	IND,MIS,DRI	40	500	100	380	460
625	P111628W	28-Aug-98	CAN	42	N	75	W	16	NWSE	WYO BOARD OF LAND COMMISSIONERS** YATES PETROLEUM CORP.	Collins Draw CS State #1	STO,CBM					
626	P112352W	05-Oct-98	CAN	42	N	75	W	16	NWSE	WYO BOARD OF LAND COMMISSIONERS** YATES PETROLEUM CORP.	Enl Collins Draw CS State #1	STO,CBM					
627	P59466W	08-Feb-82	CAN	42	N	75	W	20	NESE	T-CHAIR LIVESTOCK CO.	HOPE #1	MIS					
628	P33496W	25-May-76	CAN	42	N	75	W	21	SWNE	WOODS PETROLEUM CORPORATION	PINE TREE UNIT #8 1	TEM,IND,DRI	50	800	130	360	620
629	P54505W	29-Jul-80	CAN	42	N	75	W	22	NENW	THE CLEVELAND-CLIFFS IRON COMPANY	DW - 8U	MON	0	421	266	354	413
630	P54506W	29-Jul-80	CAN	42	N	75	W	22	NENW	THE CLEVELAND-CLIFFS IRON COMPANY	DW - 8M	MON	0	534	259	439	531
631	P54507W	29-Jul-80	CAN	42	N	75	W	22	NENW	THE CLEVELAND-CLIFFS IRON COMPANY	DW - 8L	MON	0	722	270	636	720
632	P114090W	17-Feb-99	CAN	42	N	75	W	25	NWNW	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN FED 25S-4	STO,CBM					
633	P114091W	17-Feb-99	CAN	42	N	75	W	25	SENW	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN FED 25S-6	STO,CBM					
634	P114092W	17-Feb-99	CAN	42	N	75	W	25	NWSW	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN FED 25S-12	STO,CBM					
635	P114093W	17-Feb-99	CAN	42	N	75	W	25	SESW	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN FED 25S-14	STO,CBM					

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	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Type_Permit_No	Priority	Status	T	Dir_NS	R	Dir_EW	Sec	Qtrqtr	Applicant	Facility_Name	Uses	Yld_Act	Well Depth	Static Depth	Top Completion	Bottom Completion
636	P114383W	03-Mar-99	CAN	42	N	75	W	25	SWSE	1) DEVON ENERGY CORP 2) MR. MARK IBERLIN, IBERLIN RANCH PARTNERSHIP	IBERLIN 25S-15	STO,CBM					
637	P114384W	03-Mar-99	CAN	42	N	75	W	25	NESE	1) DEVON ENERGY CORP 2) MR. MARK IBERLIN, IBERLIN RANCH PARTNERSHIP	IBERLIN 25S-9	STO,CBM					
638	P114385W	03-Mar-99	CAN	42	N	75	W	25	SWNE	1) DEVON ENERGY CORP 2) MR. MARK IBERLIN, IBERLIN RANCH PARTNERSHIP	IBERLIN 25S-7	STO,CBM					
639	P114386W	03-Mar-99	CAN	42	N	75	W	25	NENE	1) DEVON ENERGY CORP 2) MR. MARK IBERLIN, IBERLIN RANCH PARTNERSHIP	IBERLIN 25S-1	STO,CBM					
640	P72760W	17-Jun-86	CAN	42	N	75	W	25	SWNE	W. A. MONCRIEF, JR.	TRANSCO 25 1	MIS	40	780	150	525	760
641	P114094W	17-Feb-99	CAN	42	N	75	W	26	NWNW	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN FED 26S-4	STO,CBM					
642	P114095W	17-Feb-99	CAN	42	N	75	W	26	SENW	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN FED 26S-6	STO,CBM					
643	P114096W	17-Feb-99	CAN	42	N	75	W	26	NWSW	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN FED 26S-12	STO,CBM					
644	P114097W	17-Feb-99	CAN	42	N	75	W	26	SESW	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN FED 26S-14	STO,CBM					
645	P51780W	14-Apr-80	CAN	42	N	75	W	26	NWSW	BIG HORN CONSTRUCTION CO.** WYOMING STATE HIGHWAY DEPT.	BIG HORN CONST TEST WELL #1	MON					
646	P52996W	07-Jul-80	CAN	42	N	75	W	26	NENE	BIG HORN CONSTRUCTION CO.** WYOMING HIGHWAY DEPT.	BIG HORN CONST #2	MIS					
647	P54847W	24-Nov-80	CAN	42	N	75	W	26	NWSW	WYOMING STATE HIGHWAY DEPARTMENT	BIG HORN CONST #1	MIS	100	1140	80	Unknown	Unknown
648	P54848W	24-Nov-80	CAN	42	N	75	W	26	NENE	WYOMING HIGHWAY DEPARTMENT	BIG HORN CONST #2	MIS	25	750	200	Unknown	Unknown
649	P54874W	16-Dec-80	CAN	42	N	75	W	26	SENW	WOODS PETROLEUM CORPORATION	ENL TAYLOR 56-1	MIS					
650	P60164W	21-May-80	CAN	42	N	75	W	26	SESE	CONOCO INC.	CONOCO SR 1	IND,MIS					
651	P67949W	09-Jul-84	CAN	42	N	75	W	26	NWSW	WYOMING STATE HIGHWAY DEPT.	BIG HORN CONST. #1	MIS	100	1140	80	Unknown	Unknown
652	P67950W	09-Jul-84	CAN	42	N	75	W	26	NENE	WYOMING STATE HIGHWAY DEPT.	BIG HORN CONST. #2	MIS	25	750	200	Unknown	Unknown
653	P79077W	25-Jan-89	CAN	42	N	75	W	26	NWSW	WYOMING STATE HIGHWAY DEPARTMENT	BIG HORN CONST #1	MIS	100	1140	80	Unknown	Unknown
654	P79078W	25-Jan-89	CAN	42	N	75	W	26	NENE	WYOMING STATE HIGHWAY DEPARTMENT	BIG HORN CONST #2	MIS	25	750	200	Unknown	Unknown
655	P114098W	17-Feb-99	CAN	42	N	75	W	27	NWNE	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN FED 27S-2	STO,CBM					
656	P114099W	17-Feb-99	CAN	42	N	75	W	27	SENE	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN FED 27S-8	STO,CBM					
657	P114100W	17-Feb-99	CAN	42	N	75	W	27	NWSE	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN FED 27S-10	STO,CBM					
658	P114101W	17-Feb-99	CAN	42	N	75	W	27	SWSW	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN FED 27S-16	STO,CBM					
659	P139132W	17-Sep-01	CAN	42	N	75	W	27	NENW	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN 27S-3	CBM					
660	P139135W	17-Sep-01	CAN	42	N	75	W	27	SWSW	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN 27S-13	CBM					

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1	Type_Permit_No	Priority	Status	T	Dir_NS	R	Dir_EW	Sec.	Qtrqtr	Applicant	Facility_Name	Uses	Yld_Act	Well Depth	Static Depth	Top Completion	Bottom Completion
661	P139481W	24-Sep-01	CAN	42	N	75	W	28	SWSE	DEVON ENERGY PRODUCTION COMPANY, L.P.** IBERLIN RANCH PARTNERSHIP	IBERLIN 28S-15	CBM					
662	P115378W	22-Apr-99	CAN	42	N	75	W	30	SWSW	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN FEDERAL 30S-13	STO,CBM					
663	P115382W	22-Apr-99	CAN	42	N	75	W	30	NESW	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN FEDERAL 30S-11	STO,CBM					
664	P115379W	22-Apr-99	CAN	42	N	75	W	31	SWNW	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN FEDERAL 31S-5	STO,CBM					
665	P115380W	22-Apr-99	CAN	42	N	75	W	31	NWSW	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN FEDERAL 31S-12	STO,CBM					
666	P115383W	22-Apr-99	CAN	42	N	75	W	31	NENE	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN FEDERAL 31S-1	STO,CBM					
667	P115384W	22-Apr-99	CAN	42	N	75	W	31	NENW	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN FEDERAL 31S-3	STO,CBM					
668	P115385W	22-Apr-99	CAN	42	N	75	W	31	SWNE	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN FEDERAL 31S-7	STO,CBM					
669	P115386W	22-Apr-99	CAN	42	N	75	W	31	NESE	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN FEDERAL 31S-9	STO,CBM					
670	P115387W	22-Apr-99	CAN	42	N	75	W	31	NESW	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN FEDERAL 31S-11	STO,CBM					
671	P115388W	22-Apr-99	CAN	42	N	75	W	31	SWSE	DEVON ENERGY CORP.** IBERLIN RANCH PARTNERSHIP	IBERLIN FEDERAL 31S-15	STO,CBM					
672	P59168W	24-Nov-81	CAN	42	N	75	W	32	NENE	TAYLOR RANCH CO. LTD.	PINE TREE UNIT #32 45	STO	25	1300	400	Unknown	Unknown
673	P114373W	03-Mar-99	CAN	42	N	75	W	34	SENE	1) DEVON ENERGY CORP 2) MR. MARK IBERLIN, IBERLIN RANCH PARTNERSHIP	IBERLIN FED 34S-8	STO,CBM					
674	P60172W	05-Dec-80	CAN	42	N	75	W	34	SWNE	SEQUOYAH FUELS CORPORATION	PIT 34	IND,MIS					
675	P114103W	17-Feb-99	CAN	42	N	75	W	35	NWNE	DEVON ENERGY CORP.** WALKER CREEK LIVESTOCK CO.	WALKER CREEK FED 35S-2	STO,CBM					
676	P114104W	17-Feb-99	CAN	42	N	75	W	35	SENE	DEVON ENERGY CORP.** WALKER CREEK LIVESTOCK CO.	WALKER CREEK FED 35S-8	STO,CBM					
677	P114105W	17-Feb-99	CAN	42	N	75	W	35	NESE	DEVON ENERGY CORP.** WALKER CREEK LIVESTOCK CO.	WALKER CREEK FED 36S-9	STO,CBM					
678	P114389W	03-Mar-99	CAN	42	N	75	W	35	SESE	1) DEVON ENERGY CORP 2) WALKER CREEK LIVESTOCK	WALKER CREEK FED 35S-16	STO,CBM					
679	P114390W	03-Mar-99	CAN	42	N	75	W	35	NWSE	1) DEVON ENERGY CORP 2) WALKER CREEK LIVESTOCK	WALKER CREEK FED 35S-10	STO,CBM					
680	P114392W	03-Mar-99	CAN	42	N	75	W	35	NENW	1) DEVON ENERGY CORP 2) WALKER CREEK LIVESTOCK	WALKER CREEK FED 35S-3	STO,CBM					
681	P114396W	03-Mar-99	CAN	42	N	75	W	35	SESW	1) DEVON ENERGY CORP 2) WALKER CREEK LIVESTOCK	WALKER CREEK 35S-14	STO,CBM					
682	P60165W	21-May-80	CAN	42	N	75	W	35	NENE	CONOCO INC.	CONOCO SR 2	IND,MIS					
683	P60166W	21-May-80	CAN	42	N	75	W	35	NESE	CONOCO INC.	CONOCO SR 3	IND,MIS					
684	P60167W	21-May-80	CAN	42	N	75	W	35	SESE	CONOCO INC.	CONOCO SR 4	IND,MIS					
685	P60173W	05-Dec-80	CAN	42	N	75	W	35	SWNE	SEQUOYAH FUELS CORPORATION	PIT 35N	IND,MIS					
686	P60174W	05-Dec-80	CAN	42	N	75	W	35	SWSW	KERR-MCGEE NUCLEAR CORPORATION	PIT 35S	IND,MIS					
687	P114394W	03-Mar-99	CAN	42	N	75	W	36	NENE	1) DEVON ENERGY CORP 2) STATE BOARD OF LAND COMMISSIONERS	WALKER CREEK ST 36S-1	STO,CBM					

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1	Type_Permit_No	Priority	Status	T	Dir_NS	R	Dir_EW	Sec	Qtrqtr	Applicant	Facility_Name	Uses	Yld_Act	Well Depth	Static Depth	Top Completion	Bottom Completion
688	P114395W	03-Mar-99	CAN	42	N	75	W	36	SWNE	1) DEVON ENERGY CORP 2) STATE BOARD OF LAND COMMISSIONERS	WALKER CREEK ST 36S-7	STO,CBM					
689	32/1/413W	11-Sep-01	REJ	42	N	75	W	25	NENW	DEVON ENERGY PRODUCTION COMPANY, L.P.	IBERLIN FEDERAL 25S-3	CBM					
690	32/2/413W	11-Sep-01	REJ	42	N	75	W	25	SWNW	DEVON ENERGY PRODUCTION COMPANY, L.P.	IBERLIN FEDERAL 25S-5	CBM					
691	32/3/413W	11-Sep-01	REJ	42	N	75	W	25	NESW	DEVON ENERGY PRODUCTION COMPANY, L.P.	IBERLIN FEDERAL 25S-11	CBM					
692	32/4/413W	11-Sep-01	REJ	42	N	75	W	25	SWSW	DEVON ENERGY PRODUCTION COMPANY, L.P.	IBERLIN FEDERAL 25S-13	CBM					
693	32/5/413W	11-Sep-01	REJ	42	N	75	W	26	NENW	DEVON ENERGY PRODUCTION COMPANY, L.P.	IBERLIN FEDERAL 26S-3	CBM					
694	32/6/413W	11-Sep-01	REJ	42	N	75	W	26	SWNW	DEVON ENERGY PRODUCTION COMPANY, L.P.	IBERLIN FEDERAL 26S-5	CBM					
695	32/7/413W	11-Sep-01	REJ	42	N	75	W	26	NESW	DEVON ENERGY PRODUCTION COMPANY, L.P.	IBERLIN FEDERAL 26S-11	CBM					
696	32/8/413W	11-Sep-01	REJ	42	N	75	W	26	SWSW	DEVON ENERGY PRODUCTION COMPANY, L.P.	IBERLIN FEDERAL 26S-13	CBM					
697	32/10/413W	11-Sep-01	REJ	42	N	75	W	27	NESE	DEVON ENERGY PRODUCTION COMPANY, L.P.	IBERLIN FEDERAL 27S-9	CBM					
698	32/9/413W	11-Sep-01	REJ	42	N	75	W	27	NENE	DEVON ENERGY PRODUCTION COMPANY, L.P.	IBERLIN FEDERAL 27S-1	CBM					
699	32/1/414W	11-Sep-01	REJ	42	N	75	W	34	SWNE	DEVON ENERGY PRODUCTION COMPANY, L.P.	IBERLIN FEDERAL 34S-7	CBM					
700	32/2/414W	11-Sep-01	REJ	42	N	75	W	35	NENE	DEVON ENERGY PRODUCTION COMPANY, L.P.	WALKER CREEK FEDERAL 35S-1	CBM					
701	32/3/414W	11-Sep-01	REJ	42	N	75	W	35	SWNE	DEVON ENERGY PRODUCTION COMPANY, L.P.	WALKER CREEK FEDERAL 35S-7	CBM					
702	32/4/414W	11-Sep-01	REJ	42	N	75	W	35	NESE	DEVON ENERGY PRODUCTION COMPANY, L.P.	WALKER CREEK FEDERAL 35S-9	CBM					