SAFETY EVALUATION REPORT

License Renewal of the Willow Creek Uranium In Situ Recovery Project Johnson and Campbell Counties, Wyoming, Materials License No. SUA-1341

Docket No. 040-08502
URANIUM ONE USA, INC.

U.S. Nuclear Regulatory Commission

Office of Federal and State Materials and Environmental Management Programs

March 2013

CONTENTS

FIGURES

TABLES

ACRONYMS/ABBREVIATIONS

ADAMS	Agencywide Documents Access and Management System
AEA	Atomic Energy Act of 1954, as amended
AEC	U.S. Atomic Energy Commission
ALARA	As Low As Is Reasonably Achievable
ANSI	American National Standards Institute
ARMZ	JSC Atomredmetzoloto
BLM	Bureau of Land Management
CBM	Coal Bed Methane
CFR	Code of Federal Regulations
CPP	Central Processing Plant
COGEMA	COGEMA Mining, Inc.
DAC	Derived Air Concentration
EA	Environmental Assessment
EPA	Environmental Protection Agency
ES	Environmental Statement
FITC	Fuel International Trading Company
HPT	Health Physics Technician
ISR	In Situ Recovery
IX	Ion Exchange
LLD	Lower Limits of Detection
LRA	License Renewal Application
MDC	Minimum Detectable Concentration
MIT	Mechanical Integrity Test
MU	Mine Unit
NRC	U.S. Nuclear Regulatory Commission
PRI	Power Resources, Inc.
QA	Quality Assurance
R&D	Research and Development
RAI	Request for Additional Information
RO	Reverse Osmosis
RSO	Radiation Safety Officer
RST	Radiation Safety Technician
SER	Safety Evaluation Report
SERP	Safety and Environmental Review Panel
SOP	Standard Operating Procedure
SPCC	Spill Prevention, Control and Countermeasures
TEDE	Total Effective Dose Equivalent
TLD	Thermoluminescent Dosimeter
Uranium One	Uranium One USA, Inc.
WDEQ	Wyoming Department of Environmental Quality
WMC	Wyoming Mineral Corporation
WSEO	Wyoming State Engineers Office
WYOGCC	Wyoming Oil and Gas Conservation Commission
WYPDES	Wyoming Pollutant Discharge Elimination System

INTRODUCTION

On May 30, 2008, COGEMA Mining, Inc. (COGEMA) submitted a License Renewal Application (LRA) to the U.S. Nuclear Regulatory Commission (NRC) for the continuation of operations at the Irigaray and Christensen Ranch uranium in situ recovery (ISR) Projects, located in Campbell and Johnson Counties, Wyoming (COGEMA, 2008c). COGEMA requested that the current license be approved for a period of 10 years. Subsequent to the LRA, the ownership of the projects changed twice, first from COGEMA to Uranium One, Inc. (NRC, 2009), and then from Uranium One, Inc. to JSC Atomredmetzoloto (ARMZ) (NRC, 2010b). The current licensee is Uranium One USA, Inc. (Uranium One), a subsidiary of Uranium One, Inc., which is a subsidiary of ARMZ. Uranium One refers to both the Irigaray and Christensen Ranch Projects as the Willow Creek Project. The Willow Creek Project is a uranium ISR project subject to the safety requirements found in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 40, "Domestic Licensing of Source Material," and 10 CFR Part 20, "Standards for Protection Against Radiation."

The NRC staff (staff) reviewed the licensee's LRA and relevant supporting materials as part of NRC's safety review of the existing Source Material License SUA–1341 (license). The NRC staff visited the Willow Creek Project in September 2008 to get first-hand information about site characteristics, operating procedures, and operating facilities. The staff also visited the site in October and December 2010 as part of an NRC inspection team for the restart of uranium recovery operations (NRC, 2010a). Since the restart of operations, the staff has inspected the Willow Creek Project as part of NRC regularly scheduled inspections (Safety Evaluation Report (SER) Table 1.1). This SER documents the NRC's review of the public health and safety aspects of the proposed uranium ISR operations at the Willow Creek Project. Additional information concerning the environmental aspects of the proposed renewal is contained in the accompanying Environmental Assessment (EA) and Supplemental EA for the license renewal of SUA–1341 (NRC, 2011b, 2013b). The EA was prepared to address environmental impacts of the proposed action in accordance with 10 CFR Part 51, which contains NRC's implementation regulations for the National Environmental Policy Act of 1969, as amended.

SITE HISTORY AND PROPOSED ACTIVITIES

The Irigaray Project was one of several research and development (R&D) sites in Wyoming and South Dakota. It was originally licensed under Source Materials License SUA-1204. The R&D license was issued by the NRC's predecessor, the U.S. Atomic Energy Commission (AEC), in 1974 to the Wyoming Mineral Corporation (WMC), a subsidiary of Westinghouse Electric Corporation (AEC, 1974). Under this license, WMC was licensed to perform research at two pilot sites at the Irigaray Project, which are referred to as site 517 and the 9AI or USMT site.

In 1978, WMC obtained Materials License SUA-1341 for commercial operations at the Irigaray Project from the NRC (NRC, 1978a). In 1982, the project was placed on standby status due to the depressed market for uranium. In addition, the R&D License SUA-1204 was terminated in 1982, provided that monitoring at the former R&D sites was continued under license SUA-1341. In 1987, Malapai Resources Company (Malapai), a subsidiary of Pinnacle West Capital Corporation, acquired Materials License SUA-1341 from WMC and resumed operations at the Irigaray Project.

During this period, the Christensen Ranch Project was being developed under R&D License SUA-1337, which was issued by NRC in 1978, to Western Nuclear, Inc., a subsidiary of J&P Corporation. In 1981, J&P Corporation sold its interest in the Christensen Ranch R&D Project to the Arizona Public Service Company (Malapai), and Western Nuclear, Inc. continued R&D as the designated licensee. In 1985, Malapai acquired all interests in the project from Western Nuclear, Inc. During this period, research had been performed at one location at the Christensen Ranch Project, the Willow Creek R&D site.

The Irigaray Project license SUA–1341 was renewed in March 1987 (NRC, 1987). In 1988, Malapai amended the Materials License SUA-1341 to include Christensen Ranch as a satellite to the Irigaray Project (NRC, 1988a). In 1989, the Christensen Ranch R&D License SUA-1337 was terminated.

In 1990, Pinnacle West Capital Corporation sold Malapai to Fuel International Trading Company (FITC), a subsidiary of Electricite de France, a French utility. FITC entered into an agreement with Total Minerals Corporation, another French company, as operator of the Malapai Wyoming Project. Malapai was sold to Electricite de France, a French nuclear utility company, in September 1990.

In 1993, a stock ownership transfer occurred which resulted in COGEMA becoming the licensee for the Irigaray and Christensen Ranch Project. COGEMA was a subsidiary of Cogema Resources, Inc., a subsidiary of Areva NC. In 2001, the Irigaray and Christensen Ranch Project went into restoration and decommissioning status due to the depressed price for uranium yellowcake.

COGEMA submitted a license amendment request to NRC on April 3, 2007 to revert from restoration and decommissioning status to operating (uranium production) status (COGEMA, 2007a). While NRC staff was reviewing the request for a return to operating status, COGEMA submitted an LRA on May 30, 2008, for SUA–1341 to continue uranium ISR operations at the Irigaray and Christensen Ranch Project (COGEMA, 2008c). COGEMA requested that the NRC approve the continuation of uranium ISR operations for an additional 10-year period, consistent with the past license renewal applications. COGEMA did not request any changes to its license. In the LRA, the licensee proposed to carry out all uranium recovery operations at the Christensen Ranch Project; while the Irigaray Project would be used for yellowcake processing and packaging (see SER Section 3.0 for details). NRC approved the request to return to operating status on September 30, 2008 (NRC, 2008).

In 2010, a stock ownership transfer occurred which resulted in COGEMA shares being purchased by Uranium One Exploration U.S.A., Inc., a subsidiary of Uranium One Americas, Inc., Uranium One Investments, Inc., and Uranium One, Inc., with Uranium One, Inc. being the ultimate parent company. This resulted in an indirect change of control of Materials License SUA-1341 from Areva NC to Uranium One, Inc. (NRC, 2009). On January 27, 2010, NRC was notified that name of the licensee would be changed from COGEMA to Uranium One USA, Inc. This was not a change of control, but simply a name change of the existing licensee, which remained a subsidiary of Uranium One, Inc. The NRC approved the name change on August 18, 2010. After the change of control of license SUA-1341 from AREVA to Uranium One, Inc., and the change of name to Uranium One, USA, Inc., another change of control from Uranium One, Inc., to ARMZ occurred on November 23, 2010 (NRC, 2010b). As a result of this change of control, the current licensee is Uranium One USA, Inc., a subsidiary of Uranium One, Inc., a subsidiary of ARMZ.

Although the Willow Creek Project was returned to operational status on September 30, 2008, the licensee could not operate the project until it was inspected by the NRC and approved for resumption of operations. NRC staff performed a series of pre-operational inspections that resulted in the approval of the restart of operations in December 2010 (NRC, 2010a). The Willow Creek Project has been in active operations since that time.

REVIEW SCOPE

The staff's safety review of the Willow Creek Project was performed using: NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications," (standard review plan or NUREG-1569); the regulations at 10 CFR Part 40, Appendix A, "Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material from Ores Processed Primarily for Their Source Material Content;" and the regulations at 10 CFR Part 20, "Standards for Protection Against Radiation."

This SER reviews the licensee's site operations and performance, new information and proposed changes, and license amendments since the last license renewal, following the review procedures given in the standard review plan, Appendix A. (NRC, 2003). This SER generally addresses the first six chapters of the standard review plan, i.e., proposed activities, site characterization, description of the project, effluent control systems, operations, and ground water quality restoration, surface reclamation and project decommissioning. The NRC's Environmental Assessment for the renewal of SUA–1341 (NRC, 2010) addresses the remaining chapters of the standard review plan, i.e., environmental effects, alternatives, cost-benefit analysis, and environmental approvals and consultations.

The Atomic Energy Act of 1954, as amended (AEA), authorizes the NRC to issue licenses for the possession and use of source material and byproduct material. The NRC must license facilities, including ISR operations, in accordance with NRC regulatory requirements to protect public health and safety from radiological hazards. In accordance with 10 CFR 40.32, "General Requirements for Issuance of Specific Licenses," the NRC staff is required to make the following safety findings when issuing an ISR license:

- The application is for a purpose authorized by the AEA.
- The applicant is qualified by reason of training and experience to use the source material for the purpose requested in such a manner as to protect health and minimize danger to life or property.
- The applicant's proposed equipment, facilities, and procedures are adequate to protect health and minimize danger to life or property.
- The issuance of the license will not be inimical to the common defense and security or to the health and safety of the public.

Accordingly, NRC's license renewal review focuses on the licensee's record of fulfilling the commitments made during past licensing reviews upon which the NRC based its original safety findings. The information reviewed in previous SERs is not the focus of this review. The NRC staff will focus on licensee's operations and areas where additional safety concerns are identified by NRC staff. The NRC safety review of the LRA included evaluations of: (i) the license renewal application (COGEMA, 2008c); (ii) supplementary information and page

changes submitted by both COGEMA and Uranium One (COGEMA, 2008a, 2009a, Uranium One, 2010a, 2012c, 2012b); (iii) semiannual environmental monitoring reports the licensee submitted since the previous license renewal; and (iv) NRC inspection reports generated since the previous license renewal.

The licensee has provided a summary of proposed changes and a record of amendments since the last license renewal (COGEMA, 2008c). In responses to comments and requests for additional information (RAI) from the NRC staff, the licensee also provided page changes to the LRA by letters dated October 31, 2008 (COGEMA, 2008a), July 17, 2009 (COGEMA, 2009a), November 19, 2010 (Uranium One, 2010a), March 7, 2012 (Uranium One, 2012c) and July 10, 2012 (Uranium One, 2012b). The original LRA (COGEMA, 2008c) and replacement pages (COGEMA, 2008a; 2009a; Uranium One, 2010a, 2012c, 2012b) are collectively referred to as the LRA in this SER.

Because COGEMA submitted a license renewal application on May 30, 2008, the existing Uranium One license is in timely renewal and will remain so until a decision is made by the NRC on the LRA in accordance with 10 CFR 40.42(a). The renewal period begins at the time of the NRC staff approval of the application. In addition to the responses to RAIs, this safety evaluation incorporates the staff review of actions completed during the intervening period since the LRA was initially submitted.

The NRC staff review of the Willow Creek LRA identified a number of project specific issues that require additional or modified license conditions to ensure that the operation of the project is adequately protective of public health and safety. SER Table I.1 includes the license condition language and the section of this SER where the regulatory need for a license condition or modification has been identified. The current license conditions in SUA-1341 have not been deleted or modified unless noted in Table I.1 and the SER. Some minor clarification, punctuation or numbering changes have been made to license conditions that are not reflected in the SER. For example the term 11e.(2) was clarified to the term AEA 11e.2 and some renumbering of license conditions occurred due to deletion of one condition. The staff concludes that the findings described in succeeding sections of this SER, including the necessary license conditions, support the renewal of this license for a period of 10 years. By email dated January 23, 2013 (Uranium One, 2013b), the licensee accepted the license conditions described in this SER and in a draft license issued to the licensee dated January 17, 2013 (NRC, 2013a).

Table I.1

License Conditions

SER Section	Number	License Condition
1.4	9.3	The licensee shall conduct operations in accordance with the commitments, representations, and statements contained in the following: • License Renewal Application (LRA), May 30, 2008, NRC Agencywide Documents Access and Management System (ADAMS) Accession Package Number ML081850689 • LRA Revision, October 31, 2008, ADAMS Accession Number ML083110405

Table I.1 License Conditions		
		• LRA Revision, July 17, 2009, ADAMS Accession Package Number ML092110700 • LRA Revision, November 19, 2010, ADAMS Accession Number ML103280266. • LRA Revision, March 7, 2012, ADAMS Accession Package Number ML120820095. • LRA Revision, July 10, 2012, ADAMS Accession Number ML12206A436. • Response to Confirmatory Action Letter, September 21, 2012, ADAMS Accession Number ML12268A270 The approved license renewal application is hereby incorporated by reference except where superseded by license conditions below. The land and structures will be decommissioned according to the Decommissioning Plan submitted December 19, 2000 (ADAMS Accession No. ML003781238), as revised by submittals dated June 15, 2001 (ADAMS Accession No. ML011700655), June 18, 2011 (ADAMS Accession No. ML011710035), and August 31, 2001 (ADAMS Accession No. ML012490112) and in accordance with 10 CFR 40.42. Whenever the word "will" is used in the above referenced documents, it shall denote a requirement.
2.2.4	9.15	The licensee shall review and compare the data collected from a regional weather station during the same period as the onsite meteorological data collected to the long-term data collected from the same regional weather station. The licensee shall determine if the data collected onsite is representative of long-term conditions. Justification of the similarity or validity of the data will include analysis of the statistical data presented to illustrate confidence in the representativeness of the data. The meteorological data will include wind speed, wind direction, an annual wind rose, and a summary of the stability classification. The licensee shall submit this review and comparison to NRC within 6 months of license renewal for NRC review and written verification that the onsite meteorological parameters previously collected will allow the licensee to demonstrate compliance with regulatory requirements of 10 CFR Part 20.
2.4.4	11.8	The licensee shall identify the location of any new ground water wells or new use of existing wells, where the information is publicly available and/or known to the licensee, that are located within the license area and within 2 kilometers of any production area monitoring ring wells. The licensee shall also report publicly available information such as well depth, screen depth and estimated pumping rate. The licensee shall evaluate the impact of ISR operations on

Table I.1 License Conditions		
		ground water wells and recommend any additional monitoring or other measures to protect ground water users. The evaluation shall be submitted as part of the annual reporting to the NRC.
3.1.4	10.2	Mechanical integrity testing is required prior to returning to service any injection well suspected of having subsurface damage due to unusual operating conditions or unusual natural phenomenon.
3.1.4	10.14	The licensee will analyze any material not normally associated with the uranium recovery process (e.g., scrubber solids) for compatibility (e.g., chemical and mechanical) with the uranium recovery process prior to processing that material to recover residual uranium.
3.1.4	10.5	The licensee is authorized to conduct operations at a maximum flow rate of 9,000 gallons per minute, exclusive of restoration flow. Annual dried yellowcake production shall not exceed 2.5 million pounds.
4.1.4	10.8	Parameters that determine efficiency of yellowcake stack emission control must be identified and these parameters must be checked and logged hourly. If automated systems are used to satisfy the checking and logging requirements, the licensee must demonstrate in its SOPs [Standard Operating Procedures] how the automated system will meet the hourly requirement. In addition, the licensee must identify the type and locations of human interfaces (alarms, lights, and monitoring stations), how and what frequency the operability of emission control systems are tested and recorded, and, in the case of inoperability, how shutdown is initiated (manually or automatically).
4.2.3.1	10.7	Additionally, the licensee is authorized to dispose of process solution, injection bleed, and restoration brine in the flowing wells: Christensen Ranch DW No. 1 Christensen Ranch 18-3 Christensen Ranch DW No. 2 Christensen Ranch DW No. 3
5.2.4	9.4	Change, Test and Experiment License Condition a) The licensee may, without obtaining a license amendment pursuant to 10 CFR 40.44, and subject to conditions specified in paragraph (b) of this condition: i Make changes in the project as described in the license application (as updated); and ii Make changes in the procedures as described in the license application (as updated); and

Table I.1 License Conditions		
		iii Conduct tests or experiments not described in the license application (as updated). b) The licensee shall obtain a license amendment pursuant to 10 CFR 40.44 prior to implementing a proposed change, test, or experiment if the change, test, or experiment would: i Result in more than a minimal increase in the frequency of occurrence of an accident previously evaluated in the license application (as updated); ii Result in more than a minimal increase in the likelihood of occurrence of a malfunction of a project structure, equipment, or monitoring system (SEMS) important to safety previously evaluated in the license application (as updated); iii Result in more than a minimal increase in the consequences of an accident previously evaluated in the license application (as updated); iv Result in more than a minimal increase in the consequences of a malfunction of an SEMS previously evaluated in the license application (as updated); v Create a possibility for an accident of a different type than any previously evaluated in the license application (as updated); vi Create a possibility for a malfunction of an SEMS with a different result than previously evaluated in the license application (as updated); vii Result in a departure from the method of evaluation described in the license application (as updated) used in establishing the final safety evaluation report (FSER), environmental statement (ES), environmental assessment (EA) or technical evaluation reports (TERs) or other analyses and evaluations for license amendments. For purposes of this paragraph as applied to this license, SEMS means any SEMS that has been referenced in a staff SER, TER, EA, or ES, and supplements and amendments thereof. c) The licensee is not required to obtain a license amendment if a proposed change, test, or experiment is consistent with NRC's previous conclusions, or the basis of, or analysis leading to, the conclusions of actions, designs, or design configurations analyzed and selected in the site or project SER, TER, ES, or EA. This would include all supplements and amendments to this license,

Table I.1 License Conditions		
		and the TERs, EAs, EISs issued with those amendments. d) The licensees determinations concerning whether a proposed change, test, or experiment meets the criteria in paragraphs (b) or (c) of this condition, shall be made by a Safety and Environmental Review Panel (SERP). The SERP shall consist of a minimum of three individuals. One member of the SERP shall have expertise in management (e.g., Plant Manager) and shall be responsible for financial approval for changes; one member shall have expertise in operations and/or construction and shall have responsibility for implementing any operational changes; and one member shall be the radiation safety officer (RSO) or equivalent, with the responsibility of assuring changes conform to radiation safety and environmental requirements. Additional members may be included in the SERP, as appropriate; to address technical aspects such as ground water or surface water hydrology, specific earth sciences, and other technical disciplines. Temporary members or permanent members, other than the three above-specified individuals, may be consultants. e) The licensee shall maintain records of any changes made pursuant to this condition until license termination. These records shall include written safety and environmental evaluations made by the SERP that provide the basis for determining changes are in compliance with paragraph (b) of this condition. The licensee shall furnish, in an annual report to the NRC, a description of each change, test, or experiment, including a summary of the safety and environmental evaluation made under paragraph (d) of this condition. In addition, the licensee shall annually submit to the NRC changed pages to the approved license renewal application, which shall include both a change indicator for the area changed, e.g., a bold line vertically drawn in the margin adjacent to the portion actually changed, and a page change identification (date of change or change number or both), to the operations plan and reclamation plan of the approved license application (as updated) to reflect changes made under this condition.
5.4.4	9.8 9.8	Personnel performing contamination surveys for items released for unrestricted use shall meet the qualifications as health physics technicians or radiation safety officer as defined in Regulatory Guide 8.31 (as revised). Personal effects (e.g., notebooks and flash lights) which are hand carried need not be subjected to the qualified individual survey or evaluation, but these items should be subjected to the same survey requirements as the individual possessing the items. The licensee may identify a qualified designee(s) to perform surveys, as needed, associated with the licensee's contamination control

Table I.1 License Conditions		
		program when moving or transporting potentially contaminated equipment, materials, or packages from restricted or controlled areas through uncontrolled areas and back into controlled or restricted areas. The qualified designee(s) shall have completed education, training, and experience, in addition to general radiation worker training, as specified by the licensee. The education, training, and experience required by the licensee for qualified designees shall be submitted to the NRC for review and written verification. The licensee shall receive written verification of the licensees qualified designee(s) training program prior to its implementation.
5.4.4	9.12 9.12	The licensee shall follow the guidance set forth in Regulatory Guide 8.30, as revised, "Health Physics Surveys in Uranium Recovery Facilities," or NRC-approved equivalent with the following exception: Within 90 days of license renewal, the licensee will develop an SOP and specific training for personnel that do not meet the qualifications of RSO or Health Physics Technician, as defined in Regulatory Guide 8.31, as revised, that are designated to survey resin trucks leaving a restricted area and traveling to another restricted area authorized by the license. The SOP and training shall be submitted to the NRC for review and verification. The licensee shall follow the guidance set forth in Regulatory Guide 8.31, as revised, or NRC-approved equivalent with the following exception: The licensee shall describe in an SOP the training provided and procedures used by the RSO designate to conduct daily inspections in the temporary absence of the RSO or Radiation Safety Technician. The SOP for the conduct of daily inspections and training requirements shall be submitted to the NRC for review and written verification. Weekly inspections shall be performed by the RSO and follow the recommendations of Regulatory Guide 8.31, as revised. The licensee shall describe in an SOP the procedures used to conduct weekly inspections in the temporary absence of the RSO. The SOP for the conduct of weekly inspections shall be submitted to the NRC for review and written verification.
5.5.4	11.9	The licensee shall revise the applicable radiation safety training program to specify when alpha and beta contamination surveys are required to be conducted for personnel, equipment, and materials leaving a restricted area.
5.6.4	9.17	The security requirements and control of radioactive materials located outside restricted areas and during transportation activities by the licensee shall conform to the requirements of 10 CFR Part 20, Subpart I and 10 CFR 71.5. The licensee will develop SOPs or other

Table I.1 License Conditions		
		plans to comply with 10 CFR Part 20, Subpart I and 10 CFR 71.5 requirements.
5.7.2.4	11.7	The licensee shall conduct surveys in accordance with 10 CFR 20.1501 in header houses to evaluate the magnitude and extent of radiation levels and to determine potential radiological hazards present.
5.7.3.4	11.3	The licensee shall conduct airborne samples for natural uranium, Ra-226, Po-210, Th- 230 and Pb-210 at each in-plant air particulate sampling location at a frequency of once every 6 months for 2 years, and annually thereafter, to ensure compliance with 10 CFR 20.1204. The licensee shall also evaluate changes to plant operations to determine if more frequent radionuclide analyses are required to demonstrate compliance with 10 CFR 20.1204. The licensee may demonstrate compliance or provide alternative procedures specific to in-plant air particulate sampling to show compliance with 10 CFR 20.1204 to the NRC for review and verification within 6 months of license renewal.
5.7.6.4	11.9	The licensee shall provide for NRC review the surface contamination detection capability (minimum detectable concentration (MDC)) for radiation survey instruments, including scan MDC for portable instruments, used for contamination surveys to release equipment and materials for unrestricted use and for personnel contamination surveys. The detection capability in the scanning mode for the alpha and beta radiation expected shall be provided in terms of dpm per 100 cm^2.
	9.8	Release of surface contaminated equipment, materials, or packages from restricted areas shall be in accordance with the NRC guidance document "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," dated April 1993 (ADAMS Accession No. ML003745526) (the Guidelines) or suitable alternative procedures approved by NRC prior to any such release.
	9.8	Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides shall apply independently.
	9.8	Regulatory Guide 8.30 (as revised), Table 2, shall apply to the removal of equipment, materials, or packages that have the potential for accessible radiological surface contamination levels above background to unrestricted areas. The licensee shall submit to the NRC for review and written verification a contamination control

Table I.1 License Conditions		
		program within 90 days of license renewal. The program shall provide sufficient detail to demonstrate how the licensee will maintain control over the equipment, materials, or packages that have the potential for accessible radiological surface contamination levels above background, until they have been released for unrestricted use as specified in the Guidelines, and what methods will be used to limit the spread of contamination to unrestricted areas. The contamination control program shall demonstrate how the licensee will limit the spread of contamination when moving or transporting potentially contaminated equipment, materials, or packages (i.e. pumps, valves, piping, filters, etc.) from wellfield areas (restricted or controlled areas) through uncontrolled areas. The licensee shall receive written verification of the licensee's contamination control program prior to its implementation.
5.7.7.4	11.3	The licensee shall provide the following information for the airborne effluent and environmental monitoring program in which it shall develop written procedures, that shall be submitted to NRC for verification prior to implementation, to: A) Discuss, in accordance with 10 CFR 40.65, how the quantity of the principal radionuclides from all point and diffuse sources will be accounted for, and verified by, surveys and/or monitoring. B) Evaluate, consistent with 10 CFR 20.1301 and 10 CFR 20.1302, the highest exposures likely for member(s) of the public from licensee operations. C) Discuss how radon progeny (radon-222) will be factored into the determination of potential public dose from the licensee's operations consistent with 10 CFR Part 20, Appendix B, Table 2. D) Discuss, in accordance with 10 CFR 20.1501, how the occupational dose (gaseous and particulate) received throughout the entire license area from licensee operations will be accounted for, and verified by surveys and/or monitoring. The licensee shall conduct airborne samples for natural uranium, Ra-226, Po-210, and Pb-210 at each Christensen Ranch environmental monitoring location at a frequency of once every 6 months for 2 years, and annually thereafter, to ensure compliance with 10 CFR 20.1301. The licensee shall also evaluate changes to plant operations to determine if more frequent radionuclide analyses are required to demonstrate compliance with 10 CFR Part 20.1301. The licensee may demonstrate compliance or provide alternative

Table I.1 License Conditions		
		procedures specific to environmental monitoring for natural uranium, Ra-226, Po-210, and Pb-210 to show compliance with 10 CFR 20.1301 to the NRC for review and verification within 6 months of license renewal. The licensee shall describe how the environmental monitoring program demonstrates that 10 CFR Part 20 public dose limits in controlled and unrestricted areas are met. The documentation of the areas designated as restricted, controlled and unrestricted areas and the environmental monitoring station locations shall be updated periodically, as needed.
5.7.7.4	12.1	Effluent and environmental monitoring program results provided in the semi-annual report and in accordance with 10 CFR 40.65, "Effluent monitoring reporting requirements," shall be reported in the format shown in Table 3 of Regulatory Guide 4.14, (Rev. 1) entitled, "Sample Format for Reporting Monitoring Data." The report shall also include injection rates, recovery rates and injection manifold pressure, status of well fields in operation (including last date of lixiviant injection), status of well fields in restoration and restoration progress, status of any long term excursions, and a summary of mechanical integrity tests during the reporting period.
5.7.8.4	10.3	The licensee shall establish pre-operational baseline water quality data for all production units. Baseline water quality sampling shall provide representative pre-mining ground water quality data and restoration criteria as described in the approved license application. The data shall be from wells established in the mining zone, the mining zone perimeter, the upper aquifer and the lower aquifer where present, with spacing and locations as specified in the approved license application. The data shall, at a minimum, consist of the sample analyses shown in Table 5.24 of Section 5.8.2.2 of the approved license renewal application, unless superseded by this license condition. The wells used for obtaining baseline ground water quality in current and future production areas shall be established at the following minimal density: <u>Monitored Unit</u> — <u>Density</u> Ore Zone Monitors — All Ore Zone Baseline (restoration) — 1 well per 3 acres of pattern area Shallow Zone Monitors — 1 well per 4 acres of pattern area

Table I.1 License Conditions		
		Deep Zone Monitors (where zone present) 1 well per 4 acres of pattern area Baseline ground water quality in previously approved production areas shall be the mean data values (well field average) from the following submittals: <u>Christensen Ranch</u> Unit 3 and Module 2 expansion — December 1, 1988 (Table 2) Unit 3 expansion and Module 4A expansion — August 8, 1991 (Table 6) Unit 2 south portion — November 27, 1992 (Table 2) Unit 2 north portion — April 16, 1992 (Table 2) Unit 4 — April 1, 1994 (Table 6) Unit 5 — February 28, 1995 (Table 7) Four samples shall be collected and analyzed for Assay Suite A from each monitor well to establish baseline water quality parameters including the ore zone perimeter, overlying and underlying monitor wells, and mine unit baseline wells. Consecutive sampling events shall be at least 14 calendar days apart. The third and fourth sample events may be analyzed for a reduced list of parameters. The parameters that may be deleted from the third and fourth sampling events are those that are below the minimum analytical detection limits during the first and second sampling events.
6.1.4	10.15	The licensee shall conduct ground water restoration and post-restoration monitoring as described in Section 6.1 of the approved license application. The primary goal of restoration shall be to return the ground water quality, on a production-unit average, to baseline concentrations on a parameter-by-parameter basis. If the primary goal cannot be achieved, the ground water will, at a minimum, be returned to an alternate standard approved by the NRC. In submitting any license amendment application requesting review of proposed alternate concentration limits pursuant to 10 CFR 40, Appendix A, Criterion 5(B)(6), the licensee must also show that it has first made practicable efforts to restore the specified hazardous constituents to the background or maximum contaminant levels (whichever is greater).
	10.15	The licensee shall conduct ground water restoration activities in accordance with the approved license renewal application. Permanent cessation of lixiviant injection in a production area would signify the licensee's intent to shift from the principal activity of uranium production to the initiation of ground water restoration and decommissioning for any particular production area. If the licensee

Table I.1 License Conditions		
		determines that these activities are expected to exceed 24 months for any particular production area, then the licensee shall submit an alternate schedule request that meets the requirements of 10 CFR 40.42.
	10.1	The licensee shall maintain an inward hydraulic gradient by maintaining a bleed in each individual wellfield starting when lixiviant is first injected into the production zone and continuing until the ground water restoration stability monitoring has begun.
	10.15	The licensee shall conduct four rounds of sampling of all WDEQ-LQD Guideline 8, Assay Suite A constituents during stabilization monitoring, with each well sample being at least three months apart. The applicant shall continue the stability monitoring until the data show the most recent four consecutive samples indicate no statistically significant increasing trend for individual constituents which would lead to an exceedance above the approved target restoration values.
7.4	9.18	The SERP shall review annually LRA Section 7.5, Effects of Accidents, and update the LRA as necessary to reflect newly identified accident analyses based on industry experience or the licensee's lessons-learned

1 PROPOSED ACTIVITIES

1.1 REGULATORY REQUIREMENTS

The purpose of this section is to determine whether the licensee's description of the proposed activities at the Willow Creek Project in the LRA is in compliance with the applicable requirements in 10 CFR 40.31.

1.2 REGULATORY ACCEPTANCE CRITERIA

The application was reviewed for compliance with the applicable requirements of 10 CFR 40.31 using the acceptance criteria presented in Section 1.3 of the standard review plan.

1.3 STAFF REVIEW AND ANALYSIS

Unless otherwise stated, information presented in this section was obtained from the LRA. Uranium One is proposing to renew its source and byproduct materials license SUA-1341 for an additional 10-year period. The proposal is for the continued operations of the Willow Creek Project located in Johnson and Campbell Counties, Wyoming. The project consists of several mine units, restored mine units, a central processing plant (CPP), a satellite plant, a former R&D site, commercial evaporation ponds, and deep injection disposal wells, all of which are located within the license area.

The licensee is permitted by the current license to recover uranium (herein described as yellowcake), a source material, through the ISR process and dispose of byproduct material through environmentally isolated evaporation ponds and injection in Class I deep waste disposal wells permitted by the Wyoming Department of Environmental Quality (WDEQ). Pursuant to the current license, the maximum permitted production flow rate is 15,140 liters per minute (Lpm) [4,000 gallons (gal) per minute (gpm)] and maximum annual yellowcake production is 1,133,750 kilograms (kg) [2,500,000 pounds (lbs)]. Uranium One has requested an increase in the flow rate from 15,140 Lpm (4,000 gpm) to 34,070 Lpm (9,000 gpm) (Uranium One, 2012c; 2012b).

The licensee does not propose substantive changes to the current license for the renewal period beyond the increase in flow rate. Uranium One anticipates that production may continue until 2026 (Uranium One, 2012c; 2012b). Completion of ground water restoration for all mine units is scheduled for 2030.

Uranium One Americas, Inc. also has submitted, under a separate cover letter, a license amendment request to expand its ISR operations to the Ludeman Project area. If approved, the Ludeman expansion will be developed and operated as a satellite project to the existing Irigaray CPP in the same manner as the Christensen Ranch satellite plant. A satellite plant is one in which the above ground processing capabilities are limited (i.e., the plant does not include a dryer to produce the final yellowcake product). Uranium One plans to transport uranium bearing resins from the Ludeman satellite to the existing CPP to complete the processing to yellowcake. The Ludeman amendment request seeks the authorization of activities beyond the scope of those sought by the LRA—that being the renewal of the Willow Creek Project. The NRC staff review of the amendment request for the Ludeman expansion was not included as part of the safety review for the existing LRA, and instead will be addressed in a separate staff review.

Aspects of the Willow Creek Project licensed activities that remain unchanged from the previous license renewal include the location of the project, land ownership, ore-body locations, the proposed recovery process, and waste management and disposal plans. These particular aspects of the licensee's activities were approved during the previous license renewal, and the staff did not identify any information provided in the current LRA that invalidates or calls into question the staff's previous approvals (NRC, 1998).

Production and restoration schedules are different from the last license renewal. Currently, Irigaray mine units 1 through 9 have been restored and restoration has been approved by the NRC (NRC, 2006). There are no operating mine units at the Irigaray location. Christensen Ranch mine units 2 through 6 have been restored by the licensee and a Restoration Report has been submitted to the NRC for review (COGEMA, 2008b). This Restoration Report review was completed in October 2012 (NRC, 2012a). Mine Unit (MU)-7, MU-8, MU-10 and one module in MU-5 is currently in production.

License condition 9.5 requires Uranium One to update its financial assurance annually. The latest approved surety update is dated August 2, 2011 and was approved as SUA 1341, Amendment No. 21 (SER table 1.2). Uranium One's current surety is $16,308,890. Uranium One maintains a letter of credit for the full surety amount with the WDEQ, which is revised annually and a copy submitted to the NRC.

The staff reviewed the inspections reports prepared since the last license renewal, the list of which is provided in SER Table 1.1. A review of the inspection reports indicates that the licensee incurred several Security Level IV violations during the renewal period as described in the table. Security Level IV violations are those that are less serious, but are of more than minor concern, that resulted in no or relatively inappreciable potential safety or security consequences.

Table 1.1
NRC Inspections at Willow Creek Project since the previous license renewal

Inspection Date	ADAMS Accession No.	Inspection Results
August 25-27, 1998	9810020313	No Violations.
April 6-8, 1999	9905060225	No Violations.
August 31-September 2, 1999	9910050298	Level IV Violation - failure to post a "Radiation Area" at the Irigaray facility in accordance with 10 CFR 20.1902(a).
April 25-26, 2000,	ML003716294	No Violations.
April 17-19, 2001	ML011370186	No Violations.
November 6-8, 2001	ML013300308	No Violations.
August 26, 2004	ML042710124	No Violations.
June 26-28, 2007	ML072080382	Level IV Violation – (1) exceeding annual

Table 1.1 NRC Inspections at Willow Creek Project since the previous license renewal		
Inspection Date	**ADAMS Accession No.**	**Inspection Results**
		production limit specified in the license of 50,000 pounds of yellowcake. Level IV Violation – (2) having an expired waste disposal agreement.
October 25-28, 2010	ML103540468	No Violations, interim inspection results and authorization for restart of operations.
December 7-9, 2010	ML110590753	No Violations, final inspection results and authorization for restart of operations.
March 29-21, 2011	ML11168A106	Level IV Violation – (1) Failure to provide training to comply with appropriate Department of Transportation regulations; Level IV Violation – (2) Failure of an employee to survey when exiting a restricted area as required by the license.
October 5-12, 2011	ML11301A220	Special Inspection, No Violations.
December 1, 2011	ML11362A470	Special Inspection, No Violations.
April 16-18, 2012	ML12172A383	Level IV Violation – (1) Failure to survey at two locations and post as radiation area as defined by 10 CFR 20.1003. Level IV Violation – (2) Failure to maintain doses in an unrestricted area less than 0.02 milliSieverts (2 millirems) in any one hour.

SER Table 1.2, below, presents a list of amendments issued to the licensee since the license was last renewed on June 30, 1998 (ML01060061).

Table 1.2 Willow Creek SUA-1341 license amendments since the previous license renewal			
Date	**Amendment No.**	**Amendment Purpose**	**Accession No.**
January 12, 1999	1	Decrease in surety.	9901220330
November 15, 1999	2	Decrease in surety.	ML993240438
November 29, 1999	3	Added a date to license condition 12.5 for COGEMA to submit a decommissioning plan.	ML993400518

Table 1.2 Willow Creek SUA-1341 license amendments since the previous license renewal			
Date	**Amendment No.**	**Amendment Purpose**	**Accession No.**
March 29, 2001	4	Removed or modified several license conditions to change license from an operating license to a possession only license.	ML062900015
October 4, 2001	5	Changed license condition 10.5 by increasing annual production limit of uranium from ground water restoration activities from 30,000 pounds per year of yellowcake to 50,000 pounds per year.	ML012820334
December 31, 2001	6	Approved the Decommissioning Plan for the Irigaray and Christensen Ranch Project, approved a small decrease in the surety amount, and made minor changes in standard performance-based license language.	ML020020527
January 28, 2003	7	Decrease in surety.	ML030290747
November 4, 2003	8	Removed seven monitoring wells from excursion status at the Irigaray site.	ML033160637
February 6, 2004	9	Decrease in surety.	ML040400485
December 21, 2004	10	Decrease in surety.	ML043570055
February 8, 2006	11	Decrease in surety.	ML060320181
March 15, 2007	12	Decrease in surety.	ML070540011
September 30, 2008	13	Change from restoration and decommissioning status to operating status.	ML072840550
February 25, 2009	14	Increase in surety.	ML090210510
December 17, 2009	15	Order approving change of control and license amendment.	ML093290085
June 22, 2010	16	Increase in surety.	ML101390055
August 13, 2010	17	Change the licensee name from Cogema Mining, Inc. to Uranium One USA, Inc.	ML101900309
November 23, 2010	18	Order approving indirect change of control of U.S. Nuclear Regulatory Commission licenses from Uranium One, Inc., to State Atomic Energy Corporation Rosatom.	ML103120147
December 16, 2010	19	Increase in surety.	ML103140486
August 2, 2011	20	Amendment to use either sulfuric acid or hydrochloric acid in the yellowcake precipitation process and to make the technical qualifications for the radiation safety technician consistent with NRC Regulatory Guide 8.31.	ML111310060
January 24, 2012	21	Increase in surety.	ML113540383

Table 1.2 Willow Creek SUA-1341 license amendments since the previous license renewal			
Date	**Amendment No.**	**Amendment Purpose**	**Accession No.**
June 7, 2012	22	Flow rate change from 4,000 gpm maximum rate to 4,000 gpm rate on an annual average	ML12151A279

Since this is a license renewal, the licensee has made changes to the 1996 LRA and has made additional commitments in the current LRA. Accordingly, staff is amending license condition 9.3 in SER Section 1.4 to require the licensee to conduct operations in accordance with the commitments, representation, and statements made in the six separate submittals that make up the current LRA.

During the license renewal process, Uranium One also made commitments in response to a NRC Confirmatory Action Letter (NRC, 2012b). The letter containing commitments made by the licensee in response the Confirmatory Action Letter have been added to the list in license condition 9.3 (Uranium One, 2012a). Further discussion of the Confirmatory Action Letter can be found in SER Section 3.1.3.5.

1.4 EVALUATION FINDINGS

The staff reviewed the proposed activities at the Willow Creek Project in accordance with review procedures in Section 1.2 and acceptance criteria outlined in Section 1.3 of the standard review plan, considering changes to the project since the last license renewal, consistent with Appendix A of the standard review plan. The staff determined that the following aspects of the Willow Creek Project have not changed since the last license renewal: (1) the location of the project; (2) land ownership; (3) ore-body locations; (4) the proposed recovery process; and (5) waste management and disposal plans. In its review, the staff found nothing to invalidate or call into question the previous conclusions regarding these activities. Aspects of the Willow Creek Project that have changed are as follows: (1) the corporate entities holding or having control of the license; (2) operating plans including the increase in flow rate; (3) schedules for construction; startup, and duration of operations; and (4) financial assurance. For these aspects of the operations that have changed, the staff reviewed both information provided by the licensee and licensing actions approved by the staff since the last license renewal. Furthermore, the staff reviewed inspection reports prepared during the renewal period (SER Table 1.1). Inspection reports indicate that the project has been cited for several Security Level IV violations since the previous license renewal.

Based upon the staff's review of the information presented above, the information provided in the LRA, as supplemented by information from NRC staff licensing actions, meets the applicable acceptance criteria of Section 1.3 of the standard review plan and the requirements of 10 CFR 40.31.

As discussed, staff is amending license condition 9.3 to require the licensee to conduct operations in accordance with the commitments, representation, and statements made in the six separate submittals that make up the LRA and commitments made by the licensee in response to NRC Confirmatory Action Letter.

The licensee shall conduct operations in accordance with the commitments, representations, and statements contained in the following:

- License Renewal Application (LRA), May 30, 2008, NRC Agencywide Documents Access and Management System (ADAMS) Accession Package No. ML081850689
- LRA Revision, October 31, 2008, ADAMS Accession No. ML083110405
- LRA Revision, July 17, 2009, ADAMS Accession Package No. ML092110700
- LRA Revision, November 19, 2010, ADAMS Accession No. ML103280266.
- LRA Revision, March 7, 2012, ADAMS Accession Package No. ML120820095.
- LRA Revision, July 10, 2012, ADAMS Accession No. ML12206A436.
- Response to Confirmatory Action Letter, September 21, 2012, ADAMS Accession Number ML12268A270

The approved license application is hereby incorporated by reference except where superseded by license conditions below.

The land and structures will be decommissioned according to the Decommissioning Plan submitted December 19, 2000 (ADAMS Accession No. ML003781238), as revised by submittals dated June 15, 2001 (ADAMS Accession No. ML011700655), June 18, 2011 (ADAMS Accession No. ML011710035), and August 31, 2001 (ADAMS Accession No. ML012490112) and in accordance with 10 CFR 40.42.

Whenever the word "will" is used in the above referenced documents, it shall denote a requirement.

2 SITE CHARACTERIZATION

2.1 SITE LOCATION AND LAYOUT

2.1.1 Regulatory Requirements

The staff determines if the licensee has adequately identified the site location in accordance with the requirements of 10 CFR 40.31(g)(2).

2.1.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria presented in standard review plan Section 2.1.3 (NRC, 2003).

2.1.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Uranium One in its LRA. NRC staff visited the site on several occasions from 1998 to present during NRC inspections (SER Table 1.1) and site visits for other licensing reviews.

NRC staff reviewed the site characterization information relevant to site location and layout at the Willow Creek Project. The licensee describes the site location and layout in the LRA Sections 1.2.2, 1.2.3, and 2.1. The Willow Creek Project is located approximately 88 kilometers (km) [55 mi] southeast of Buffalo, Wyoming, and 82 km [51 mi] northeast of Midwest, Wyoming (SER Figure 2.1). The license area of the Willow Creek Project contains approximately 61 km^2 [15,000 acres] of land located within the southern portion of the Powder River Basin. The Christensen Ranch Project is dissected by the Johnson County and Campbell County lines, whereas the Irigaray Project is located in southeast Johnson County approximately 8 km [5 mi] northwest of the Christensen license boundary and 21 km [13 mi] northwest of the Christensen Ranch Project. Willow Creek, an ephemeral tributary of the Powder River, is the primary drainage within both the Irigaray and Christensen Ranch license areas.

In the original Irigaray license application and the amendment request to incorporate Christensen Ranch into license SUA–1341, and in previous LRAs that were submitted, the licensee had acceptably described: the site location and layout with appropriately scaled and labeled maps; political subdivisions; nearby population centers, farms, and settlements; wellfields and all principal structures such as evaporation ponds, deep injection wells, recovery plant buildings; restricted and unrestricted area boundaries and fences; and site topography (Wyoming Mineral Corporation, 1976; Westinghouse Electric Corporation, 1985; Malapai, 1988; COGEMA,1996).

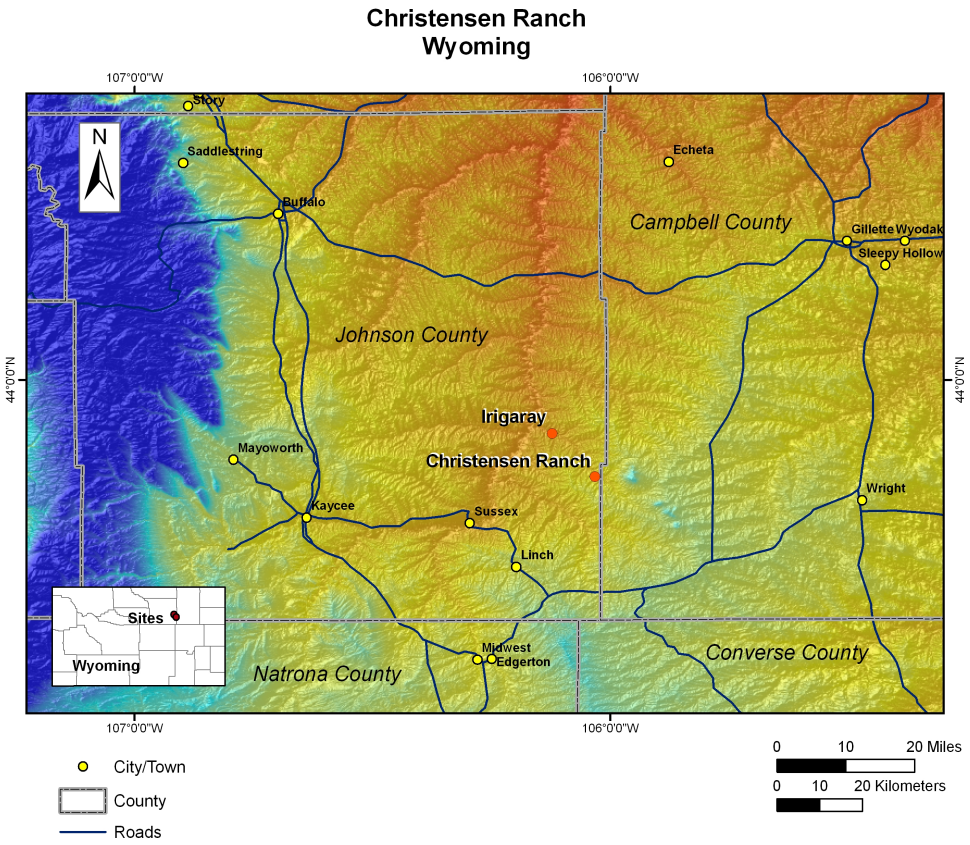

Figure 2.1 Map of the Willow Creek Project (background is a shaded relief map generated from the digital elevation map).

The licensee indicates that future uranium ISR operations primarily would be carried out within the Christensen Ranch license boundary, involving completion and operation of MUs 7 through 12. The loaded resin would be transported to the Irigaray site for elution, precipitation, and yellowcake drying and packaging. The licensee also states that future operations might include production from previously restored wellfield MU 5 and possibly MU 6 at the Christensen Ranch Project.

NRC staff notes three ISR sites are located near the Willow Creek Project. The Power Resources Inc. (PRI) licensed North Butte Project is located approximately 3.2 km (2.0 mi) to the southeast of the Christensen Ranch Project. PRI has stated that the North Butte Project may potentially begin operations in 2012. The Uranerz Energy Corporation's Nichols Ranch Unit is located approximately 9.7 km (6.0 mi) south of the Christensen Ranch Project and the Hank Unit is located approximately 6.4 km (4.0 mi) to the southeast.

The LRA contains new information that describes and assesses the potential effect of coal bed methane (CBM) production on the proposed ISR activities in or near the Willow Creek Project. In the LRA Appendix B, the licensee indicates that CBM production in the license area is presently in the process of being developed. The LRA states five CBM wells have been installed near the Christensen Ranch Project and about 400 more are planned. The licensee provided locations of all existing and planned CBM well locations within 0.8 km [0.5 mi] of the Christensen Ranch license boundary in LRA Appendix B, Figures B.1 and B.1.A (COGEMA, 2009a). The licensee states the installed and permitted CBM wells are owned by three

companies: Anadarko Petroleum Corporation, Yates Petroleum Corporation, and Windsor Petroleum.

As of February 2010, an NRC staff review of Wyoming Oil and Gas Conservation Commission (WYOGCC) records identified 59 CBM wells that have been completed within the Christensen Ranch Project. NRC staff also found a few hundred more CBM wells that are either installed or permitted to be installed over the next few years in the vicinity of both the Irigaray and Christensen Ranch Projects. According to NRC staff review of WYOGCC records, four of these CBM wells, three owned by Anadarko and one owned by Yates, are now operational and have produced water in 2010 and 2011. The NRC staff also determined there are five impoundments that are permitted by WDEQ to receive CBM produced water within a half mile of the Christensen Ranch Project, with one located within the license area.

In accordance with Appendix A of the standard review plan, the staff reviewed the licensee's description of the site location and layout at the Willow Creek Project including any changes thereto. The licensee has sufficiently described the site layout and location, and, therefore, meets the requirements of 10 CFR 40.31(g)(2).

2.1.4 Evaluation Findings

The staff has reviewed the site location and layout of the Willow Creek Project in accordance with the review procedures in NUREG-1569, Appendix A, and per the acceptance criteria in NUREG-1569, Section 2.1.3. The NRC staff finds that the licensee has described the site location and layout with appropriately scaled and labeled maps showing the site layout, principal facilities and structures, boundaries, and topography. The staff notes that the license area, site location, and layout have not changed since the previous renewal and staff has found nothing to invalidate previous findings; therefore, the previous staff determinations remain valid. Based upon its review conducted as indicated above, the NRC staff concludes that the information provided in the application meets the applicable acceptance criteria of standard review plan Section 2.1.3 (NRC, 2003) and the requirements of 10 CFR 40.31(g)(2).

2.2 METEOROLOGY

This section discusses the meteorological conditions of the region surrounding and including the Willow Creek Project. Meteorological data is used for the selection of environmental monitoring locations, the assessment of the impact of operations on the environment, and the performance of radiological dose assessments.

2.2.1 Regulatory Requirements

The staff will determine if the licensee has demonstrated that its meteorology program, which is part of the site monitoring programs required by Criterion 7 of Appendix A to 10 CFR Part 40, is sufficiently complete to allow for estimating doses to workers and members of the public.

2.2.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed to ensure that the project will continue to operate in a manner protective of health and safety and the environment following the applicable requirements of 10 CFR Part 40, Appendix A, Criterion 7, using the acceptance criteria presented in NUREG-1569, Section 2.5.3 (NRC, 2003).

2.2.3 Staff Review and Analysis

The following sections present the NRC staff review and analysis of various aspects of the meteorological conditions at the Willow Creek Project. Aspects reviewed in the following sections include: general site conditions, meteorological data acquisition, wind data, and atmospheric dispersion. The information reviewed in this section is from information, data, and maps contained in the LRA. NRC staff visited the site on several occasions from 1998 to present during inspections (SER Table 1.1) and site visits for other licensing reviews.

NRC has completed its review of meteorology at the Willow Creek Project. The licensee classifies the climate at the Willow Creek Project as semiarid continental, which is consistent with the staff observations during site visits. The licensee indicates that the nearby meteorological data collection stations operated by the National Oceanic and Atmospheric Administration include: Midwest 48 km [30 mi] (southwest), Kaycee 50 km [31 mi] (west), Gillette 69 km [43 mi] (northeast), Buffalo 82 km [51 mi] (northwest), Billy Creek 53 km [33] (northwest), and Casper 109 km [68 mi] (southwest) (see also SER Figure 2.1). In the past, the licensee had used records from these locations to provide general long-term weather data for the area surrounding the sites.

The licensee conducted onsite meteorological monitoring at Irigaray for a full year from December 1980 through December 1981. The licensee evaluated the regional meteorological data in the 1996 LRA to assess whether there have been long-term changes in temperature and precipitation patterns in the region since the last license renewal. In the 1996 LRA, the licensee compared average monthly and average annual temperature and precipitation for the period 1962 through 1989 to its December 1980 through December 1981 onsite data. The licensee compiled data from five regional weather stations listed in SER Table 2.1, excluding Casper. The comparison showed no significant changes in temperature patterns between the two periods. The licensee also compared the 1981 temperature data with those from the regional weather stations to support its conclusion that regional temperature data are reflective of the local temperatures at Irigaray. Similarly, comparison of the annual precipitation data between the two periods showed no dramatic changes in annual precipitation patterns. NRC staff agrees with the licensee's temperature and precipitation assessment.

Table 2.1 Weather stations used in long-term trend assessment (COGEMA, 2009a).

Station	Distance to Site, km [mi]	Direction from Willow Creek
Buffalo	82 [51]	NW
Gillette	69 [43]	NE
Kaycee	50 [31]	W
Midwest	48 [30]	SW
Billy Creek	93 [58]	NW
Casper	109 [68]	SW

The licensee had characterized the local wind speed and directions in its previous license applications, including wind rose diagrams and wind velocity data (COGEMA, 1996). The licensee examined recent data sources to assess whether there have been long-term changes in wind speed and direction patterns. Specifically, the licensee examined (i) the wind data available at the Buffalo and Gillette weather stations, (ii) the historical summaries of wind direction and speed for reporting stations in Wyoming (Western Regional Climate Center, 2009), and (iii) the Wyoming Climate Atlas (Curtis and Grimes, 2009). The licensee concluded in LRA Section 2.5 that analyses of this data indicated that the overall regional patterns of wind speed and direction have not changed appreciably since the last license renewal (COGEMA, 2009a). Based on visits to the site since the last renewal, the NRC staff also has observed that there have been no appreciable changes in topography and terrain at the site or in the geographic setting within the Powder River Basin of both the Irigaray and Christensen Ranch Projects.

However, the staff has determined that in order to continue to use the previously collected data in calculations to demonstrate compliance with 10 CFR Part 20 as low as is reasonably achievable (ALARA) requirements, and 10 CFR Part 20 dose and effluent release limits the licensee must demonstrate that the onsite data collected in 1980 and 1981 is representative of long-term conditions (see NRC Regulatory Guide 3.63, "Onsite Meteorological Measurement Program for Uranium Recovery Facilities – Data Acquisition and Reporting," dated March 1988 (NRC, 1988d)). Accordingly, the licensee will be required by the license condition presented in SER Section 2.2.4 to review and compare the data collected from a regional weather station to the onsite data to insure wind data is representative for the site and can be used in10 CFR Part 20 dose and effluent release limits calculations. Guidance regarding this type of review and comparison is contained in Regulatory Guide 3.63 (NRC, 1988d). The analysis will require comparing the data collected from a regional weather station during the same period as the onsite meteorological data collection (e.g., 1980 through 1981) to the long-term data collected from the same regional weather station to determine if the data collected onsite is representative of long-term conditions. Essentially, the licensee needs to show that the 1980-1981 data at one of the nearby regional weather stations was not a statistical outlier and unusual weather year. If the data is not a statistical outlier at the regional station, then the data collected at Irigaray may be considered representative of a typical weather year.

The licensee addressed the status of the existing air quality in the region. The licensee states that the Willow Creek Project is located in an area compliant with the National Ambient Air Quality Standards. The only nonattainment area in Wyoming is located outside the 80-km [50-mi] radius of the licensee's project. NRC staff reviewed the Environmental Protection Agency (EPA) Green Book map of nonattainment areas and agrees with the licensee's determination (EPA, 2011).

2.2.4 Evaluation Findings

The licensee's 2008 LRA refers to the 1996 LRA for onsite meteorological data and does not provide updated meteorological data for the site. The licensee collected onsite meteorological parameters at the Irigaray CPP location from 1980 through 1981. In the 1996 LRA, the licensee analyzed precipitation and temperature data from nearby weather stations to their data collected at the Irigaray CPP but did not analyze wind data. The precipitation and temperature analysis is acceptable to the NRC staff. The NRC staff has determined that the licensee has not shown that the 1981-1982 wind data are representative of long-term conditions as recommended in

Regulatory Guide 3.63 and that it can be accurately used in 10 CFR Part 20 dose and effluent release limits calculations. License condition 9.15 is proposed below to address this situation.

> The licensee shall review and compare the data collected from a regional weather station during the same period as the onsite meteorological data collected to the long-term data collected from the same regional weather station. The licensee shall determine if the data collected onsite is representative of long-term conditions. Justification of the similarity or validity of the data will include analysis of the statistical data presented to illustrate confidence in the representativeness of the data. The meteorological data will include wind speed, wind direction, an annual wind rose, and a summary of the stability classification. The licensee shall submit this review and comparison to NRC within 6 months of license renewal for NRC review and written verification that the onsite meteorological parameters previously collected will allow the licensee to demonstrate compliance with regulatory requirements of 10 CFR Part 20.

The NRC staff is only requiring that Uranium One confirm the data obtained from 1980-1981 is representative of onsite conditions.

2.3 GEOLOGY AND SEISMOLOGY

2.3.1 Regulatory Requirements

The staff determines if the licensee has demonstrated that the characterization of geology and seismology at the licensee's project is sufficient to document the licensee's ability to maintain control over production fluids containing source and byproduct materials, as required by 10 CFR 40.41(c).

2.3.2 Regulatory Acceptance Criteria

The licensee's characterization of geology and seismology at the Willow Creek Project was reviewed for compliance with the applicable requirements of 10 CFR Part 40, relying on the acceptance criteria presented in NUREG-1569, Section 2.6.3 (NRC, 2003).

2.3.3 Staff Review and Analysis

The following sections present the NRC staff review and analysis of various aspects of the geology, soils, and seismology of the Willow Creek Project. The aspects reviewed in the following sections include: regional geology, site geology, soils, and seismology. The information reviewed in this section is from information, data, and maps submitted by the licensee in its LRA. NRC staff visited the site on several occasions from 1998 to the present during NRC inspections (SER Table 1.1) and site visits for other licensing reviews. This review included an evaluation using the review procedures in NUREG-1569, Appendix A (NRC, 2003).

2.3.3.1 Geology

The licensee had provided detailed characterization of regional and site geology in previous applications (WMC, 1976; Malapai, 1988; COGEMA, 1996), which the NRC staff reviewed and found to be adequate (NRC, 1978a, 1988a, 1998). The licensee described the subsurface

geology of the site as fluvial deposits of the Eocene Wasatch Formation, Paleocene Fort Union, and Cretaceous Lance Formation, where the Wasatch Formation contains the uranium-bearing deposits. The licensee characterized the Wasatch Formation beneath the license area as consisting of the following units: the L sandstone (underlying aquifer), lower confining layer, the K sandstone (mineralized zone), upper confining layer, and the J sandstone (overlying aquifer). Geologic characteristics are not expected to change from initial licensing of both the Irigaray and Christiansen Ranch sites and, therefore, existing geologic cross sections and analysis that were found to be adequate during new license and license renewal reviews remain acceptable to NRC staff.

The K unit is the geologic formation in which uranium extraction will take place. The licensee supported this description by providing several new cross sections through proposed MU-7 in Figures B.1.A through B.1.G in the LRA Appendix B (COGEMA, 2008a, Appendix B). The cross sections also showed the location and screens of some of the monitoring wells in the overlying and underlying aquifer. The NRC staff found the licensee's updated evaluation of the site geology acceptable as it conforms to the guidance in NUREG-1569, Sections 2.6.3 (1), (2) and (3) (NRC, 2003).

Since the last license renewal, the licensee reported in the LRA that CBM production activities have begun in the Christensen Ranch Project area. The licensee discussed the potential effect of CBM production on the proposed ISR activities in LRA Appendix B (COGEMA, 2009a). On the basis of the information provided therein, the NRC staff prepared a schematic stratigraphic column of the CBM production zone relevant to the uranium production zone that is shown in SER Figure 2.2. The licensee reported CBM is being produced from the first major coal seam, which is designated as the Wyodak seam in some locations and the Big George coal seam in other locations as shown in LRA, Appendix B, Figure B.2 (COGEMA, 2009a). The distance between the CBM production zone and the uranium production zone (K unit) is approximately 300 m [1,000 feet (ft)]. The licensee states in the LRA, Appendix B that, although unlikely, artificial connections through the shales above the first major CBM coal seam could be developed through deep exploration drill holes or deep wells that penetrate the coal seam. The NRC staff agrees this scenario is unlikely, since the coal seam is approximately 300 m [1,000 ft] below the ore zone.

2.3.3.2 Soils

The LRA states the licensee conducted a baseline soil study on the Christensen Ranch permit area during the fall of 1986, which the NRC staff reviewed and found to be adequate (NRC, 1998). The LRA states the soil survey included identification of quantitative and qualitative soil characteristics in the area. Soil characteristics are not expected to change from initial licensing of both the Irigaray and Christiansen Ranch sites and, therefore, existing baseline soil studies that were found to be adequate during new license and previous license renewal reviews remain acceptable to NRC staff.

2.3.3.3 Seismology

Previously, the licensee had provided detailed characterization of seismology in previous applications (WMC, 1976; Malapai, 1988; COGEMA, 1996) that the NRC staff has reviewed and found to be adequate (NRC, 1978, 1988a, 1998). The staff reviewed the seismological characteristics of Johnson County, Wyoming, reported by the Wyoming State Geological Survey as follows (Case, et.al. 2002):

> There have been thirteen historic earthquakes with a magnitude greater than 2.5 recorded in or near Johnson County. Because of the limited historic record, it is possible to underestimate the seismic hazard in Johnson County if historic earthquakes are used as the sole basis for analysis. Earthquake and ground motion probability maps give a more reasonable estimate of damage potential in areas without exposed active faults at the surface, such as Johnson County.
>
> Current earthquake probability maps that are used in the newest building codes (2500 year maps) suggest a scenario that would result in moderate damage to buildings and their contents, with damage increasing from the northwest to the central and southeast areas of the county. More specifically, the probability-based worst-case scenario could result in the following damage at points throughout the county: Intensity VII Earthquake Areas: Barnum, Buffalo, Kaycee, Linch, Mayoworth, Sussex.
>
> In intensity VII earthquakes, damage is negligible in buildings of good design and construction, slight-to-moderate in well-built ordinary structures, considerable in poorly built or badly designed structures such as unreinforced masonry buildings. Some chimneys will be broken.

The licensee states in LRA Section 2.6 that there are no new updates or changes concerning seismology (COGEMA, 2008c). NRC staff found the licensee's evaluation of seismology acceptable as it conforms to the guidance criteria in NUREG-1569, Section 2.6.3 (NRC, 2003). The staff has found nothing in the Wyoming State Geological Survey study to invalidate previous findings; therefore, the original findings and previous staff conclusions remain valid. In accordance with NUREG-1569, Appendix A (NRC, 2003), the staff is not reexamining its previous findings of the licensee's seismological data.

2.3.4 Evaluation Findings

Based on NRC staff review of the LRA and the observations during NRC staff site visits, the NRC staff determined that the licensee has acceptably described the regional geology, local geology, soils and seismology. As noted above, the staff previously approved the regional geologic, local geologic, seismologic, and soils data in the prior license renewal review (NRC, 1998). The licensee updated the geological characteristics of the project by providing cross sections for the MU-7 area and provided new characterization and analysis of CBM activities in the area sufficient for the NRC staff to perform a safety evaluation. The staff has found no other information to invalidate previous findings; therefore, the original findings and previous staff conclusions remain valid. In accordance with NUREG-1569, Appendix A (NRC, 2003), the staff is not reexamining its previous findings of the licensee's geologic, seismologic, and soils data except for the updated information related to CBM activities as discussed above.

CHRISTENSEN RANCH STRATIGRAPHY

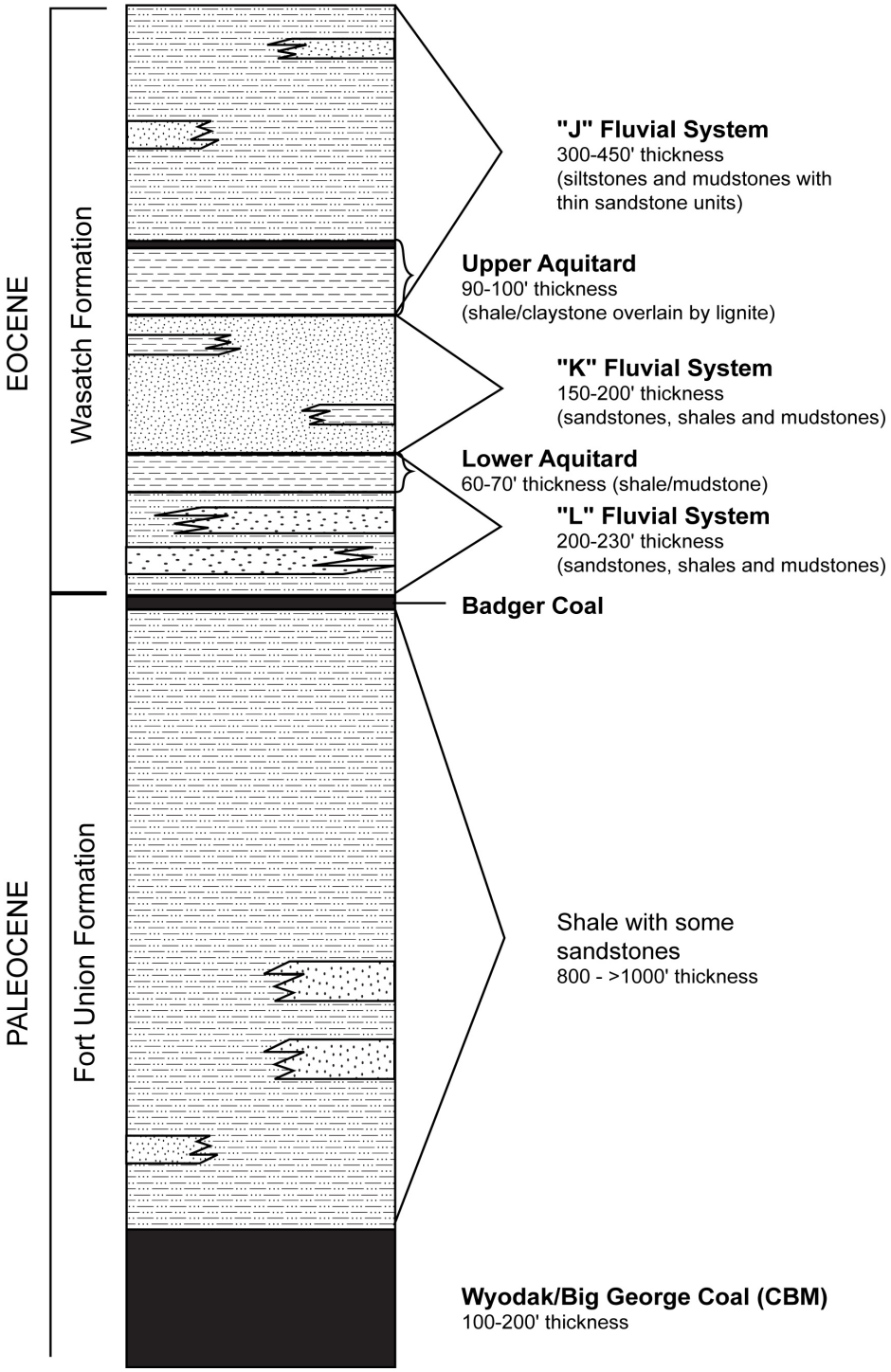

Figure 2.2 Schematic drawing of geostratigraphy in the Christensen Ranch Project, where the K unit corresponds to the ore zone and the CBM production occurs in the Big George Coal unit (COGEMA, 2008a).

2.4 HYDROLOGY

2.4.1 Regulatory Requirements

The staff determines if the licensee has demonstrated that the characterization of surface and ground water hydrology at the Willow Creek Project is sufficient to document the licensee's ability to maintain control over production fluids containing source and byproduct materials, as required by 10 CFR 40.41(c).

2.4.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria presented in Section 2.7.3 of the standard review plan (NRC, 2003).

2.4.3 Staff Review and Analysis

The following sections present the NRC staff review and analysis of various aspects of the surface water and ground water hydrology at the project. Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by the licensee in its LRA. The licensee provided detailed characterization of regional and local surface and subsurface hydrology in its previously submitted license application, license amendments, and LRAs (WMC, 1976; Malapai, 1988; COGEMA, 1996), which the NRC staff reviewed and found adequate.

The NRC staff visited the site on several occasions from 1998 to present during NRC inspections (SER Table 1.1) and site visits for other licensing reviews. NRC has completed its review of the hydrologic site characterization information for the Willow Creek Project using review procedures in NUREG-1569, Appendix A (NRC, 2003).

2.4.3.1 Surface Water Hydrology

The ephemeral Willow Creek, which crosses the license area to the north, is the only surface water feature in the immediate vicinity of the license area. The licensee previously conducted regional and site-specific surface water studies to develop quantitative and qualitative data and to assess the potential impact of the proposed ISR operation on the surface water and drainage system within the Irigaray and Christensen Ranch Project license area. In summary, the licensee had previously:

- Mapped and described the drainage basins within and adjacent to the license area;
- Characterized surface water bodies in the license area and adjacent to it, including Willow Creek, its primary tributaries, and permanent stock ponds;
- Constructed drainage channel profiles for Willow Creek and its major tributaries;
- Performed flood frequency analyses from field data; and
- Sampled surface water quality in Willow Creek and its major tributaries.

The LRA states that COGEMA continues to maintain a WPDES permit, WY0033642, to allow it to discharge treated process waste water into the Willow Creek Drainage at outfall 002 which is

located in a dry drainage of Willow Creek just east of the Christensen satellite plant (COGEMA, 2009a, Figure B.1.A.). The NRC staff obtained a copy of the renewed permit from WDEQ, dated 7/22/2008 with an expiration date of 7/31/2013. This permit lists the effluent water quality limits and surface water and effluent sampling requirements for any treated water released at this outfall. The limit for uranium is a daily maximum of 4.0 milligrams (mg)/liter and total Ra 226 has a daily maximum limit of 12 pCi/l. There is no limit on volume which may be released. An NRC staff review of WDEQ discharge monitoring records for this permit shows it was intermittently used by the licensee in the past and the reported discharges met water quality permit limits. The licensee indicates it has no plans to use this outfall, but continues to maintain the permit.

The licensee reported in the LRA that CBM produced water discharged to impoundments is occurring near the license boundary and may begin within the license area. The licensee provided a map (COGEMA, 2009a, Figure B.1.A) that shows existing or planned CBM produced water discharge points in and near the Christensen Ranch license boundary (COGEMA, 2009a) and five CBM impoundments. Surface discharge points include one Wyoming Pollutant Discharge Elimination System (WYPDES) permit (WY0044059) with three outfall points which discharge to the three permitted CBM impoundments which were discussed in LRA, Appendix B, Section B.1.2. The licensee provided effluent limits for this discharge under permit WY0044059 in LRA, Appendix B, Table B.0 (COGEMA, 2009a). The licensee showed on LRA, Appendix B, Figure B.1.A two other impoundments, Christensen 43-5-44-76, within the license area just to the west of MU-7; and P24-1, located outside the license boundary to the north of MU-8 (COGEMA, 2009a). The NRC staff was able to find the Wyoming State Engineers Office (WSEO) surface water rights permits for both of these impoundments which were identified as stock reservoirs which would receive CBM-produced water. The impoundment identified as Christensen 43-5-44-76 is permitted to receive CBM-produced water from Williams RMT Corporation wells, and is located on a tributary to the Willow Creek drainage within the Christensen Ranch Project. The P24-1 impoundment is identified as receiving CBM-produced water from Bill Barrett Corporation. NRC staff was not able to locate any WYPDES permits to allow these two impoundments to receive CBM produced water discharge at this time.

The NRC staff notes that the permitted impoundments are designed to receive CBM-produced water and retain it. However, according to the WYPDES permit, they are allowed to overtop their banks as a consequence of natural precipitation. Therefore, this release of CBM produced water from impoundments may impact surface water. The NRC staff finds that all outfall points and impoundments, except for the impoundment identified as Christensen Ranch 43-5-44-76, are downgradient from the surface water sampling locations and therefore would not affect the Christensen Ranch surface water quality sampling program. Any discharge from Christensen Ranch 43-5-44-76 which is released to the surface drainage it is located on could impact Willow Creek Drainage, but as these discharges are permitted by WYDES permits, they are regulated to be protective of surface water. The licensee also states in the LRA that their routine surface water quality sampling would detect any change in water quality. The NRC staff concludes, based on the above analysis, that the CBM impoundments do not impact the safety of the ISR operations. The NRC staff found the licensee's evaluation of the surface water hydrology acceptable as it conforms to the guidance criteria in Section 2.7.1(1) in the standard review plan (NRC, 2003).

2.4.3.2 Site Ground Water Hydrogeology

During the initial permitting process, the licensee conducted a number of studies to assess the impact of the proposed ISR activities on the aquifers within the license area. Nine aquifer/aquitard investigations were performed at six test sites within the Christensen Ranch Project to define aquifer characteristics. Ten horizontal permeability tests were performed within the K sandstone at different locations within the license area to confirm permeability values calculated from pumping test data. The licensee also conducted detailed aquifer/ aquitard properties analysis, confirmation of monitor well communication through pumping, and sampling and water quality analysis of all monitor wells and ore zone restoration wells (baseline water quality wells) during the approval process of individual production wellfields. The licensee inferred from aquifer investigations that: (i) the host K sandstone and Upper Irigaray sandstone act as a single hydraulic unit with strong directional anisotropy; (ii) there does not seem to be direct hydraulic connection between the host K sandstone and the overlying and underlying aquifers; and (iii) the confining layers separating the K sandstone from other water-bearing strata act as continuous, low permeability barriers within each MU tested (LRA, Section 2.7). The NRC staff found the licensee's characterization of the ground water hydrogeology acceptable as it conforms to the guidance criteria in Section 2.7.3(3) in the standard review plan (NRC, 2003).

In LRA Section 6.1.3.3, the licensee committed to provide pre-operational, operational, post-operational, and stability phase ground water piezometric surface maps for the wells in the production zone, including the perimeter ore zone monitoring wells, and piezometric surface maps for the monitor wells located in the aquifers immediately above and below the production zone (Uranium One, 2010a). The staff finds this approach acceptable to allow for the comparison of ground water level changes before and after ISR operations. Since the licensee has made this commitment in the LRA and will be bound to this commitment by virtue of license condition 9.3, the staff will not require similar language as a separate license condition.

The licensee reported that ground water use in the vicinity of the Irigaray and Christensen Ranch Project license areas has not changed since the original license was issued. The licensee also states that there have been no new domestic or livestock wells installed in the area of Christensen Ranch or Irigaray. The NRC staff reviewed the WSEO water rights database and verified that no new domestic wells have been installed in the Christensen Ranch Project license area in the past ten years. The licensee states that the ISR operations temporarily will lower water levels in wells completed in the production zone aquifer in the immediate vicinity of the wellfields. The staff notes this is typical for ISR operations due to the volume of water used. The NRC staff found the licensee's evaluation of the ground water use acceptable as it conforms to the guidance criteria in Section 2.7.3(6) in the standard review plan (NRC, 2003). However, NRC staff also will require a license condition listed in SER Section 2.4.4 that will require the licensee to determine if any new domestic or livestock wells are installed near the Willow Creek Project and assess any possible impacts the ISR operations could have on the use of such wells pursuant to 10 CFR 40.41(c), that requires each person licensed by the Commission confine his possession and use of source or byproduct material to the locations and purposes authorized in the license.

The licensee states in SER Section 5.8.2.1 that five stock watering and domestic water wells located within two km of the Christensen Ranch mining area and one well located near Irigaray have been routinely sampled. Grab samples of ground water from these wells were collected quarterly when the wells were operational, except for Willow No. 2 at Irigaray, which was

sampled semi-annually. Ground water monitoring results are summarized in LRA Table 5.23. The licensee proposes to institute the same regional ground water monitoring program during future operations. LRA Table 5.24 summarizes the proposed regional ground water sampling program. The NRC staff finds this acceptable as NRC has already approved this monitoring schedule in past reviews. However, NRC staff will require a license condition in SER Section 2.4.4 that the licensee shall evaluate any new domestic or livestock wells that are located within 2 km of a MU and recommend additional monitoring of such wells in its annual report to the NRC pursuant to 10 CFR 40.41(c) that requires each person licensed by the Commission confine his possession and use of source or byproduct material to the locations and purposes authorized in the license.

Although the licensee is correct that ground water usage has not changed since the license was issued, the PRI North Butte Project and the Uranerz Nichols Ranch Project, Hank Unit, that are near the license area are expected to be operational in the future and will increase the ground water usage in aquifers in the Wasatch. The NRC staff concludes the North Butte and the Hank Unit ISR license areas are sufficiently close to the Christensen Ranch Project to require an evaluation of impact on the safety of wellfield operations. Therefore, the NRC staff evaluated the potential of the simultaneous operation of the wellfields to affect water levels in targeted aquifers at the Christensen Ranch, North Butte and Hank Unit Projects.

The licensee reported in the LRA that the target ore zones at the Christensen Ranch Project are located in the K1, K2 and K3 sand aquifers in the Wasatch at depths of about 122 to 182 m (400 to 600 ft). NRC notes the target ore zones at the PRI North Butte license area are located in the C, B and A sand aquifers in the Wasatch formation also at depths of 122 to 182 m (400 to 600 ft) (PRI, 2006). An NRC staff review of driller logs from wells completed into the ore zones at Christensen Ranch and at North Butte demonstrate that the target sands in both license areas are located beneath a signature coal layer around 91 m (300 ft) below surface and have similar lithology. Therefore, the NRC staff concludes that the target ore zone sands at Christensen Ranch and North Butte are likely the same even though the nomenclature is different. At the Hank Unit, the NRC staff notes the target ore zone aquifer is in the F sand which is above the A, B and C sands at North Butte (Uranerz, 2007). Pumping tests in the Hank Unit have shown no communication between the F sand and the underlying C and B sands in the Hank Unit (Uranerz, 2007).

Based on this analysis, the NRC staff concludes the operations at Christensen Ranch are unlikely to impact the water levels within the F sand ore zone aquifer at the Hank Unit, which lies above the K sand ore zone aquifer and is separated by a large aquitard. However, the NRC staff concludes operations in the K sands at Christensen Ranch may create a substantial drawdown in aquifer water level in and around the license area. This drawdown is likely to extend into the same aquifer at the North Butte ISR and, therefore, may also drawdown the water levels in the ore sand aquifers at North Butte. In addition, the NRC staff concludes that when ISR operations begin at North Butte, the consumptive use of water will drawdown water levels in and around the North Butte Project and potentially extend to impact water levels at Christensen Ranch.

The increase in flow rate from 15,140 Lpm (4,000 gpm) to 34,070 Lpm (9,000 gpm) proposed by Uranium One may add to this drawdown. The proposed flow rate increase will not increase the flow rate in individual MU's since the geologic characteristics of each MU controls the rate groundwater can be pumped from each MU. Uranium One states the flow rate of individual MUs will not be increased. The flow rate increase will allow Uranium One to operate more MUs

simultaneously, and these MUs are located further away from PRI's North Butte Project, which will lessen the impacts of the drawdown.

Although NRC has determined that the two projects' combined operations may impact water levels in the same aquifer, the safety review requires a determination of whether this represents a safety issue. The NRC staff concludes, based on the analysis provided above, that the water level drawdown at North Butte from extraction at Christensen Ranch does not impact the safety of operations at Christensen Ranch. However, future operations at North Butte may impact water levels and wellfield operations at Christensen Ranch and pose a safety issue if it affects hydraulic control of the wellfields. The licensee states in the LRA that it will monitor water levels during both operation and restoration to assess the amount of drawdown in surrounding wells. The NRC staff concludes that this proposed water level monitoring will enable the licensee to detect any additional ground water level drawdown from the future operation of the North Butte Project. This will allow the licensee to adjust its wellfield operations to ensure that the required ground water bleed is maintained to prevent excursions. Therefore, the NRC staff concludes the additional drawdown from North Butte operations and the increase in flow rate at the Christensen Ranch Project will not pose a safety concern.

The licensee indicates in the LRA there are significant CBM operations existing and planned in and around the Willow Creek Project. During CBM production, water is pumped from wells completed in the coal aquifer. As pressure decreases in the aquifer due to pumping, both methane and CBM-produced water rise to the surface through the well. The methane is captured, and the CBM-produced water either is discharged to surface impoundments, discharged to drainages, used for irrigation, or re-injected into isolated formations.

The licensee reported in LRA, Appendix B, that approximately four hundred CBM wells are permitted and may be installed in the vicinity of both the Irigaray and Christensen Ranch Projects. The licensee provided locations of all existing and planned CBM well locations within 0.8 km [0.5 mi] of the Christensen Ranch license boundary (COGEMA, 2009a, Figure B.1 and B.1.A). The licensee reported that Anadarko Petroleum Corporation, Yates Petroleum Corporation, or Windsor Energy Corporation own the CBM wells. The licensee states that as of 2008, only five CBM wells had been installed in the Christensen Ranch license and none were in production (COGEMA, 2008a). In February 2010, the NRC staff performed a search of the WYOGCC records to assess the number of CBM wells that have been completed in the Christensen Ranch Project license area. The staff determined that 59 CBM wells have been installed within the Christensen Ranch Project license area. The NRC review of WYOGCC records also revealed that four of these CBM wells, three owned by Anadarko and one owned by Yates, are now operational and have produced water in 2010 and 2011.

The licensee stated in LRA, Appendix B, Section B.1.4 that the majority of the CBM water produced by Anadarko Petroleum Company CBM wells will be transported through a pipeline to a conventional oil/gas field near Midwest, Wyoming, for reinjection into a deep aquifer. For the other CBM wells in and near the Willow Creek Project, WDEQ requires that all CBM produced water be discharged to CBM water impoundments or storage/treatment tanks under WYDES permits. The licensee showed that five WDEQ permitted CBM produced water impoundments exist within 1.9 km [1.2 mi] of the license area (COGEMA, 2009a, Figure B.1.A, Figure B1.A). Three of these impoundments are permitted to receive CBM-produced water under a WYPDES permit, WY0044059, held by Windsor Energy Corporation (COGEMA, 2009a, Figure B.1.A). In a review of the permit, the NRC staff determined there are three outfalls numbered 001-004,008-0013 and 016-018 located southwest of the Christensen Ranch Project license area which discharge to these impoundments (COGEMA, 2009a Figure B.1.A, Figure B1.A). The

licensee showed two other impoundments, Christensen 43-5-44-76, within the license area just to the west of MU-7; and P24-1 located outside the license boundary to the north of MU-8. The NRC staff was able to find the WSEO surface water rights permits for both of these impoundments which were identified as stock reservoirs which would receive CBM produced water. The impoundment identified as Christensen 43-5-44-76 is permitted to receive CBM produced water from Williams RMT Corporation wells. The P24-1 impoundment is identified as receiving CBM-produced water from Bill Barrett Corporation. The licensee did not identify either of these corporations as CBM producers in and near the license area. In addition, the NRC staff was not able to locate any WYPDES permits to allow these two impoundments to receive CBM-produced water discharge at this time, so it is assumed they are inactive. The licensee provided no information on how Yates Petroleum would manage its CBM produced water within and around the Christensen Ranch Project license area.

Given the extent of new CBM production that is taking place and planned to occur in and around the Christensen Ranch Project, the NRC staff evaluated its potential impact on safety of the ISR operation. CBM-produced water discharges to impoundments or the surface may infiltrate into ground water and potentially impact baseline and operational water quality monitoring in the overlying aquifer (i.e., the J unit). As CBM-produced water is typically high in salinity, the NRC staff concludes its infiltration into an aquifer may mimic an excursion event. However, the licensee demonstrated in LRA, Appendix B, Figures B.1.C through B.1.G that a thick aquitard exists underneath all CBM impoundments and would retard movement of CBM-produced water from the surface down to the J unit surficial aquifer (COGEMA, 2009a; Uranium One, 2010a). If an excursion is detected in the J unit during operations, the NRC staff notes the licensee did not provide a specific methodology for differentiating between contamination caused by CBM-production water and contamination from ISR spillages. However, the licensee stated in an RAI response that CBM-produced water typically contains large amounts of dissolved solids but is an order of magnitude lower in chloride as compared to ISR lixiviant (Uranium One, 2010b). Therefore, the licensee stated in an RAI response, that the CBM-produced water could be distinguished from lixiviant by the chloride concentrations (Uranium One, 2010b). The NRC staff finds the use of chloride concentrations to be an acceptable method by which the licensee will be able to distinguish whether contamination of ground water is from ISR operations or from contamination from CBM-produced water infiltration in the J unit aquifer. The NRC staff notes CBM-produced water also may be accidentally spilled on the surface. The NRC staff also concludes the licensee could use chloride ion to distinguish between spills of CBM-produced water on the surface and ISR fluid spills. The NRC staff finds the licensee's evaluation of the detecting CBM-produced water impacts acceptable as it conforms with the guidance criteria in Section 5.7.8.3(2) in the standard review plan (NRC, 2003) which states the licensee should provide adequate indicators to identify excursions to aquifers.

In addition to potential for CBM-produced water infiltration to ground water, the licensee states in LRA, Appendix B, that CBM production in the area may draw down the water levels in the aquifers overlying the targeted coal aquifers (COGEMA, 2009a; Uranium One, 2010a). The licensee states CBM production could result in several hundred feet [1 ft = 0.30 m] of hydraulic head loss in the coal aquifer due to removal of the produced water. However, the licensee reported that the Bureau of Land Management (BLM) has installed a network of coal and sand monitor wells to monitor the effects of CBM production on Wasatch aquifer water levels. The licensee provided locations of these monitor wells in LRA, Appendix B, Figure B.7. The water-level monitoring indicates that sand wells completed a few hundred feet above the coal in this area have not exhibited appreciable head loss. An exception is the Bullwhacker sand well (located 19 km [12 mi] to south-southwest of the Christensen Ranch Project), which exhibited approximately 43 m [140 ft] of head loss over a 5-year period. The licensee attributed the

observed greater head loss in the Bullwhacker sand well to potential artificial connection between the sand and coal aquifers at this location. The staff finds this explanation acceptable and, since the well is located approximately 19 km [12 mi] to south-southwest of the Christensen Ranch Project, finds that further inquiry into the matter is not warranted at this time.

The licensee further developed a multilayer MODFLOW model to evaluate the potential hydrologic impacts of CBM production on the uranium ore-bearing sands in the LRA. MODFLOW (Harbaugh, et al., 2000) is an industry-standard code developed by USGS for modeling ground water flows. The licensee's MODFLOW model consists of 13 confined layers of varying thicknesses and transmissivities. The total simulation period was 20 years. The modeling results in the LRA suggested that the continuous shale layers may dampen head loss in ore–sand aquifers and the CBM-induced head loss would not have a measurable impact on ore–sand water levels unless there is an artificial connection through an improperly completed well or improperly abandoned bore hole (Uranium One, 2010a, Appendix B.5).

If water level drawdown does occur within an aquifer MU because of artificial connections, the NRC staff notes it is more likely to introduce a vertical excursion than a horizontal excursion due to the presence of vertical gradients. Therefore, the capability to detect and rectify artificial connections within an ISR wellfield area is critical for preventing excursions. The licensee has committed to install a network of aquifer monitor wells in each MU that can detect the excursions and changes in water level that could be caused by CBM operations. The licensee's in situ monitoring network is evaluated in Chapter 3 and Section 5.7.8 of this SER. The NRC staff finds the licensee's evaluation of the impacts of artificial connections on water levels acceptable, as it conforms with the guidance criteria in Section 2.2.3(1), 2.7.1(3), and 2.7.1(6) in the standard review plan (NRC, 2003).

Based on the BLM data and ground water modeling provided by the licensee, the NRC staff concludes that in and near the Willow Creek Project there is sufficient isolation and separation of the ore zone from the CBM target zone to preclude any water level drawdown that would affect the safety of the operations in the ore zone. The NRC staff also concludes that any water level changes from CBM operations will be detected by the proposed MU monitoring well network. The monitoring well network in each MU also will detect any excursions, which will be corrected by the licensee. Finally, the NRC staff finds the use of chloride should be sufficient to distinguish between spills and ground water contamination caused by infiltration of CBM produced water versus those caused by ISR fluids. Therefore, the NRC staff finds that the CBM production in and around the Willow Creek Project license area will not affect the safety of the ISR operations.

2.4.4 Evaluation Findings

The licensee provided new information on the impact of existing and anticipated CBM production on ground water quality by providing adequate descriptions of the characteristics of the underlying soils and geologic formations. In particular, the licensee provided an appropriate assessment of the potential effect of CBM production on surface water quality. The staff has determined the effects of CBM production discharges on surface water quality and the surface water sampling program are expected to be minimal. The licensee has sufficiently addressed its methodology for differentiating the CBM-induced aquifer contamination from an ISR excursion, or from leaks or spills. The staff has determined that the likely effects of CBM operations on the Willow Creek Project will be minimal. The licensee has provided a

commitment in the LRA to monitor water levels in production units that overly CBM production that is acceptable to the NRC staff.

Staff has determined that the increase in flow rate from 15,140 Lpm (4,000 gpm) to 34,070 Lpm (9,000 gpm) will not pose a safety concern. Individual wellfields will not be pumped at a higher flow rate. Staff has determined that Uranium One's monitoring program to assess the amount of drawdown in surrounding wells that includes monitoring water levels during both operation and restoration phases is acceptable.

The NRC staff has identified one additional license condition that will require the licensee to determine if any new domestic or livestock wells are installed near the license area and assess any possible impacts the ISR operations could have on the use of such wells. The staff has determined that new domestic or livestock wells installed within 2 km of a MU must be identified and assessed by the licensee to ensure the protection of public health and safety. This requirement is consistent with the licensee's current sampling activities as stated in LRA Section 5.8.2.1, and will be inserted in the license as license condition 11.8.

> The licensee shall identify the location of any new ground water wells or new use of existing wells, where the information is publicly available and/or known to the licensee, that are located within the license area and within 2 kilometers of any production area monitoring ring wells. The licensee shall also report publicly available information such as well depth, screen depth and estimated pumping rate. The licensee shall evaluate the impact of ISR operations on ground water wells and recommend any additional monitoring or other measures to protect ground water users. The evaluation shall be submitted as part of the annual reporting to the NRC.

The NRC staff found the licensee's discussion of surface and ground water hydrology for the Willow Creek Project acceptable in the initial commercial applications (WMC, 1976; Malapai, 1988) and during the last license renewal (COGEMA, 1996). The information previously evaluated by NRC staff is not discussed in this SER. Based on the information provided in the LRA and staff review based on the criteria in the standard review plan (NRC, 2003), the NRC staff concludes that the licensee's characterization of site hydrology is acceptable.

2.5 BACKGROUND SURFACE WATER AND GROUND WATER QUALITY

2.5.1 Regulatory Requirements

The NRC staff determines if the licensee has demonstrated that the characterization of surface and ground water quality at the Willow Creek Project has been performed to meet the requirements of 10 CFR Part 40, Appendix A, Criterion 7.

2.5.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria presented in Section 2.7.3 of NUREG-1569 (NRC, 2003).

2.5.3 Staff Review and Analysis

The following sections present the NRC staff review and analysis of preoperational data for surface water and ground water quality at the Willow Creek Project supplied by the licensee. Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by the licensee in its LRA. The NRC staff visited the site on several occasions during the course of this review to confirm information presented in the LRA.

2.5.3.1 Surface Water

Prior to commercial operations, the licensee conducted regional background surface water quality analysis on samples collected from all surface water bodies within the license area. The data were reported in the original commercial license applications (WMC, 1976: Malapai, 1988). The initial program included the analysis of physical indicator parameters, common cation and anion constituents, trace and minor metals and radionuclides uranium and radium-226. The licensee has conducted monitoring of surface water during the life of the license, though the analytical parameters are limited to the radionuclides and to surface water bodies that could be affected by the operations at that time (see SER Section 5.7.8). The licensee provided no updates on background surface water quality within the license area from the original application.

Based on this data, the staff previously determined that operation of the Willow Creek Project is protective of health and safety (NRC, 1978a; 1978b; 1988a; 1988c; 1998). The staff has found nothing to invalidate or call into question its previous findings; therefore, the original findings and previous staff conclusions remain valid. In accordance with NUREG-1569, Appendix A (NRC, 2003), NRC staff is not reexamining the results of the licensee's air particulate sampling background radiological data.

2.5.3.2 Ground Water

Prior to commercial operations, the licensee conducted regional background ground water quality analysis. The data were reported in the original commercial license application (WMC, 1976; Malapai, 1988). The initial program included the analysis of physical indicator parameters, common cation and anion constituents, trace and minor metals, radionuclides uranium and radium-226, and water elevation. The licensee has conducted monitoring of ground water during the life of the license, though the analytical parameters are limited to the radionuclides and locations have been modified over the life of the project, based on distance from an operating wellfield (see SER Section 5.7.8). Background ground water radiological constituents for each wellfield have been determined in accordance with previously approved license applications and license renewal applications and are referenced in SUA-1341, license conditions 10.3 and 10.4. For new wellfields brought into production, the licensee is required under Section 10.4 of its license to establish baseline water quality data for a list of radiological and non-radiological constituents listed in LRA Table 5.25.

The licensee provided no updates on background ground water quality in the license area from the original application. Based on the data from the original application, the staff previously determined that operation of the Willow Creek Project is protective of health and safety (NRC, 1978a; 1978b; 1988a; 1988c; 1998). The staff has found nothing to invalidate previous findings; therefore, the original findings stand and previous staff conclusions remain valid. In accordance

with NUREG-1569, Appendix A (NRC, 2003), the NRC staff is not reexamining the results of the licensee's background ground water data.

2.5.4 Evaluation Findings

As noted above, the staff previously approved preoperational background quality of surface and ground water sources (NRC, 1978a; 1978b; 1988a; 1988c; 1998). The staff has found nothing to invalidate or call into question its previous findings; therefore, the original findings stand and previous staff findings remain valid. In accordance with NUREG-1569, Appendix A (NRC, 2003), the staff has not identified any safety-related concerns and, therefore, is not reexamining the licensee's surface and ground water background water quality information.

2.6 BACKGROUND RADIOLOGICAL CHARACTERISTICS

This section discusses the background radiological characteristics of the surrounding environment. Background radiological characteristics are used to evaluate the potential radiological impact of operations on human health and the environment. Such impacts could result from spills, routine discharges from operations, and other potential releases to the environment. In addition, the data collected are used to identify a radiological baseline for decommissioning, restoration, and reclamation.

2.6.1 Regulatory Requirements

The staff determines if the licensee has demonstrated that the pre-operational environmental monitoring program and the site background radiological characteristics are in compliance with 10 CFR Part 40, Appendix A, Criterion 7.

2.6.2 Regulatory Acceptance Criteria

The LRA was reviewed for compliance with the applicable requirements of 10 CFR Part 40, Appendix A, Criterion 7, using the acceptance criteria presented in standard review plan Section 2.9.3 (NRC, 2003). Regulatory Guide 4.14 (NRC, 1980), provides guidance on the pre-operational effluent and environmental monitoring program elements.

2.6.3 Staff Review and Analysis

The licensee previously reported background radiological characteristics in the original licensing documents for both the Irigaray and Christensen Ranch Projects (WMC, 1976; Malapai, 1988) and in the licensee's NRC-approved Decommissioning Plan dated December 2000, as revised, (COGEMA, 2000; 2001; 2003) that provided a summary of background radiological characteristics to support remediation and decommissioning of the Willow Creek Project.

2.6.3.1 Radon Monitoring

The licensee conducted preoperational radon monitoring prior to submitting a license application for the Irigaray Project in 1976 (WMC, 1976) and conducted preoperational radon monitoring prior to submitting a license application for the Christensen Ranch Project in 1988 (Malapai, 1988). The NRC staff notes that for the purposes of this SER, radon refers to radon-222. This

data was originally reviewed by the NRC prior to issuing NRC license SUA-1341 and the license amendment approving operations at the Christensen Ranch Project that was incorporated into license SUA-1341 in 1988.

The Willow Creek Project LRA Section 5.8.1, Table 5.21, describes the current radiological monitoring conducted at the Christensen Ranch Project. Radon is continuously monitored at Christensen Ranch at four locations: three onsite plant locations; and one offsite location.

The Willow Creek Project LRA Section 5.8.1, Table 5.22, describes the current radiological monitoring conducted at the Irigaray Project. Radon is continuously monitored at five locations at the Irigaray Project, four onsite plant locations and one offsite location.

NRC staff previously determined that operation of the Willow Creek Project is protective of health and safety (NRC, 1978a; 1978b; 1988a; 1988c; 1998). The NRC staff has found nothing to invalidate or call into question its previous findings; therefore, the original findings and staff's prior conclusions remain valid. In accordance with NUREG-1569, Appendix A (NRC, 2003), the staff is not reexamining the results of the licensee's radon monitoring background radiological data.

2.6.3.2 Air Particulate Sampling

The licensee conducted preoperational air particulate sampling prior to submitting a license application for the Christensen Ranch Project in 1988 (Malapai, 1988). This data was originally reviewed prior to issuing license amendment approving operations at the Christensen Ranch Project that was incorporated into license SUA-1341 in 1988. The licensee conducted preoperational air particulate sampling prior to submitting the Decommissioning Plan in 2000 (COGEMA, 2000).

The NRC staff previously determined that preoperational air particulate monitoring of the Christensen Ranch Project was consistent with 10 CFR Part 40, Appendix A, C (NRC, 1988a; 1988c). The staff has found nothing to invalidate or call into question its previous findings; therefore, the original findings and staff's prior conclusions remain valid. In accordance with NUREG-1569, Appendix A (NRC, 2003), the staff is not reexamining the results of the licensee's air particulate sampling background radiological data.

2.6.3.3 Soils and Vegetation

The licensee conducted soil and vegetation sampling prior to submitting a license application for the Irigaray Project in 1976 (WMC, 1976) and conducted soil and vegetation sampling prior to submitting a license application for the Christensen Ranch Project in 1988 (Malapai, 1988). This data was originally reviewed by the NRC prior to issuing NRC license SUA-1341 and license amendment approving operations at the Christensen Ranch Project that was incorporated into license SUA-1341 in 1988.

The NRC staff previously determined that soil and vegetation preoperational sampling at the Willow Creek Project was adequate (NRC, 1978a; 1978b; 1988a; 1988c; 1998). The staff has found nothing to invalidate or call into question its previous reviews; therefore, the original findings and staff's prior conclusions remain valid. In accordance with NUREG-1569, Appendix A (NRC, 2003), the staff is not reexamining the results of the licensee's soil and vegetation background radiological data.

2.6.3.4 Direct Radiation

The effects of direct radiation were evaluated by the NRC staff prior to issuance of the Irigaray license SUA-1341 in 1978 (NRC, 1978a; 1978b). The licensee conducted direct radiation monitoring prior to submitting a license application for the Christensen Ranch Project in 1988 (Malapai, 1988). This data was originally evaluated and reviewed by the NRC prior to issuing NRC license SUA-1341 and the license amendment approving operations at the Christensen Ranch Project that was incorporated into license SUA-1341 in 1988. Additional direct radiation monitoring was conducted by the licensee and submitted for review in the 2000 Decommissioning Plan, as revised (COGEMA, 2000; 2001; 2003).

The NRC staff previously determined that background direct radiation monitoring at the Willow Creek Project was adequate (NRC, 1978a; 1978b; 1988a; 1988c; 1998). The staff has found nothing to invalidate or call into question its previous reviews; therefore, the original findings and staff's prior conclusions remain valid. In accordance with NUREG-1569, Appendix A (NRC, 2003), the staff is not reexamining the results of the licensee's air particulate sampling background radiological data.

2.6.4 Evaluation Findings

NRC reviewed background radiological data for the Irigaray and Christensen Ranch ISR Projects during prior application reviews and determined that background data was adequate. The staff has found nothing to invalidate or call into question its findings from previous reviews; therefore, the original findings and staff's prior conclusions remain valid. In accordance with 10 CFR Part 40, Appendix A, Criterion 7 and NUREG-1569, Appendix A (NRC, 2003), the staff has not identified any concerns related to background radiological monitoring and, therefore, is not reexamining the results of the licensee's background radiological data.

3 DESCRIPTION OF PROPOSED FACILITY

3.1 ISR PROCESS AND EQUIPMENT

3.1.1 Regulatory Requirements

The purpose of this section is to determine whether the licensee has demonstrated that the equipment and processes used in the wellfields during operation at the Willow Creek Project will meet the requirements of 10 CFR 40.32(c) and 40.41(c), which, respectively, requires that the licensee's equipment, facilities, and procedures be adequate to protect health and minimize danger to life or property; and that the licensee confine source or byproduct material to the locations and purposes authorized in the license.

3.1.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria presented in Section 3.1.3 and guidance in NUREG-1569, Appendix A (NRC, 2003).

3.1.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Uranium One in its LRA. The NRC staff also examined the inspection reports for the period 1998 through 2012. In addition, the NRC staff visited the Willow Creek Project on several occasions during the course of its review to confirm information presented in the LRA.

The following sections present the NRC staff review and analysis of various aspects of the ISR processes and equipment proposed for the Willow Creek Project.

3.1.3.1 Mine Unit and Mineralized Zone Description

The licensee states that the ore bodies at both the Irigaray and Christensen Ranch Projects are typical roll front deposits. Uranium minerals occur as sand grain coatings and interstitial fillings in medium to fine-grained sandstones and arkosic sandstones of the Eocene Wasatch Formation. The uranium was derived from volcanic and granitic detritus by oxygen containing waters that leached and transported it via aquifers to where the oxidation potential of the ground water was overcome by the reducing conditions in the aquifer. At that point, the uranium and some other dissolved metals became insoluble and precipitated as coatings and interstitial fillings in the aquifer (Uranium One, 2010a).

The licensee estimated the ore reserves based on exploration drill holes and ore-body delineation holes drilled during wellfield installation. It estimated that approximately 4 million kg [9 million lbs] of reserves exist on the Christensen Ranch Project. The majority of production is planned to take place over the next 10 years in MUs 7 through 12 (Uranium One, 2010a). The licensee has restarted production in a portion of MU-5.

Prior to the restart of operations in 2010 (NRC, 2010a), the licensee ended all uranium production activities (lixiviant injection) at the Christensen Ranch Project in June 2000. MUs 2, 3, and 4 went into restoration in 1997, and MUs 5 and 6 went into restoration in 2000. The licensee submitted a Restoration Report to NRC stating the restoration of all existing Christensen Ranch wellfields (MUs 2 through 6, including stability monitoring) was completed by 2006 (COGEMA, 2008b). The NRC staff completed the Restoration Report review in 2012 (NRC, 2012a). In its review, the NRC staff did not approve restoration of MUs 2 through 6 and requested the licensee submit additional plans to complete restoration.

The licensee states in LRA Section 3.3.1.1 that the Willow Creek MUs consist of groups of cells or well patterns installed to correspond to the geometry of the ore body. Well patterns include five-spot patterns, alternating line drives, and staggered line drives depending on the size and shape of the deposit. The tendency of the roll fronts to change direction abruptly typically results in irregularity of the pattern shapes. A single five-spot pattern is roughly rectangular and consists of four injection wells surrounding one center recovery well. The licensee states that the spacing between the corner injection wells is typically 26 m (85 ft), although it can range from 15 to 30 m (50 to 100 ft) depending upon the topography and ore characteristics (Uranium One, 2010a). The NRC staff has observed these well patterns at the Willow Creek Project and they are consistent with the original application and license renewal applications (WMC, 1976; Malapai, 1988; COGEMA, 1996; 2008c). The staff notes these patterns are typical of what is used by the ISR industry at other sites and finds them acceptable. The staff has previously approved the well patterns during the prior licensing and license renewal reviews (NRC, 1978a; 1978b; 1988a; 1988c, 1998). The staff has previously approved the wellfield locations for MUs 2 through 12 at the Christensen Ranch Project. Wellfield locations can be found in LRA Table 3.1 and have been observed by the staff during visits and inspections at the project. The staff has found nothing to invalidate or call into question previous findings; therefore, the original findings and staff's prior conclusions remain valid. In accordance with NUREG-1569, Appendix A (NRC, 2003), the staff is not reexamining this issue.

3.1.3.2 Well Design, Construction and Integrity Testing

The licensee presents its well injection and recovery well construction technique in LRA Section 3.3.2.1 (Uranium One, 2010a). The licensee's method of injection well construction uses a 5-inch diameter pilot hole cased with either a 5.6-inch or 6.6-inch outside diameter Standard Dimension Ratio polyvinylchloride casing surrounded with cement or bentonite grout and a screen installed for communication with the aquifer at the desired interval. The licensee has slightly modified its construction procedures indicating that bentonite may be added to the cement and that a wiper plug may be used between the cement and the displacement water. The licensee must meet the WDEQ well construction standards for injection wells. The NRC staff agrees that following the State's guidelines is acceptable. It is consistent with the recommendation of NUREG-1569, Section 3.1.2 that NRC reviewers shall consider the technical evaluations conducted by a State or other Federal agency with authorities overlapping those of the NRC. The staff has previously approved the well installation and completion methods during the prior license renewal review (NRC, 1998). The staff has found nothing to invalidate or call into question previous findings; therefore, the original findings and staff's prior conclusions remain valid. In accordance with NUREG-1569, Appendix A (NRC, 2003), the staff is not reexamining this issue.

The licensee states in LRA Section 3.3.2.2 that all cased wells are tested for integrity after installation. Wells also are retested for integrity after undergoing any physical alteration from

under-reaming or after any workover operation wherein the casing could be damaged. The integrity of operating wells will be tested routinely on a schedule of once every 5 years. The licensee also states in LRA Section 3.3.2.2 that any incompetent wells will be repaired or replaced, and will pass an integrity test before being placed back into service. The licensee did not commit to mechanical integrity test (MIT) of any wells suspected of having subsurface damage due to unusual operating conditions such as over pressurization or due to unusual natural phenomenon such as earthquakes or tornados that may damage subsurface piping that could lead to a loss of ISR fluids. Therefore, the NRC staff has prescribed a license condition in SER Section 3.1.4 to require the licensee to evaluate the need for MIT testing if such conditions are suspected. The licensee has committed in LRA Section 3.3.2.2 to keeping all integrity test records on file. These records are subject to NRC inspection. The NRC staff has previously approved the MIT testing and reporting during the prior license renewal review (NRC, 1998). Other than as noted, the staff has found nothing to invalidate or call into question its previous findings; therefore, the original findings and staff's prior conclusions remain valid. In accordance with NUREG-1569, Appendix A (NRC, 2003), the staff is not reexamining this issue.

3.1.3.3 Excursion Monitoring Wells

The NRC staff observes the licensee has monitoring wells in the aquifer overlying the production zone, in the aquifer underlying the production zone (depending on site conditions) and in the aquifer surrounding the production zone at all MUs. The wells surrounding the production zone are referred to by the licensee as perimeter ore zone monitoring wells and commonly referred to in the industry as production zone monitoring "ring" wells. These overlying, underlying, and perimeter ore zone monitoring wells are used to detect wellfield fluid migration away from the production zone. These wells are referred to throughout the industry as excursion monitoring wells.

The staff previously approved the distance of the perimeter ore zone monitoring wells from the upgradient, downgradient, and sides of each MU. The density of monitoring wells within the ore zone and in aquifers above and below the ore zone has also been established by the licensee and previously approved by staff. The details of the location of the monitoring well network can be found in LRA Section 3.3.1.2 (Uranium One, 2010a) and are consistent with what was previously approved by the NRC (NRC, 1998). The monitoring well locations and densities are consistent with what the staff has observed in use throughout the ISR industry and, as such, the staff finds them acceptable. The NRC staff has inspected the project on numerous occasions and has found that wellfield installation and the monitoring well network has been installed consistent with the commitments in the currently approved LRA. The NRC staff has found nothing to invalidate or call into question its previous findings; therefore, the original findings and staff's prior conclusions remain valid. In accordance with NUREG-1569, Appendix A (NRC, 2003), the staff is not reexamining this issue.

3.1.3.4 Spills and Leaks

The licensee discusses spills and leaks in LRA Section 3.3.3.3 as follows:

> The recovery and injection flow meters connect via signal wires to remote collection devices. The instantaneous and totalized flow information is then entered directly into a computer data base for flow balancing. Remote transmitting units are used to transmit the data to a centralized location. The computer system is also used to flag abnormal flow values which could be

indicative of a leak in the trunkline, or a problem with an individual well. Any irregularities will initiate inspection of the trunklines, feeder lines, or individual wells. Upon identification of a leak, relevant operations are curtailed until a repair is completed. A significant spill (>420 gallons if not into a draw or drainage) associated with a line leak of injection or recovery solution is documented regarding date of spill, nature and estimated quantity of lost fluid, soil sample results (if taken), results of any post remediation surveys (if taken), and posting on a map showing the spill location and impacted area. Any free standing fluid is contained and retrieved when feasible for proper disposal. Contaminated soils are excavated for proper disposal. The above documentation/steps are taken regarding a spill of any quantity of injection or recovery solution that enters a draw or drainage, or regarding a spill of any quantity of a solution other than recovery or injection solution. Documented spills are reported by telephone to the Wyoming DEQ and USNRC within 48 hours of the event.

Since the last license renewal, the licensee has had numerous leaks and spills that were required to be reported to the WDEQ due to their volume and/or contaminant concentration. As required by license condition 12.2, the licensee has also reported these spills to NRC (NRC, 2013b). The NRC staff observes that, when warranted, the licensee has investigated the impacts immediately following leaks and spills and taken corrective actions to clean up leaks and spills as required by WDEQ, NRC and commitments made by the licensee in the LRA. The licensee also is required by license condition 12.2 to maintain a list of the leaks and spills on site and will be required to demonstrate compliance with the soil and ground water standards for unrestricted release during NRC review of decommissioning. The NRC staff has previously evaluated the spill reporting and record keeping requirements during the prior license renewal review (NRC, 1998). The staff has found nothing to invalidate or call into question its previous findings; therefore, the original findings and staff's prior conclusions remain valid. In accordance with NUREG-1569, Appendix A (NRC, 2003), the staff is not reexamining this issue.

3.1.3.5 In Situ Process

The licensee reports in the LRA Section 3.0, Description of Proposed Operations, that the major components of the Christensen Ranch ISR operations will consist of uranium production from the ore bodies in previously approved wellfields and uranium ion exchange in the satellite plant, which includes the lixiviant injection circuit and the uranium production circuit. In the uranium production circuit, uranium will be loaded on ion exchange resins. Wellfield injection pressures, uranium production rates, bleed rates, plant material balances, flow rates, lixiviant makeup, and drawdown are discussed by the licensee in LRA Section 3.0. Operations at the Christensen Ranch Project also will include the restoration circuit, management of liquid waste, wellfield restoration, and surface reclamation. The licensee states in its LRA that loaded uranium resin will be trucked to the Irigaray CPP where the primary operations will be uranium elution, precipitation, drying, and packaging. The NRC staff has previously evaluated the ISR process at the Willow Creek Project during the prior licensing reviews (NRC, 1978a; 1978b; 1988a; 1988c, 1998). With the exception of minor changes in process relating to the use of either sulfuric or hydrochloric acid, the increase in flow rate, and an item identified in response to the NRC's Confirmatory Action Letter (NRC, 2012b) as discussed below, the staff has found nothing to invalidate or call into question its previous findings; therefore, the original findings and staff's prior conclusions remain valid. In accordance with NUREG-1569, Appendix A (NRC, 2003), the staff is not reexamining these issues.

The licensee has made minor changes to the ISR process. In 2011, the licensee requested to use either hydrochloric acid or sulfuric acid in the yellowcake precipitation process at the Irigaray Project (Uranium One, 2011). The NRC staff found that the licensee's request to use either sulfuric acid or hydrochloric acid in the yellowcake precipitation process was acceptable, as these chemicals are commonly used in the uranium recovery industry and have similar chemical properties (NRC, 2011a). In accordance with NUREG-1569, Appendix A (NRC, 2003), the staff is not reexamining this issue.

Uranium One proposes to increase its Christensen Ranch satellite plant throughput from 15,140 Lpm (4,000 gpm) to 34,070 Lpm (9,000 gpm) (Uranium One, 2012c; 2012b). To accommodate the increased flow, Uranium One is proposing to add six additional ion exchange (IX) columns (three column pairs) to the Christensen Ranch satellite plant, as shown in LRA figure 3.12. The additional columns would give the plant a total of seven IX column pairs, an increase from the current four column pairs currently in place. Uranium One states the additional IX columns are identical in size and flow capacity to the existing IX columns and that only a small expansion of approximately 660 ft^2 in to the existing satellite plant is required to accommodate a resin transfer bay. Uranium One plans to use the old transfer bay location to house groundwater restoration related equipment that was previously located where the new IX columns will be located. Uranium One states that any other modifications needed to the satellite plant to accommodate the flow increase will be within the existing foot print of the satellite plant. NRC staff finds this description to the change in the ISR process in the LRA adequate and will update the license to reflect this increase in flow.

Uranium One states operational standard operating procedures (SOPs) will not have to be changed as a result of the proposed change. Uranium One states the proposed increase in flow rate will not have any effect on the operations of the individual wellfields, individual wellfield operating pressures or individual well flow rates. Uranium One anticipates the Christensen Ranch Project will need an additional deep disposal well to handle production and restoration disposal capacities. Uranium One anticipates that the Christensen Ranch satellite plant would conduct two uranium-laden resin transfers daily to the Irigaray CPP and the Irigaray CPP would conduct two barren resin transfers to the Christensen Ranch plant, which is an increase from one trip per day. The NRC staff agrees that the increase in flow rate will not impact the operations of the individual wellfields, individual wellfield operating pressures or individual well flow rates and the additional IX columns proposed are sufficient to handle the increase in flow. The NRC staff agrees that an additional deep disposal well will be needed and this will be further discussed in SER Section 4.2.3.

On June 25, 2012, NRC was notified of an event regarding the opening of a pressurized drum of Uranium One's yellowcake by a Canadian uranium refinery to which the material had been shipped for further processing (NRC, 2012b). This event involved a yellowcake drum, shipped from Uranium One's Irigaray CPP in Wyoming to Cameco's Blind River, Ontario refinery, that either left the CPP under pressure or became pressurized during shipment. A worker at the Blind River refinery loosened the lid clamp of this pressurized drum, and uranium concentrate powder was ejected from the drum into the immediate work area. This resulted in three workers being exposed to airborne uranium. In response to the event, the NRC required Uranium One to investigate the cause of the event and take corrective action (NRC, 2012b). As a result of Uranium One's investigation, the licensee committed to changing several procedures related to yellowcake drying time and drum sealing (Uranium One, 2012a). NRC staff has evaluated the commitments made by Uranium One and finds the corrective actions and changes in procedures acceptable. The NRC staff will require that the commitments made by Uranium One

in response to the Confirmatory Action Letter be incorporated into the license. Therefore, the staff will require a license condition, as discussed in SER Section 1.4, to address this issue.

During the review process of the pressurized drum event, Uranium One confirmed, as discussed in LRA Section 3.4.1.4, that scrubber solids from the scrubber, used to remove contaminants prior to discharge to the atmosphere, are placed into the recovery process. The compatibility of this material to the recovery process is not discussed in the LRA. NRC staff has determined that Uranium One should confirm the compatibility of this material, or any material not normally associated with the uranium recovery process, before it is introduced back into the uranium recovery circuit. Therefore, the staff will require a license condition in SER Section 3.1.4 to address this issue.

In addition, the Ion Exchange/Lixiviant Makeup Circuit has been decommissioned at Irigaray and this section has been removed from the LRA. The NRC staff has observed, during inspection, that this circuit has been decommissioned and finds removal of this section from the LRA acceptable, as it is no longer required.

3.1.4 Evaluation Findings

The proposed ISR process and equipment for the Willow Creek Project are similar to those the licensee used in its past operations, which the NRC staff has reviewed and accepted during the last license renewal (NRC, 1998). The NRC staff concludes that the licensee's proposed ISR processes, equipment, and procedures are adequate to protect health and minimize danger to life or property and is in compliance with the requirements of 10 CFR 40.32(c), which requires licensee-proposed equipment, facilities, and procedures to be adequate to protect health and minimize danger to life or property; and 10 CFR 40.41(c), which requires the licensee to confine source or byproduct material to the locations and purposes authorized in the license, except as otherwise noted.

As discussed above, the following license condition related to MIT testing will be required:

> Mechanical Integrity testing is required prior to returning to service any injection well suspected of having subsurface damage due to unusual operating conditions or unusual natural phenomenon.

As discussed above, the following language will be added to the license requiring that material not normally associated with the uranium recovery process be analyzed before its introduction to the process:

> The licensee will analyze any material not normally associated with the uranium recovery process (e.g., scrubber solids) for compatibility (e.g., chemical and mechanical) with the uranium recovery process prior to processing that material to recover residual uranium.

As discussed above, the following language will be added to the license allowing an increase in flow rate:

> The licensee is authorized to conduct operations at a maximum flow rate of 9,000 gallons per minute, exclusive of restoration flow. Annual dried yellowcake production shall not exceed 2.5 million pounds.

Based upon the review conducted by the staff, as indicated above and the information provided in the LRA, the licensees description of its ISR process and equipment meets the applicable acceptance criteria of Section 3.1.3 of the standard review plan and the requirements of 10 CFR 40.32(c) and 10 CFR 40.41(c).

3.2 RECOVERY PLANT, SATELLITE PROCESSING FACILITIES, WELLFIELDS, AND CHEMICAL STORAGE FACILITIES—EQUIPMENT USED AND MATERIALS PROCESSED

3.2.1 Regulatory Requirements

The purpose of this section is to determine whether the licensee has sufficiently demonstrated that the equipment and processes to be used during operations in the CPP and other facilities at the Willow Creek Project will meet the requirements of 10 CFR 40.32(c) and 40.41(c), which, respectively, requires that the licensee's equipment, facilities, and procedures be adequate to protect health and minimize danger to life or property; and that the licensee confine source or byproduct material to the locations and purposes authorized in the license.

3.2.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria presented in Section 3.2.3 of the standard review plan (NRC, 2003).

3.2.3 Staff Review and Analysis

The NRC staff observes that the CPP, satellite processing facilities, wellfields, and chemical storage facilities at the Willow Creek Project are essentially the same as those the licensee has used in its past operations and that are currently in use. The NRC staff has reviewed and accepted the project location and designs during the last license renewal (NRC, 1998). The licensee will continue to use the Irigaray CPP to process uranium recovered from wellfields at the Christensen Ranch Project. At the Irigaray Project, the licensee's current operation involves a 0.12-km^2 [30-acre] wellfield (undergoing decommissioning), uranium recovery plant with a multi-hearth dryer, a wellfield restoration building, and four evaporation ponds for wastewater disposal. Continuing and future operations at Irigaray will consist of processing the Christensen Ranch ion exchange resins (elution), uranium precipitation, and yellowcake drying, packaging, and shipping. The NRC staff has inspected both facilities (SER Table 1.1) and uses these observations in making this determination.

The licensee states in LRA Section 3.1.2 that future wellfield installation and operations will occur at the Christensen Ranch Project. Existing facilities at the Christensen Ranch Project include the satellite ion exchange plant and restoration equipment, four lined brine-evaporation ponds, one unlined permeate-storage pond, two deep injection disposal wells, wellfields consisting of MUs 2 through 8, an office building, and a warehouse. In the future, the licensee plans to mine the entire ore body, MUs 9 through 12, using the satellite plant with an annual average capacity of 34,070 Lpm (9,000 gpm) connected to the various wellfields by injection and recovery trunk lines. The licensee provided in LRA Figures 3.1 through 3.3 detailed location maps of the Christensen Ranch Project license area and the wellfield development areas, as well as locations of all existing facilities (COGEMA, 2008c).

The licensee states that lixiviant will consist of either sodium bicarbonate/carbonate or carbon dioxide gas, using gaseous oxygen or hydrogen peroxide as the oxidant. Carbon dioxide gas also will be added for pH control and as an additional source of carbonate during the use of sodium bicarbonate. Lixiviant make-up is restricted to these chemicals by license condition 10.1.

The licensee provided in LRA Sections 3.4.1.9 and 3.4.2.6 an expanded description of chemicals used during processing that identified storage locations hazards associated with those chemicals. The following chemicals are stored in bulk at the Willow Creek Project: carbon dioxide, hydrogen peroxide, oxygen, hydrogen sulfide gas, hydrochloric acid, soda ash, sodium carbonate, sodium bicarbonate, sodium chloride, sodium sulfide, and sulfuric acid.

The licensee states that bulk hazardous materials, which have the potential to impact radiological safety, are segregated from areas where licensed materials are processed and stored. Oxygen is stored at the plant and in wellfields for introduction into the injection stream. The oxygen storage equipment is adequately separated from the main plant and other chemical storage areas. The NRC staff has observed and reviewed SOPs related to the handling, storage, and safety of bulk chemicals and found the SOPs adequate. NRC license SUA-1341, license condition 9.6, requires the licensee to have written SOPs for the Irigaray and Christensen Ranch sites. NRC staff inspections have determined that the licensee adequately applies administrative and process controls and design and operational measures at both facilities.

The licensee states that risk assessments completed by the NRC in NUREG-6733, “A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licensees,” identified anhydrous ammonia and bulk acids (sulfuric and hydrochloric) as the most hazardous chemicals stored by the licensee with the greatest potential for impacts to chemical and radiological safety. The licensee states in LRA Section 3.4.1.9 that strict unloading procedures are utilized to ensure that safety controls are in place during the transfer of these acids. Process safety controls are also in place at the Irigaray plant where sulfuric or hydrochloric acid is added to the elution and precipitation circuits. The licensee states that sulfuric and hydrochloric acid are also subject to Threshold Planning Quantities contained in 40 CFR Part 355, Emergency Response Plans, for threshold quantities in excess of 1,000 pounds and Reporting Quantities contained in 40 CFR 302.4.

The licensee identified petroleum and propane as chemicals that are not used directly in the uranium recovery process. Bulk quantities of petroleum and propane are stored outside away from process areas. The licensee states in LRA Section 7.5.3 that a spill prevention, control and countermeasure (SPCC) plan is in place for the Irigaray and Christensen Ranch Projects. The licensee states that although EPA only requires this plan for oil or raw petroleum fuel products, it has expanded its SPCC plan to include all stored chemicals. The SPCC plan is required by the EPA and contains preventive measures to assure that a spill from an aboveground storage tank is contained and countermeasures are established to prevent oil spills that could reach navigable waters.

To the extent that hazardous chemicals may potentially affect radiological safety at the Willow Creek Project, NRC concludes that the controls, equipment, and SOPs the licensee has developed for use to control hazardous chemicals is consistent with the acceptance criteria presented in Section 3.2.3 of the standard review plan (NRC, 2003) and is therefore acceptable. The licensee has identified where engineering controls such as ventilation equipment and

radiation monitoring equipment are located. The yellowcake dryer and packaging room is isolated when in use and personnel are required to use personal protective equipment when active drying and packaging operations are ongoing. The licensee is required by license condition 9.10 to maintain restricted area boundaries at both Irigaray and Christensen Ranch. The licensee's work practices and administrative controls are primarily outlined in SOPs the NRC staff has reviewed during inspections and found acceptable. The NRC staff has found nothing to invalidate or call into question its previous findings; therefore, the original findings and staff's prior conclusions remain valid. In accordance with NUREG-1569, Appendix A (NRC, 2003), the staff is not reexamining these issues.

3.2.4 Evaluation Findings

The NRC staff concludes that the licensee adequately described the equipment, facilities, and procedures that will be used during operations at the Willow Creek Project to protect health and minimize danger to life or property. The staff previously has approved the equipment, facilities, and procedures in use at the Willow Creek Project and the staff has found nothing to invalidate or call into question its previous findings; therefore, the original findings and staff's prior conclusions remain valid. The NRC staff concludes the additional equipment needed to support the increase in flow rate is minimal and includes three additional IX column pairs and the installation of an additional deep disposal well. Based upon the review conducted by the staff, as indicated above, the information provided in the LRA meets the acceptance criteria of Section 3.2.3 of the standard review plan (NRC, 2003) as well as the requirements of 10 CFR 40.32(c) and 10 CFR 40.41(c).

3.3 INSTRUMENTATION AND CONTROL

3.3.1 Regulatory Requirements

The purpose of this section is to determine whether the licensee has adequately demonstrated that the instrumentation and control proposed for the Willow Creek Project meet the requirements of 10 CFR 40.32(c) and 40.41(c), which, respectively, requires that the licensee's equipment, facilities, and procedures be adequate to protect health and minimize danger to life or property; and that the licensee confine source or byproduct material to the locations and purposes authorized in the license.

3.3.2 Regulatory Acceptance Criteria

If not specifically stated otherwise, the LRA was reviewed for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria presented in Section 3.3.3 of the standard review plan (NRC, 2003).

3.3.3 Staff Review and Analysis

The instrumentation and control features at the Willow Creek Project are essentially the same as those the licensee used in its past operations and are currently in use, which the NRC staff has reviewed and accepted during the last license renewal (NRC, 1998). The licensee states that at each MU at Christensen Ranch, the licensee connects groups of approximately 40 recovery wells and 50 injection wells with 1 to 2 inch [1 inch = 2.5 centimeter] polyethylene pipe into a central wellfield module building, also known as a header building. The flow capacity

of each module typically ranges from 1135 to 3410 Lpm [300 to 900 gpm]. The licensee states in LRA Section 3.3.3.3 that a central computer system is used to remotely monitor the status of MUs and automatically detect abnormal flow values that could indicate a leak in the trunk line or a problem with an individual well. The NRC staff has determined that very little additional instrumentation will be required to support the increase in flow rate and what will be used will be similar to instrumentation already in use.

The licensee states in LRA Section 3.3.3.4 the recovery rates the licensee will operate on individual recovery wells range from less than 19 to 151 Lpm [5 to 40 gpm], whereas the injection rates will be maintained at a balanced level somewhat lower than the recovery flow rates. The licensee states that the bleed rate will be approximately 1 percent of the overall flow rate, and the injection pressures are maintained below formation fracture pressure. The NRC staff observes that a 1 percent bleed rate is common in the ISR industry and has found it to be protective of public health and safety. The licensee will use chlorination (1 percent residual chlorine in the recovery solutions) to prevent biofouling in wellfields. The licensee described appropriate measures for protecting well heads and each well house, and for routine wellfield maintenance (e.g., debris removal, grass removal).

The licensee will provide the following instrumentation in the Irigaray plant: wastewater output to the lined evaporation ponds, high/low flow indicator alarms, pressure indicators (including pressure gauges and controllers on injection flow lines), pH indicators, tank level indicators, and flow indicators.

The licensee states in LRA Section 3.4.2.2 that, at the Christensen satellite plant, chemicals utilized and stored consist of carbon dioxide gas, gaseous oxygen, hydrochloric acid and sulfuric acid (small quantities), solid soda ash or sodium bicarbonate, and sodium chloride crystals. The licensee states in LRA Section 3.4.2.2 that all chemical storage tanks outside of the plant building are bermed to contain the volume of their contents in the case of a tank rupture. The licensee has replaced pipeline reducers at Christensen Ranch wellfields with a bell-type reducer to reduce pipe stress and avoided pipe failure as much as possible. In the event of a power failure, the licensee will use auxiliary power or carbon dioxide to clear the pipelines. The NRC staff reviewed solid, liquid, and gaseous waste management in Chapter 4.

The licensee has established appropriate procedures to manage spills as discussed in LRA Section 3.3.3. This includes (i) retrieving free-standing fluids and removing contaminated soils for disposal; (ii) documenting the date, nature, and estimated quantity of lost fluid, soil sample results, and results of any post-remediation surveys; and (iii) reporting spill incidents to WDEQ and NRC within 48 hours of the occurrence.

The staff reviewed NRC inspection reports dating from 1998 to 2012. During each of these inspections (SER Table 1.1), NRC inspectors reviewed various aspects of the licensee's ISR processing facilities. These reviews included a visual inspection of equipment associated with the CPP, wellfield header houses and the yellowcake dryer, along with their associated instrumentation and controls and a comparison of plant operating parameters (e.g., flow, pressure) with licensed limits. As a result of these inspections, the NRC inspectors determined that the licensee was conducting its ISR operations consistent with its license.

3.3.4 Evaluation Findings

The NRC staff has completed its review of the instrumentation and control techniques proposed for use at the Willow Creek Project. This review included an evaluation using the review

procedures in standard review plan Section 3.3.2 and the acceptance criteria in standard review plan Section 3.3.3. The instrumentation and control systems have been acceptably described for components, including the plant, wellfields, wellfield header houses, trunk lines, and deep disposal wells. As discussed in SER Section 3.3.3, the instrumentation will allow for continuous monitoring and control of systems, including flow rates for total inflow to the plant and total waste flow exiting the plant. Appropriate alarms are part of the instrumentation systems. The staff previously has approved the instrumentation and controls in use at the Willow Creek Project and the staff has found nothing to invalidate or call into question its previous findings; therefore, the original findings and staff's prior conclusions remain valid.

Based on the information provided in the LRA and the staff's detailed review of the instrumentation and control for the Willow Creek Project, the staff concludes that the proposed instrumentation is acceptable and is in compliance with 10 CFR 40.32(c) and 10 CFR 40.41(c).

4 EFFLUENT CONTROL SYSTEM

4.1 GASEOUS AND AIRBORNE PARTICULATES

This section discusses the basic design of the gaseous and airborne particulates effluent control systems for the Willow Creek Project as proposed by the licensee in its LRA. The purpose of the effluent control systems is to prevent and minimize the spread of gaseous and airborne particulate contamination to the atmosphere by the use of emission controls and to ensure compliance for radiation dose limits to the public.

4.1.1 Regulatory Requirements

For gaseous and airborne particulates generated at the Willow Creek Project, the NRC staff determines if the licensee has demonstrated compliance with Criterion 8 of Appendix A to 10 CFR Part 40, requiring milling operations be conducted so that all airborne effluent releases are reduced to levels that are ALARA. The licensee must also demonstrate that gaseous and airborne particulates comply with other relevant sections of 10 CFR Part 20 and 10 CFR Part 40.

4.1.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Parts 20 and 40, using the acceptance criteria presented in standard review plan Section 4.1.3 (NRC, 2003).

4.1.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by the licensee in its LRA. The staff also visited the project on several occasions during the course of this review to confirm information presented in the LRA. The following sections present the staff review and analysis of various aspects of the gaseous and airborne particulates that will be generated at the Willow Creek Project, as well as the licensee's proposed control measures for those gaseous and airborne particulates.

The licensee identified radon as the primary radioactive airborne effluent from the Christensen Ranch Project in the LRA Section 4.1.1, and identified radon and airborne yellowcake as the primary radioactive effluents from the Irigaray plant in LRA Section 4.1.2. The staff agrees with the licensee's assessment of the principal contaminants of concern.

4.1.3.1 Airborne Uranium Effluent Releases

The licensee states in LRA Section 4.1.2 that airborne uranium radioactive emissions in the Irigaray CPP are a result of yellowcake particulate emissions from the drying/packaging circuit. The Irigaray CPP employs a multi-hearth dryer for yellowcake processing. The process uses a hydrogen peroxide precipitation technique and a washing stage that forms a cake that does not require high-temperature firing to remove chemical contaminants. Few contaminants are

present when the yellowcake enters the dryer, allowing operating at a lower temperature resulting in lower dryer emissions.

The licensee states in LRA Section 4.1.2 that it plans to operate the dryer at Irigaray for up to 8,760 hr/yr to process uranium from Christensen Ranch operations. In the future, uranium from other projects may be dried at Irigaray. The licensee provided an updated MILDOS evaluation for an operation with a 1.1 million kg per year [2.5 million lb/yr] dryer throughput. The results of the MILDOS evaluation were provided in the LRA Section 7.3. The licensee states that WDEQ currently permits up to a 1.19 million kg per year [2.628 million lb/yr] throughput.

The licensee states in LRA Section 4.1.2 that to limit emissions of uranium fines, the exhaust systems in the dryer/packaging area are equipped with filters and a Venturi scrubber system. As the off-gases flow from the dryer to the Venturi scrubber, they are cooled in the connecting duct by the introduction of ambient air. The Venturi scrubber then removes all particulates down to the submicron size. The cleaned gas exits the top of the separator through an induced-draft fan and is discharged to the atmosphere through the stack, the top of which is 19 m [62 ft] above the ground surface and 6.4 m [21 ft] above the roof surface. Spent scrubber liquor is recycled to the main plant operation.

The licensee states in LRA Section 4.1.2 that approximately 75 to 80 percent of uranium fines at Irigaray are generated from packaging materials after drying and not from the dryer itself. The yellowcake solids exit the bottom of the dryer and are loaded into drums by a rotary valve. During the drum loading operation, the top of the drum is kept under negative pressure by the use of a drum hood fitted with a suction line. Any fugitive dust generated during the loading operation is captured by the hood and is transported by the suction line to a bag-house dust collector. The filtered air from the bag-house is combined with the dryer off-gas and is routed to the Venturi scrubber for further cleaning. The bag filters in the bag-house are periodically cleaned by an air shock back-flush that causes the solids to fall off the bag filters to the bottom of the bag-house where they are discharged to a drum by a rotary valve.

The licensee states in LRA Section 4.1.2 that the particulate emissions from the dryer are monitored on a semiannual basis through isokinetic stack testing. The licensee has provided the results of stack emission surveys performed from 1994 through 2001 in LRA Table 4.1 that indicate that the average stack emission rate was 23.7 percent of the WDEQ air permit limit of 0.14 kg/hr [0.3 lb/hr].

The NRC staff previously evaluated the licensee's drying and packaging equipment and control systems and found them acceptable (NRC, 1998). Staff could not verify during this renewal review if all the requirements of 10 CFR Part 40, Appendix A, Criterion 8, paragraph 2, relating to hourly checks and logs of all parameters relating to the yellowcake stack emission control equipment operation are being followed. Specifically, the staff could not determine how automated systems are used to satisfy the hourly checking and logging requirements. In addition, the staff could not identify how and what frequency the operability of emission control systems are tested and recorded, and, in the case of inoperability, how shutdown is initiated (manually or automatically).

10 CFR Part 40, Appendix A, Criterion 8, paragraph 2 states, in part:

> Checks must be made and logged hourly of all parameters (e.g., differential pressures and scrubber water flow rates) that determine the efficiency of yellowcake stack emission control equipment operation. The licensee shall

> retain each log as a record for three years after the last entry in the log is made. It must be determined whether or not conditions are within a range prescribed to ensure that the equipment is operating consistently near peak efficiency; corrective action must be taken when performance is outside of prescribed ranges. Effluent control devices must be operative at all times during drying and packaging operations and whenever air is exhausting from the yellowcake stack. Drying and packaging operations must terminate when controls are inoperative. When checks indicate the equipment is not operating within the range prescribed for peak efficiency, actions must be taken to restore parameters to the prescribed range. When this cannot be done without shutdown and repairs, drying and packaging operations must cease as soon as practicable.

Therefore, the staff is requiring a license condition, as detailed in SER Section 4.1.4, which will be added to the current license condition 10.8B, requiring the licensee to develop SOPs to verify compliance with10 CFR Part 40, Appendix A, Criterion 8. The staff will verify compliance with this license condition during inspection of the Willow Creek Project.

As discussed in SER Section 3.1.3.5, during the renewal period, Uranium One shipped yellowcake from the Irigaray CPP to Cameco's Blind River, Ontario refinery. One or more of the drums either left the plant under pressure or became pressurized during shipment. A worker at the Blind River plant loosened the lid clamp of the pressurized drum, and uranium concentrate powder was ejected from the drum into the immediate work area. This resulted in three workers being exposed to airborne uranium. The NRC Region IV issued a Confirmatory Action Letter requiring Uranium One to determine if any other drums are pressurized, conduct and investigation as to the cause of the pressurization of the drums, provide the Region IV Office with the results of the investigation, and provide any corrective actions taken to prevent the reoccurrence (NRC, 2012b). Uranium One responded to the Confirmatory Action Letter and outlined a series of corrective action taken to ensure pressurization of yellowcake drums does not reoccur (Uranium One, 2012a). The NRC staff finds the corrective actions taken acceptable.

The licensee states in LRA Section 4.1.1 that because the Christensen Ranch process is an entirely wet process and because uranium [yellowcake] is not concentrated onsite, there are no uranium particulate effluents released from the plant. Spills inside the Christensen Ranch plant are immediately washed down to reduce the potential for any buildup of radioactive particulates. The NRC staff has determined that since no yellowcake is produced at the Christensen Ranch plant, uranium releases are likely to be small, but not entirely absent. The NRC staff evaluation indicates that spills are likely to be a potential source of airborne uranium releases at this satellite plant. However, the NRC staff has determined that the licensee's procedures and commitments to immediately wash down an area affected by a spill will reduce the potential for any buildup of radioactive particulates is adequate. The NRC staff has required a license condition related to environmental and effluent air particulate monitoring in addition to radon monitoring at Christensen Ranch. The license condition described in SER Section 5.7.3.4 will require the licensee to demonstrate uranium releases are ALARA and within the requirements of 10 CFR Part 40, Appendix A, Criterion 7.

4.1.3.2 Radon Effluent Releases

The licensee describes the radon emissions from the Christensen Ranch process systems in LRA Section 4.1.1 as a closed, pressurized system, and that local ventilation systems are provided for specific tanks. Barren lixiviant contains radon gas, a small amount of which is

released into the atmosphere in the lixiviant makeup tanks at the Christensen Ranch plant. These unpressurized makeup tanks are vented directly to the atmosphere outside of the plant building to minimize personnel exposure. The licensee states that small releases of radon gas at the Christensen Ranch plant can occur during the resin transfer from the loaded ion-exchange column to the resin tanker trailer. The ion exchange column is vented to the atmosphere directly outside of the plant building to release the radon gas liberated during the transfer process. In addition to the tank ventilation, the plant building is equipped with exhaust fans to further remove radon that is released inside the building, on an as-needed basis.

The licensee describes the radon emissions from the Irigaray CPP in LRA Section 4.1.2. At the Irigaray CPP, radon emitted from resin processing is one source of radioactive emissions. The majority of the radon emissions are from the top of the elution columns, which are self-contained pressure vessels and are vented to the atmosphere outside the plant building. The plant buildings are equipped with exhaust fans to remove radon that is released inside the plant, on an as-needed basis.

The licensee describes radon emissions, radon controls, and radon monitoring conducted at onsite header houses in LRA Section 4.1.1. The licensee has reviewed those situations where radon progeny survey results exceeded 25 percent of the derived air concentration (DAC), and has determined that venting lines inside the header houses and inoperable ventilation fans were the causes of elevated radon progeny levels. The licensee proposes in LRA Section 4.1.1 to incorporate steps into maintenance procedures to assure that lines are vented outside the header houses and that ventilation fans are operable. Additionally, the licensee has committed to ensure that fans are operable during maintenance on bag filter systems, when production vent lines are being bled into the building and as determined by the radiation safety officer (RSO). The licensee notes that static vents in the header houses act to circulate outside air into the buildings. The NRC staff has determined based on the radon monitoring results provided by the licensee and commitments provided by the licensee that the radon controls to assure worker protection are adequate for header houses.

The NRC staff previously evaluated the licensee's radon effluent control systems at the Willow Creek Project and found them acceptable. NRC staff has determined that the radon emission controls, which include closed, pressurized systems, and local ventilation systems for other tanks that are vented outside the plants, are adequate. The staff has determined that the emission controls appear adequate based on the radon progeny monitoring results in the plants, and based on evaluations of similar operations at other ISR uranium recovery plants.

4.1.4 Evaluation Findings

The staff reviewed the proposed effluent control systems for gaseous and airborne particulates for the Willow Creek Project in accordance with Section 4.1.3 of the standard review plan (NRC, 2003).

The licensee acceptably described the sources of both uranium and radon at the Willow Creek Project and emission controls for the yellowcake dryer. Based on information provided in the LRA and information documented in annual ALARA reports, the NRC staff concludes that the effluent control systems at the Willow Creek Project are acceptable and are in compliance with 10 CFR Part 40, Appendix A, Criterion 8, which requires that all airborne effluent releases are reduced to levels as low as is reasonably achievable. The NRC staff evaluated a release of yellowcake shipped from Willow Creek at Cameco's Blind River, Ontario refinery. The NRC

staff finds that the corrective actions implemented at the Irigaray CPP are acceptable and should ensure a similar incident will not occur.

As discussed in SER Section 4.1.3.1, the NRC staff concludes that the licensee's gaseous airborne particulates effluent control systems are adequate to protect health and minimize danger to life or property. However, the licensee has not adequately described its periodic checks of the yellowcake dryer emission control systems operability, and has not described the logs or other documentation of those operability checks. The Willow Creek Project license condition 10.8 specifies the limitations on dryer and associated emission control systems but the referenced parameters are not in the revised LRA Section 4.1. Therefore, the following license condition language will be added to the current license condition 10.8B:

> Parameters that determine efficiency of yellowcake stack emission control must be identified and these parameters must be checked and logged hourly. If automated systems are used to satisfy the checking and logging requirements, the licensee must demonstrate in SOPs how the automated system will meet the hourly requirement. In addition, the licensee must identify the type and locations of human interfaces (alarms, lights, and monitoring stations), how and what frequency the operability of emission control systems are tested and recorded, and, in the case of inoperability, how shutdown is initiated (manually or automatically).

4.2 LIQUIDS AND SOLIDS

4.2.1 Regulatory Requirements

For liquid effluents generated at the Willow Creek Project, the NRC staff determines if the licensee has demonstrated compliance with 10 CFR 20.1301 (which defines dose limits allowable for individual members of the public), 10 CFR 20.2002 (which requires procedures for disposing of licensed material generated in the licensee's activities), and 10 CFR 20.2007 (which requires compliance with other applicable Federal, State, and local regulations governing any other toxic or hazardous properties of materials that may be disposed of under this subpart, e.g., waste disposal by injection in deep wells). For solid effluents generated at the Willow Creek Project, the staff will determine if the licensee demonstrated compliance with 10 CFR Part 40, Appendix A, Criterion 2, which requires that the licensee provide an estimated amount of contaminated material that will be generated and to demonstrate nonproliferation of waste disposal sites.

4.2.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria presented in Section 4.2.3 of the standard review plan (NRC, 2003).

4.2.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Uranium One in its LRA. The NRC staff also visited the project on several occasions during the course of this review to confirm information presented in the LRA. The

following sections present the staff review and analysis of various aspects of the liquid and solid waste that will be generated at the Willow Creek Project and the control and disposal of such wastes.

4.2.3.1 Liquid Wastes

The licensee states in LRA Sections 3.1.2 and 4.2 that liquid effluent control at the Christensen Ranch Project includes four lined evaporation ponds for evaporation of contaminated water, two deep disposal wells for injection into the Lance formation, and one permeate storage pond for holding water generated from the reverse osmosis (RO) unit when not used for lixiviant makeup or process stream recycle. The licensee also possesses a WYPDES permit for surface water discharges, but the licensee does not report in its LRA discharging any wastes to surface waters. NRC staff is unaware of any surface discharges under the WYPDES permit during the previous licensing period.

The licensee states in LRA Section 4.2.1 that production operations at Christensen Ranch produce two liquid waste streams: (i) a 1 percent bleed 151 Lpm [40 gpm], which is an essential component of the licensee's excursion control, and (ii) a liquid effluent stream 19 Lpm [5 gpm] that consists of sand filter backwash solutions, resin transfer wash water, and plant washdown water. The licensee discussed in LRA Section 4.2.1 several scenarios for waste disposal at the Christensen Ranch Project in the production only phase, the joint production/restoration phase, and the restoration only phase. Waste water is either sent to the lined evaporation ponds for temporary storage prior to deep well disposal, or sent directly to the deep disposal wells.

The licensee states that four evaporation ponds at the Christensen Ranch Project are capable of evaporating a 19 Lpm [5 gpm] effluent stream. The licensee states in LRA Section 4.2.1.1 that the pond system is designed so that it can totally empty the contents of one pond into the remaining ponds when there is a need to perform maintenance. The combined total capacity of the four ponds is 3.79×10^4 m^3 [30.72 ac-ft]. Each pond is lined with a reinforced Hypalon (synthetic) liner, and a leak detection system is installed under the liner. The licensee will test the leak detection taps that are installed at each end of the sumps to allow inspection and sampling on a weekly basis to check for potential pond leaks. The NRC staff has observed the evaporation ponds and leak detection system at the Christensen Ranch Project and the licensee's description of the ponds is consistent with staff observations.

The licensee states the permeate storage pond system at the Christensen Ranch Project is designed to store permeate from the RO process. The permeate quality will meet WYPDES water quality standards for surface discharge from uranium solution mines. Therefore, neither a leak detection system nor a synthetic lining is required. NRC staff has approved this pond design previously and agrees with the licensee's assessment. The licensee will use the stored permeate for process solution makeup, drilling water supply, wellfield restoration, deep well disposal, or if approved, for land application or surface discharge.

The licensee reports in LRA Section 4.2.1 that the Christensen Ranch Project possesses WDEQ permits for four deep disposal wells for Class I nonhazardous waste disposal. Only two deep disposal wells have been installed and are operating, COGEMA DW No. 1 and Christensen 18-3. The licensee states that injection into the two permitted disposal wells is specifically limited to fluids produced at the Irigaray or Christensen Ranch Projects with allowances to accept oil field or other solutions after WDEQ approval. The other two permitted

deep disposal wells, COGEMA DW No. 2 and DW No. 3, are not yet installed. The NRC staff notes that all four Christensen Ranch deep disposal wells are specifically approved for disposal of liquid wastes in SUA-1341, license condition 10.7.

The names of these four well were recently changed with the issuance of WDEQ Underground Injection Control Class I Injection Well Permit No. 10-219 that authorized Uranium One to continue to operate, or drill, complete and operated four deep disposal wells at the Christensen Ranch Project (WDEQ, 2012). The four wells were renamed:

Christensen Ranch DW No. 1
Christensen Ranch 18-3
Christensen Ranch DW No. 2
Christensen Ranch DW No. 3

License SUA-1341 LC 10.7 has been modified to reflect these new names.

The two deep disposal wells and four evaporation ponds potentially give the licensee a combined effluent capacity of greater than 568 Lpm [150 gpm]. The licensee states that it can use the evaporation ponds to store liquid effluents temporarily, if one or both deep disposal wells become inoperable for an extended period of time. Using the reported 1 percent bleed rate of 340 Lpm [90 gpm] using the increase flow rate of 34,070 Lpm (9,000 gpm) and the total capacity of the four ponds (i.e., 3.79×10^4 m^3 [30.72 ac-ft]), the NRC staff estimated that a single evaporation pond may allow the licensee to hold waste effluents for approximately 20 days, if the pond is initially empty. Therefore, the licensee has sufficient capacity to store production liquid wastes for approximately 80 days in four ponds, if both deep disposal wells become inoperable, and the ponds are initially empty. The NRC staff considers it unlikely that both deep disposal wells would become inoperable at the same time, and finds the licensee has adequate redundancy of its liquid disposal options (two wells and four ponds) to adequately maintain an inward hydraulic gradient in its wellfield to control wellfield fluids. Uranium One also has the ability to develop two additional wells at Christensen Ranch that are permitted by the WDEQ. These two wells provide additional assurance that the licensee will have adequate disposal capacity at the Christensen Ranch Project. The NRC staff has observed both installed deep disposal wells and evaporation ponds at the Christensen Ranch Project and the licensee's description of the wells and evaporation ponds is consistent with NRC staff observations.

At the Irigaray Project, there are four ponds used for evaporation of liquid wastes from the CPP operations. The licensee states in LRA Section 4.2.2 that the four ponds have essentially the same construction, consisting of a primary High-Density Polyethylene liner with a secondary Poly Vinyl Chloride liner. Between the liners is a geotextile fabric that will wick fluid to the grid of leak detection piping. The NRC staff has observed the evaporation ponds and leak detection system at the Irigaray Project and the licensee's description of the ponds is consistent with staff observations.

The licensee states that it possesses permits from the WDEQ for two deep disposal wells, DW-1 and DW-2, at the Irigaray Project. Neither well has been constructed.

At the Willow Creek Project, the licensee has developed plans and procedures for addressing contingencies for all reasonably expected system failures. The NRC inspection, conducted on December 7-9, 2010 (SER Table 1.1), for restart determined:

- **Emergency Preparedness -** The licensee established an emergency preparedness program as described in the Emergency Response Plan and associated implementing procedures. The licensee has sufficient equipment and trained personnel to respond to emergency incidents, including personnel injuries as well as releases or spills of radioactive materials. Audits of the program may be conducted as part of the ALARA program review. The licensee plans to update the Emergency Response Plan to include annual mock drills and to enhance communications with offsite emergency response entities.

- **Emergency Response Procedures -** The licensee established a detailed Emergency Response Plan for responding to emergency situations. The Plan was supplemented by implementing procedures. During the inspection, the licensee was contemplating the idea of deleting the emergency procedures since they duplicated the instructions provided in the Emergency Response Plan.

The licensee states that both the Irigaray CPP and the Christensen Ranch satellite plant are constructed with a curbed concrete floor equipped with a floor drain and sump system to control and reclaim spill and washdown water. The sumps discharge into the lined evaporation ponds outside of the plants. The NRC staff has observed these systems during inspections of the project.

The NRC staff has determined that common liquid effluents generated from the process bleed, process solutions (e.g., backwash, resin transfer waters), washdown water, well development water, pumping test water, and restoration waters are properly controlled. On-site evaporation systems are designed and operated in a manner that prevents migration of waste from the evaporation system to the subsurface. Plans and procedures are provided for addressing contingencies for all reasonably expected system failures. The NRC staff previously determined that the above-referenced liquid waste disposal options discussed by the licensee were acceptable (NRC, 1978a; 1978b; 1988a; 1988c, 1998). The staff has found nothing to invalidate or call into question its previous findings; therefore, the original findings and staff's prior conclusions remain valid.

4.2.3.2 Solid Wastes

The licensee states that the sand filter systems, tank sediments, and sump sediments will generate minor amounts of solid wastes as a result of the process effluent stream. The licensee will store unusable contaminated equipment, spent resin, bag filters, or other contaminated materials in a secured area until final disposition in an NRC-approved disposal area. The solid wastes will be disposed in the Pathfinder Mines Corporation Shirley Basin tailings impoundment that is a current NRC licensee. The licensee maintains a contract with Pathfinder for the disposal of such materials and is currently shipping byproduct materials to Shirley Basin from the Willow Creek Project. The NRC staff does not expect the increase in flow rate to increase the total amount of solid waste produced, but the waste will be produced at a faster rate. The increase in waste is expected to be minimal and Uranium One has disposal options in place to dispose of the additional waste.

The NRC staff has determined that the LRA contains a description of the methods to be used for disposing of contaminated solid wastes that are generated during operation of the project. Decommissioning wastes are addressed separately in Chapter 6 of the LRA entitled Restoration and Reclamation Plans. The NRC staff previously determined that the above-referenced solid

waste disposal options discussed by the licensee were acceptable (NRC, 1978a; 1978b; 1988a; 1988c, 1998). The staff has found nothing to invalidate or call into question its previous findings; therefore, the original findings and staff's prior conclusions remain valid.

4.2.4 Evaluation Findings

On the basis of the information presented in the LRA, the NRC staff concludes that the licensee has acceptably described the common liquid effluents generated at the Willow Creek Project. Appropriate control methods, including diversion to surface impoundments, deep well injection, and permitted surface discharge sites are identified. On-site evaporation system designs are prescribed in acceptable detail, including engineering plans and drawings. The planned sampling and analysis of contaminants in the leak detection systems are acceptable. The licensee has shown that liquid waste disposal options are adequate to handle different production and restoration stages. The licensee has an acceptable method for disposing of contaminated solid waste generated during the operation and decommissioning of the project that demonstrates compliance with 10 CFR Part 40, Appendix A, Criterion 2. The NRC staff previously determined that the effluent control systems related to liquids and solid effluents proposed by the licensee were acceptable (NRC, 1978a; 1978b; 1988a; 1988c, 1998) and therefore demonstrate compliance with 10 CFR 1301, 10 CFR 2002, and 10 CFR 20.2007. The staff has found nothing to invalidate or call into question its previous findings; therefore, the original findings and staff's prior conclusions remain valid.

5 OPERATIONS

5.1 CORPORATE ORGANIZATION AND ADMINISTRATIVE PROCEDURES

5.1.1 Regulatory Requirements

The NRC staff determines if the licensee has demonstrated that its corporate organization and administrative procedures for the Willow Creek Project are consistent with the requirements of 10 CFR 40.32(b), which requires that the licensee is qualified through training and experience to use source materials.

5.1.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed by the staff for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria presented in Section 5.1.3 of the standard review plan (NRC, 2003).

5.1.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Uranium One in its LRA. The NRC staff visited the site on several occasions during NRC inspections from 2008 to 2012.

The licensee presents the corporate organization and defines management responsibilities and authority at each organizational level in LRA Section 5. The NRC staff reviewed the organization and finds the definition of responsibilities and authority for radiation safety, industrial safety, and environmental protection programs are acceptable. The RSO responsibilities that are discussed in LRA Section 5.1.4 are consistent with the responsibilities outlined in NRC Regulatory Guide 8.31 (NRC, 2002a). The licensee states in LRA Section 5.1 that the RSO reports to the Site/Construction Manager, but retains the responsibility and authority to suspend, postpone, or modify any work activity that is unsafe or potentially a violation of NRC regulations or license conditions, including the ALARA program. The Site/Construction Manager has production- and safety-related responsibilities and reports to the Senior Vice President, ISR Operations. The licensee states in LRA Section 5.1 that the Senior Vice President, ISR Operations has the responsibility for management of all company ISR operations in the U.S. and has responsibility and authority for the radiation safety and environmental compliance programs at ISR operations. The licensee states in LRA Section 5.1 that the Manager of Environmental and Regulatory Affairs reports to the Senior Vice President, ISR Operations. The NRC staff found that sufficient independence exists in this organization so that significant safety issues can be raised to senior management for decisions.

The NRC has received notice that the management structure has changed (Uranium One, 2012d). The current Uranium One Radiation Safety and Environmental Protection Organizational Chart is displayed in SER Figure 5.1.

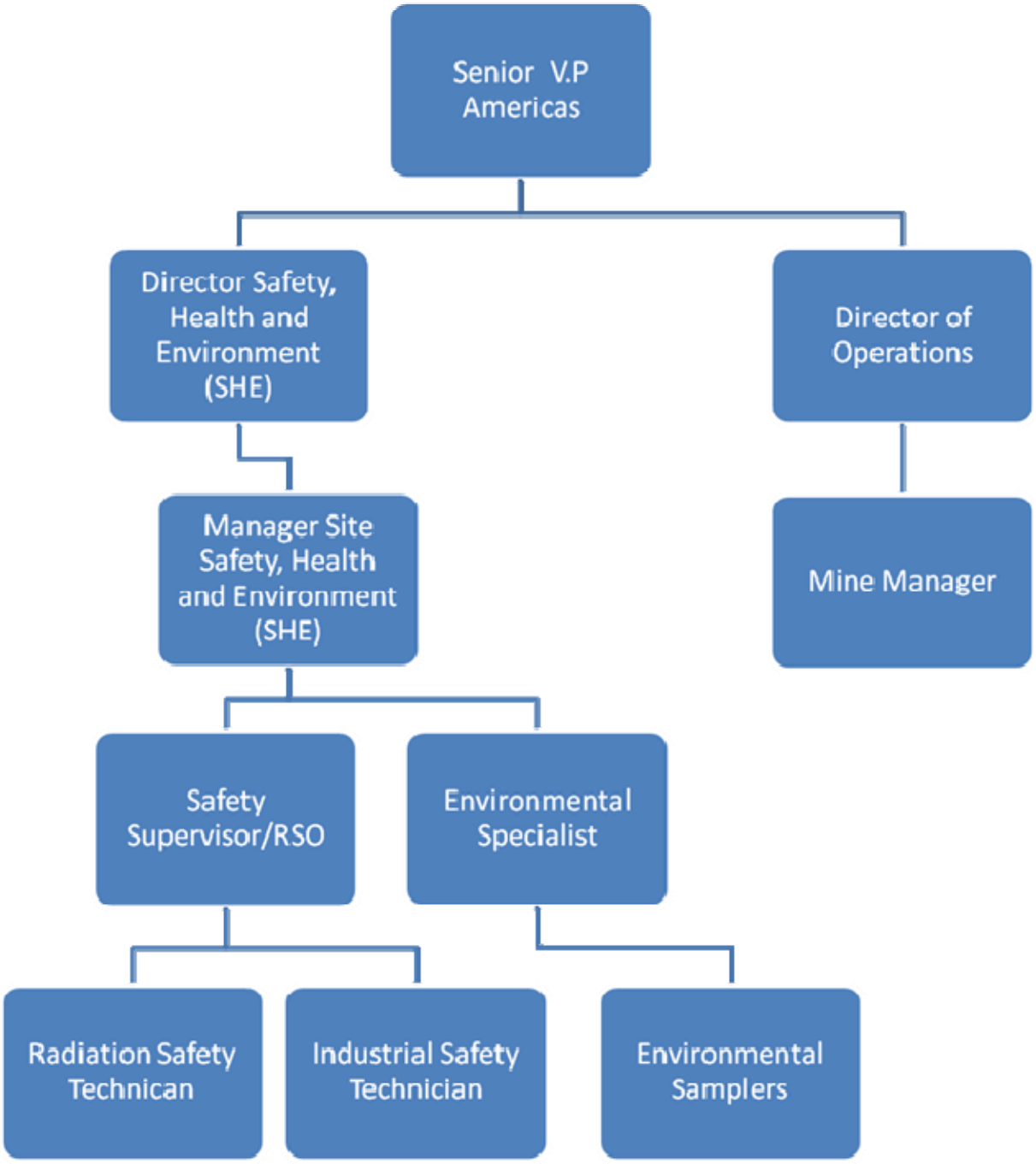

Figure 5.1. Uranium One Radiation Safety and Environmental Protection Organizational Chart

The NRC staff notes that under the new management structure, the RSO reports to the Manager, Site Safety, Health and Environment, who in turn reports to the Director, Safety, Health and Environment. In this structure, the RSO has been removed from the Operational chain of command. Ultimately, the RSO reports to the Senior Vice President, ISR Operations. The NRC staff observes that the licensee has not updated the LRA to reflect these management changes and expects the licensee to do so through the Safety and Environmental Review Panel (SERP) process and report the changes to the changes to the NRC in its annual SERP report as required by license condition 9.4.

The NRC staff previously has reviewed and approved the licensee's SERP that is utilized to make performance based licensing decisions within the bounds of SUA-1341, license condition 9.4. The staff has reviewed SERP SOPs and decisions made during NRC inspections and found them acceptable and within the bounds of license condition 9.4.

5.1.4 Evaluation Findings

The staff reviewed the corporate organization of the Willow Creek Project in accordance with the standard review plan (NRC, 2003). The licensee defined management responsibilities and authority at each level and diagramed the management organizational structure. NRC staff finds that the structure and responsibilities are acceptable and are similar to the structure observed by the NRC staff at other ISR projects that were found acceptable. The staff determined the proposed integration among groups that support operation and maintenance of the Willow Creek Project is adequate.

The NRC staff previously determined that the licensee's SERP composition is acceptable and reviewed SOPs related to SERP performance during the December 7 through 9, 2010 inspection (SER Table 1.1). Based upon the review conducted by the staff as indicated above, the staff concludes that the proposed corporate organization and administrative procedures provided in the LRA meet the acceptance criteria of Section 5.1.3 of NUREG-1569 (NRC, 2003) and the requirements of 10 CFR 40.32(b).

5.2 MANAGEMENT CONTROL PROGRAM

5.2.1 Regulatory Requirements

The staff determines if the licensee has demonstrated that the management control program for the Willow Creek Project is consistent with the requirements of 10 CFR Part 20, Subpart L, Subpart M and with 10 CFR 40.61. The staff also determines whether or not the licensee has demonstrated compliance with the health and safety requirement of 10 CFR 40.32(c).

5.2.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Parts 20 and 40 using the acceptance criteria presented in Section 5.2.3 of the standard review plan (NRC, 2003).

5.2.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Uranium One in its LRA. Additionally, as previously stated, the NRC staff visited the site on several occasions during NRC inspections from 2008 through 2012.

The licensee states that its management control program for environmental, health, and safety management consists of standards, management and operating procedures, and manuals. Written procedures are kept in accessible areas close to locations of operations and NRC inspectors have confirmed this during inspections. The licensee states that the RSO reviews and approves all procedures related to radiation safety and conducts an annual review of operating procedures. Radiation work permits are required for non-routine work tasks with a significant potential for radiological exposure and without a specific operating procedure. The licensee's records are maintained onsite and NRC inspectors have had adequate access to records during inspections.

Spills and excursions are reported to the NRC Project Manager and NRC Region IV as required by license condition 12.2 and the NRC has not cited improper spill reporting since the 1998 renewal. The NRC staff agrees with the licensee that SOPs for spill response and reporting procedures are followed. The licensee submits to the NRC an Annual Report consistent with license condition 12.1 and an ALARA report consistent with license condition 12.3.

The licensee follows a performance-based approach for considering process or procedure changes that may or may not involve prior NRC approval and an amendment to its license. NRC reviewed the performance-based approach described in the LRA and NRC inspection reports from 2000 through 2012. The inspection reports determined that the organizational structure was consistent with license requirements and that the Willow Creek Project adequately implemented performance-based license conditions. Furthermore, NRC inspections found that procedures were appropriately updated, reviewed, and were being followed.

During an NRC inspection in 2007 (SER Table 1.1), two Severity Level IV violations of NRC requirements occurred. The violations involved: (i) exceeding the annual production limit specified in the license of 22,700 kg [50,000 lb] of yellowcake; and (ii) having an expired waste disposal agreement. In response to the first violation, the licensee stated that no further uranium production would occur under the license. COGEMA requested a license amendment to permit the resumption of production at the sites with an annual production limit of 1.1 million kg [2.5 million lb] of yellowcake. An operational Standard Operating Procedure (SOP) was developed that provides routine production tracking to assure the annual operational production limit is not exceeded. In response to the second violation, the licensee executed a replacement agreement with the disposal company and modified the operational procedure concerning waste shipments to include reference to the expiration date of the disposal agreement. This provides an annual mechanism to note the expiration date so that the agreement could be renewed, if necessary, prior to expiration (COGEMA, 2007b). NRC staff found the licensee's response to identified violations acceptable.

During an NRC inspection in 2011, two Severity Level IV violations of NRC requirements occurred (SER Table 1.1). The violations involved: (i) failure to provide training to comply with appropriate Department of Transportation regulations; and (ii) failure of an employee to survey when exiting a restricted area as required by the license. In response to the first violation, the licensee committed to providing the training for the hazmat employee, and the training

procedure was updated to ensure function-specific training is listed as a requirement for hazmat employees. The NRC staff reviewed the training documentation and found it to be adequate. In response to the second violation, all employees were retrained on the importance of performing an exit survey when exiting the restricted area regardless of circumstances. The NRC staff reviewed the paperwork associated with the licensee's training and found it to be adequate.

During an NRC inspection in 2012, two Severity Level IV violations of NRC requirements occurred (SER Table 1.1). The violations involved: (i) failure to survey at two locations and post as radiation area as defined by 10 CFR 20.1003; and (ii) failure to maintain doses in an unrestricted area less than 0.02 milliSieverts (2 millirems) in any one hour. At this time, NRC staff have not reinspected the project to determine if the corrective actions taken have been adequate.

The management control program is reviewed by a SERP. The licensee has established a SERP that consists of at least three members with expertise in management with financial approval for changes, operations or construction, and radiation safety. The NRC finds the licensee's SERP is functioning as outlined in the LRA, SOPs, and license condition 9.4. However, the NRC will modify license condition 9.4 to update the terminology and to be consistent with recently licensed uranium recovery projects such as Moore Ranch, Nichols Ranch, and Lost Creek. The NRC staff has determined these changes are minor, such as changing the term, "structure, system, or component" to "facility structure, equipment, or monitoring system."

The licensee is required by license condition 9.9 to perform a cultural resource inventory before engaging in any construction activity not previously assessed by NRC. This license condition will not change with this license renewal. The NRC staff previously evaluated this information and found it acceptable (NRC, 1998). The staff has found nothing to invalidate or call into question its previous findings; therefore, the original findings and staff's prior conclusions remain valid.

5.2.4 Evaluation Findings

Based on the information provided in the LRA, operational history, and review of NRC inspection reports for the Willow Creek Project, the NRC staff concludes that the management control program is acceptable and is in compliance with:

- 10 CFR Part 40, Appendix A, Criteria 8 and 8A, which specify documentation requirements for airborne effluents and waste retention systems;
- 10 CFR 20.1101, which defines radiation protection program requirements;
- 10 CFR Part 20, Subparts L and K, which define requirements for record keeping and reporting; and
- 10 CFR 40.61(d) and (e), which also define requirements for record keeping.

Based on information submitted by the licensee, inspection reports and the results of NRC staff onsite review of operations, the staff has determined that the licensee's management control program is consistent with Regulatory Guide 8.31 (NRC, 2002a) and the standard review plan,

and is therefore acceptable. The NRC staff concludes that the licensee's management control program is adequate to protect health and minimize danger to life or property. The NRC staff previously evaluated the licensee's management control program and found it acceptable (NRC, 1998). The staff has found nothing to invalidate or call into question its previous findings; therefore, the original and staff's prior conclusions remain valid.

As discussed above, the NRC staff will modify license condition 9.4 to read:

9.4 Change, Test and Experiment License Condition

a) The licensee may, without obtaining a license amendment pursuant to 10 CFR 40.44, and subject to conditions specified in paragraph (b) of this condition:

   i Make changes in the projects as described in the license application (as updated);

   ii Make changes in the procedures as described in the license application (as updated); and

   iii Conduct tests or experiments not described in the license application (as updated).

b) The licensee shall obtain a license amendment pursuant to 10 CFR 40.44 prior to implementing a proposed change, test, or experiment if the change, test, or experiment would:

   i Result in more than a minimal increase in the frequency of occurrence of an accident previously evaluated in the license application (as updated);

   ii Result in more than a minimal increase in the likelihood of occurrence of a malfunction of a facility structure, equipment, or monitoring system (SEMS) important to safety previously evaluated in the license application (as updated);

   iii Result in more than a minimal increase in the consequences of an accident previously evaluated in the license application (as updated);

   iv Result in more than a minimal increase in the consequences of a malfunction of an SEMS previously evaluated in the license application (as updated);

   v Create a possibility for an accident of a different type than any previously evaluated in the license application (as updated);

   vi Create a possibility for a malfunction of an SEMS with a different result than previously evaluated in the license application (as updated);

   vii Result in a departure from the method of evaluation described in the license application (as updated) used in establishing the final safety evaluation report (FSER), environmental statement (ES), environmental assessment (EA) or technical evaluation reports (TERs) or other analyses and evaluations for license amendments.

For purposes of this paragraph as applied to this license, SEMS means any SEMS that has been referenced in a staff SER, TER, EA, or ES and supplements and amendments thereof.

c) The licensee is not required to obtain a license amendment if a proposed change, test, or experiment is consistent with NRC's previous conclusions, or the basis of, or analysis leading to, the conclusions of actions, designs, or design configurations analyzed and selected in the site or project SER, TER, ES, or EA. This would include all supplements and amendments to this license, and the TERs, EAs, EISs issued with those amendments.

d) The licensees determinations concerning whether a proposed change, test, or experiment meets the criteria in paragraphs (b) or (c) of this condition, shall be made by a Safety and Environmental Review Panel (SERP). The SERP shall consist of a minimum of three individuals. One member of the SERP shall have expertise in management (e.g., Plant Manager) and shall be responsible for financial approval for changes; one member shall have expertise in operations and/or construction and shall have responsibility for implementing any operational changes; and one member shall be the radiation safety officer (RSO) or equivalent, with the responsibility of assuring changes conform to radiation safety and environmental requirements. Additional members may be included in the SERP, as appropriate; to address technical aspects such as ground water or surface water hydrology, specific earth sciences, and other technical disciplines. Temporary members or permanent members, other than the three above-specified individuals, may be consultants.

e) The licensee shall maintain records of any changes made pursuant to this condition until license termination. These records shall include written safety and environmental evaluations made by the SERP that provide the basis for determining changes are in compliance with paragraph (b) of this condition. The licensee shall furnish, in an annual report to the NRC, a description of each change, test, or experiment, including a summary of the safety and environmental evaluation made under paragraph (d) of this condition. In addition, the licensee shall annually submit to the NRC changed pages to the approved LRA, which shall include both a change indicator for the area changed, e.g., a bold line vertically drawn in the margin adjacent to the portion actually changed, and a page change identification (date of change or change number or both), to the operations plan and reclamation plan of the approved license application (as updated) to reflect changes made under this condition.

5.3 MANAGEMENT AUDIT AND INSPECTION PROGRAM

5.3.1 Regulatory Requirements

The staff determines if the licensee has demonstrated that it meets the requirements of 10 CFR 40.32 (b) and (c) for the Willow Creek Project as it relates to the acceptability of management audits to ensure protection of health and minimize danger to life and property.

5.3.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria presented in Section 5.3.3 of the standard review plan (NRC, 2003).

5.3.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Uranium One in its LRA. The NRC staff visited the site on several occasions during NRC inspections from 2008 through 2012.

The licensee describes in LRA Section 5.3 its management audit and inspection program that includes daily documented walk-through inspections to observe radiation control practices, weekly inspections of the process area to observe radiation safety control practices, weekly evaporation pond inspections, and an annual ALARA audit. The licensee's inspection program for its evaporation ponds is specified by license condition 11.4. The licensee's action levels and inspections associated with yellowcake drying operations are specified by license condition 10.8. The licensee states in LRA Section 5.3, under the heading "Daily," that daily walk-through inspections will be performed at the Irigaray plant during dryer operations. The NRC staff has determined that this is not consistent with the guidance in Regulatory Guide 8.31 that indicates daily walk-throughs [inspection] should be performed at all facility [in-plant] areas. This would include the Christensen Ranch plant and the Irigaray plant even when dryer operations are not occurring at the Irigaray plant. The NRC staff observes that the licensee is required by license condition 11.5 to conduct documented daily walk-through inspections at both Irigaray and Christensen Ranch. In SER Section 4.1.4, the staff determined that it could not determine how automated systems are used to satisfy the yellowcake dryer hourly checking and logging requirements within the licensee's inspection program. In addition, the staff could not identify how and what frequency the operability of emission control systems are tested and recorded, and, in the case of inoperability, how shutdown is initiated. Staff determined a license condition was warranted in this case.

The licensee specifies in LRA Section 5.3 that the RSO or a qualified designee conducts daily and weekly inspections. The NRC staff notes that recommended qualifications for the licensee's staff for the conduct of the health physics program (including observations to determine adequate radiation safety practices) are specified in Regulatory Guide 8.31. The qualifications of the licensee's radiation protection staff (RSO and Radiation Safety Technician (RST)) proposed for the conduct of surveys of equipment leaving the restricted areas are described in LRA Section 5.4. The licensee has not provided an adequate description of the training and SOPs to be provided to qualified designees who are not radiation protection staff. A license condition is proposed in SER Section 5.4.4 to address the qualifications of personnel who are designated to conduct required inspections or surveys for personnel other than the radiation protection staff.

The staff reviewed NRC inspection reports dating from 1998 to 2012. During these inspections, NRC inspectors reviewed records associated with the licensee's health physics program area. As a result of these inspections, NRC inspectors determined that the licensee met applicable regulations and license conditions. Except as noted below under SER Section 5.4.4 relating to the qualifications of RSO designees to conduct daily or weekly inspections and properly trained employees to survey equipment prior to its release to an unrestricted area, the staff has not

found anything to invalidate or call into question its previous findings of adequate implementation of the licensee's health physics program.

The NRC staff reviewed the description of this program in the LRA and the results of the annual ALARA audits. The ALARA audit report is required by SUA-1341, license condition 12.6. In addition, the NRC staff reviewed NRC inspection reports written between 1998 and 2012. The ALARA audits documented that weekly inspections were performed and that the dryer was inspected daily when it was in use. The ALARA audit reports also demonstrated that trends in external and internal doses were being tracked and analyzed to keep doses ALARA. The NRC inspections determined that COGEMA and its successor, Uranium One, correctly implemented the performance-based conditions of the license, and that procedures were appropriately updated and reviewed. Except as noted, the NRC inspections also found that site activities were conducted in accordance with applicable license conditions and regulatory requirements. None of the inspection reports indicated any significant health or safety concerns. NRC found the licensee's management audit and inspection program, including the frequency, types, and scopes of reviews and inspections, to be acceptable.

5.3.4 Evaluation Findings

Based on the information provided in the LRA and NRC staff review of ALARA audit reports and NRC inspections, the NRC staff concludes that the management audit and inspection programs are acceptable. These audit and inspection programs address the control of air concentrations of radioactive material and trends in radiological monitoring and exposure data and, therefore, the NRC staff finds that the licensee is in compliance with 10 CFR 20.1702, which requires the use of process or other engineering measures to control the concentrations of radioactive material in the air, and 10 CFR 20.1101, which contains requirements for maintaining radiation exposure limits ALARA. In addition, the requirements of 10 CFR 40.32(b), (c), and (d) are met as they relate to the licensee's ability to ensure protection of health and minimize danger to life and property. The requirements of 10 CFR Part 40, Appendix A, Criteria 8 and 8A, are met as they relate to yellowcake drying and packaging operations and inspection of waste retention systems, except as noted in SER Section 4.1.4 regarding hourly checks of yellowcake dryer emission control equipment.

5.4 QUALIFICATIONS FOR PERSONNEL CONDUCTING THE RADIATION SAFETY PROGRAM

5.4.1 Regulatory Requirements

The NRC staff determines if the licensee has demonstrated that the personnel conducting the radiation safety program meet the requirements of 10 CFR 20.1101 and 10 CFR 40.32(b).

5.4.2 Regulatory Acceptance Criteria

The LRA was reviewed for compliance with the applicable requirements of 10 CFR Parts 20 and 40, using the acceptance criteria outlined in the standard review plan, Section 5.4.3 (NRC, 2003). Regulatory Guide 8.31, "Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Are As Low As Is Reasonably Achievable," provides recommendations for technical qualifications of radiation safety staff (NRC, 2002a).

5.4.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information and data submitted by the licensee in its LRA.

This section describes the qualification of key personnel conducting the radiation safety program. With regard to the qualifications of these key personnel, the licensee must demonstrate that its radiation safety program complies with 10 CFR 20.1101, which defines the radiation protection program requirements, and 10 CFR 40.32(b), which provides requirements for applicant qualifications. Regulatory Guide 8.31 (NRC, 2002a) provides recommendations for the technical qualifications of radiation safety staff, including the RSO and health physics technician (HPT). The NRC staff notes that the licensee uses the title of RST, but that the qualifications are identical to that of HPT as used in Regulatory Guide 8.31. The licensee is currently required by license condition 9.12 to implement the recommendations found in Regulatory Guide 8.31 (NRC, 2002a) for the RSO and RST. This license condition will be retained with this license renewal.

5.4.3.1 Radiation Safety Officer

The licensee describes minimum qualifications for the RSO in LRA Section 5.4. NRC staff reviewed the qualifications and found them acceptable because they are consistent with the qualifications specified in Regulatory Guide 8.31 for uranium recovery facilities.

The NRC staff reviewed NRC inspection reports from 1998 to 2012. During several inspections, NRC inspectors reviewed the responsibilities and qualifications of the RSO. NRC inspectors determined that all qualifications and required refresher training were complete and current as specified in the LRA, license condition, and as prescribed in Regulatory Guide 8.31 (NRC, 2002a). Based on the NRC inspections since the last LRA, except as noted in the Evaluation Findings below, the NRC staff has determined that the licensee is maintaining RSO qualifications consistent with license conditions and is therefore acceptable.

5.4.3.2 Health Physics Technicians (Radiation Safety Technicians)

The licensee describes minimum qualifications for RSTs in LRA Section 5.4. The NRC staff reviewed the qualifications and found them acceptable because they are consistent with the qualifications of HPTs specified in Regulatory Guide 8.31 for uranium recovery facilities.

The staff reviewed NRC inspection reports from 1998 to 2012. During several inspections, NRC inspectors reviewed the responsibilities and qualifications of the RST. NRC inspectors determined during the restart inspection (NRC, 2010a) that not all RST qualifications and required refresher training were complete and current as specified in the 1998 LRA or the options listed in Regulatory Guide 8.31 (NRC, 2002a).

The licensee subsequently submitted a license amendment request (Uranium One, 2011) to include all qualification options specified in Regulatory Guide 8.31 (NRC, 2002a). After reviewing the license amendment request, the NRC staff issued license amendment No. 20 (NRC, 2011a), dated August 2, 2011, which approved both qualification options specified in Regulatory Guide 8.31, Section 2.4.2, for HPT or RST qualifications.

5.4.3.3 Personnel Designated by the Radiation Safety Officer

In LRA Section 5.3, the licensee proposes to allow the RSO or qualified designee to conduct daily walk-through inspections at areas in the Irigaray plant during periods of dryer operation or weekly inspections of the process area to determine that radiation control practices are being followed. In LRA Section 5.7.6, the licensee proposes to allow the RSO, RST, or properly trained employees to conduct surveys of equipment prior to release to an unrestricted area. NRC staff observes these functions are typically performed by an RSO or RST. However, the licensee does not describe the training or qualifications in the LRA of either the "properly trained employee" or the "qualified designee" assigned to inspection or survey responsibilities.

NRC staff has determined that the licensee's LRA description of certain aspects of the health physics program areas are not consistent with either: (1) the guidance provided in Regulatory Guide 8.31 (NRC, 2002a), which indicates that the RSO or radiation safety staff are responsible for performing all routine and special radiation surveys required by license condition and 10 CFR Part 20; or (2) the Inspection and Enforcement Circular 81-07 (NRC, 1981) which recommends that only qualified radiation safety individuals perform these tasks. As previously discussed, the licensee is required by an existing license condition 9.12 to comply with the recommendations in Regulatory Guide 8.31. NRC staff has determined that the qualifications of the "properly trained employee" or the "qualified designee" to perform the specified surveys and inspections are not defined in the LRA and must be consistent with Regulatory Guide 8.31.

The NRC staff has determined that under certain circumstances the use of qualified designees may be used for specific activities such as: (1) the conduct of daily inspections for a short defined period in the temporary absence of the RSO or RST; (2) when surveying equipment, materials or packages moving from one licensed restricted area or controlled area to another licensed restricted or controlled area associated with an NRC-verified contamination control program, and (3) surveys of resin trucks leaving a restricted area and traveling to another restricted area of the licensee's Willow Creek Project. These exceptions are conditional upon the development of specific training for personnel performing these tasks that is reviewed and verified by the NRC. The NRC staff does not agree that "qualified designees" whose qualifications are not clearly defined by the licensee in a SOP should be used for weekly inspections. Weekly inspections should be done by the RSO or qualified designee that has appropriate training, as outlined in a SOP, in the absence of the RSO. License conditions are identified in SER Section 5.4.4 to address the radiation surveying of equipment leaving a restricted area, radiation surveying of resin trucks leaving one restricted are for another restricted area, requirements for the conduct of daily inspections, and use of qualified designees for weekly inspections.

5.4.4 Evaluation Findings

Based on the information provided in the LRA and the NRC staff detailed review of the qualifications for personnel conducting the radiation safety protection program at the Willow Creek Project, the NRC staff concludes that the qualifications for personnel conducting the radiation safety protection program are acceptable and are in compliance with 10 CFR 20.1101, which defines radiation protection program requirements, and 10 CFR 40.32(b), which provides requirements for applicant qualifications. The licensee describes minimum qualifications for key radiation safety personnel, the RSO and RSTs, in LRA Section 5.4. The NRC staff reviewed the qualifications and found them acceptable because they are consistent with the qualifications specified in Regulatory Guide 8.31 for uranium recovery facilities. The NRC staff previously

evaluated and approved the licensee's adoption of the recommendations of Regulatory Guide 8.31 for RST qualifications (NRC, 2011a). The staff has found nothing to invalidate or call into question its previous findings; therefore, the original findings and staff's prior conclusions remain valid.

The NRC staff has determined that the licensee's statements in LRA Sections 5.3 and 5.7.6 regarding inspections and surveys by personnel other than the RSO or RST are inconsistent with Regulatory Guide 8.31, which is binding on the licensee under existing license condition 9.12. The staff proposes a license condition to ensure that properly qualified personnel perform radiation surveys that are necessary to control the release of contaminated equipment and materials to unrestricted areas.

> Personnel performing contamination surveys for items released for unrestricted use shall meet the qualifications as health physics technicians or radiation safety officer as defined in Regulatory Guide 8.31 (as revised). Personal effects (e.g., notebooks and flash lights) which are hand carried need not be subjected to the qualified individual survey or evaluation, but these items should be subjected to the same survey requirements as the individual possessing the items.

The staff proposes a license condition related to surveying and of surveying of resin trucks leaving the restricted area and travelling to another Willow Creek Project restricted area.

> The licensee shall follow the guidance set forth in Regulatory Guide 8.30, as revised, "Health Physics Surveys in Uranium Recovery Facilities," or NRC-approved equivalent with the following exception:
>
> Within 90 days of license renewal, the licensee will develop an SOP and specific training for personnel that do not meet the qualifications of RSO or Health Physics Technician, as defined in Regulatory Guide 8.31, as revised, that are designated to survey resin trucks leaving a restricted area and traveling to another restricted area authorized by the license. The SOP and training shall be submitted to the NRC for review and verification.

The staff proposes a license condition related to the qualified designee(s) to perform surveys, as needed, associated with the licensee's contamination control program.

> The licensee may identify a qualified designee(s) to perform surveys, as needed, associated with the licensee's contamination control program when moving or transporting potentially contaminated equipment, materials, or packages from restricted or controlled areas through uncontrolled areas and back into controlled or restricted areas. The qualified designee(s) shall have completed education, training, and experience, in addition to general radiation worker training, as specified by the licensee. The education, training, and experience required by the licensee for qualified designees shall be submitted to the NRC for review and written verification. The licensee shall receive written verification of the licensees qualified designee(s) training program prior to its implementation.

The staff proposes a license condition related to the daily and weekly inspections completed by the RSO or qualified designee.

The licensee shall follow the guidance set forth in Regulatory Guide 8.31, as revised, or NRC-approved equivalent with the following exception:

The licensee shall describe in an SOP the training provided and procedures used by the RSO designate to conduct daily inspections in the temporary absence of the RSO or Radiation Safety Technician. The SOP for the conduct of daily inspections and training requirements shall be submitted to the NRC for review and written verification. Weekly inspections shall be performed by the RSO and follow the recommendations of Regulatory Guide 8.31, as revised. The licensee shall describe in an SOP the procedures used to conduct weekly inspections in the temporary absence of the RSO. The SOP for the conduct of weekly inspections shall be submitted to the NRC for review and written verification.

5.5 RADIATION SAFETY TRAINING

5.5.1 Regulatory Requirements

The NRC staff determines if the licensee has demonstrated that its radiation safety training program for the Willow Creek Project meets the requirements of 10 CFR 20.1101 and 40.32(b).

5.5.2 Regulatory Acceptance Criteria

The LRA was reviewed for compliance with the applicable requirements of 10 CFR Parts 20 and 40, using the acceptance criteria outlined in the standard review plan, Section 5.5.3 (NRC, 2003).

5.5.3 Staff Review and Analysis

Unless stated otherwise, the information reviewed in this section is from information and data submitted by the licensee in its LRA. NRC staff visited the site on several occasions during the course of this review to confirm information presented in the LRA.

The NRC staff reviewed the licensee's description of its training program in LRA Section 5.5. The NRC staff found that the radiation safety training program is consistent with NRC Regulatory Guides 8.31 (NRC, 2002a), 8.13 (NRC, 1999), and 8.29 (NRC, 1996) with exceptions noted below. The content of the training material, testing, on-the-job training, and the extent and frequency of retraining are acceptable. The licensee's ALARA audit reports indicated that training was conducted in accordance with license requirements and that quarterly safety meetings were conducted.

The staff reviewed NRC inspection reports dating from 1998 to 2012. During several inspections, NRC inspectors reviewed the employee radiation safety training program. NRC inspectors determined that all qualifications and required refresher training were complete and current as specified in the LRA, license condition, and as prescribed in Regulatory Guide 8.31 (NRC, 2002a).

Based on the licensee's commitment in LRA Section 5.7.6 that both alpha and beta contamination surveys will be performed, the licensee should revise its radiation safety training program in LRA Section 5.5.1 to reflect when surveys are required for alpha and beta contamination surveys for equipment, materials and for personnel leaving a restricted area, unless the employee takes a shower. In addition, the radiation safety training program should describe the training that is provided to personnel who conduct radiation surveys of resin trucks before they are allowed to leave restricted areas and travel to another restricted area of the Willow Creek Project. The NRC staff is proposing a license condition in SER Section 5.5.4 to address this issue.

5.5.4 Evaluation Findings

Based on the information provided in the LRA and the detailed review of the radiation safety training program at the Willow Creek Project, the NRC staff concludes that the radiation safety training program is acceptable. The training program is in compliance with 10 CFR 19.12 and 10 CFR 20.1101, which define radiation protection program requirements, and 10 CFR 40.32(b), as it relates to the licensee's qualifications through training and experience, with the following exception. Specifically, the training program does not reflect when alpha and beta contamination surveys need to be conducted before leaving a restricted area.

A license condition is proposed requiring the licensee to specify when alpha and beta contamination surveys will be conducted for personnel, equipment, and materials leaving a restricted area. The license condition for the conduct of these surveys is listed in SER Section 5.4. The staff proposes this license condition to address radiation safety training and qualifications of licensee's personnel designated to conduct radiation surveys.

> The licensee shall revise the applicable radiation safety training program to specify when alpha and beta contamination surveys are required to be conducted for personnel, equipment, and materials leaving a restricted area.

Based on the information provided in the LRA, detailed reviews of the radiation safety training program at the Willow Creek Project, and the license condition included in this section, the NRC staff concludes that the radiation safety program is acceptable and consistent with applicable NRC requirements in 10 CFR 19.12.

5.6 SECURITY

5.6.1 Regulatory Requirements

The LRA was reviewed for compliance with all applicable requirements of 10 CFR Part 20 using the acceptance criteria as outlined in NUREG-1569, Section 5.6.3 (NRC, 2003).

5.6.2 Regulatory Acceptance Criteria

The LRA was reviewed for compliance with the applicable requirements of 10 CFR Parts 20 and 71 using the acceptance criteria outlined in the standard review plan, Section 5.6.3 (NRC, 2003).

5.6.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by the licensee in its LRA. The NRC staff visited the site on several occasions during the course of this review to confirm information presented in the LRA.

The licensee states in LRA Section 5.6 that active production areas are controlled with fences and appropriate signs are posted to alert visitors that building or areas may contain radioactive materials, and that permission is required prior to entry. All areas where source or byproduct material is handled are fenced. The access road through the Willow Creek Project often carries passing traffic (such as oil and gas workers) that are allowed through the property unimpeded since they have no contact with radioactive materials.

The licensee describes the security for Irigaray in LRA Section 5.6.1 and the security for Christensen Ranch in LRA Section 5.6.2. The licensee states in LRA Section 5.6.1 and 5.6.2 that visitors to both Irigaray and Christensen Ranch are required to report to the site office where they register and receive a safety briefing and/or proper authorization prior to entering any process areas. The main access roads to both projects have locking gates and staff provides security. Pump houses that are closer to the county road are equipped with locking gates to prevent unauthorized access.

The licensee states in LRA Section 5.6.2 that CBM drilling/extraction activity in the general area is anticipated, and it is assumed that CBM personnel may have to travel by vehicles through the wellfields. The licensee states in LRA Section 5.6.2 that if CBM workers will be traversing wellfields, they will be provided appropriate radiation safety training. However, NRC staff notes that some CBM permits are within the boundaries of the licensee's wellfields, and that the details of CBM worker radiation safety training were not provided in the LRA. The licensee states that posting the header buildings as part of the restricted area will be sufficient for controlling access to these buildings. NRC staff has observed during inspections that these header building have locks to restrict access. The licensee states the historically low exposure rates within its wellfields would preclude the need to treat the wellfield as a restricted area and that posting header buildings as part of the restricted area (and controlling access to these buildings) will be sufficient to maintain security. The licensee does not propose to provide exposure monitoring for the transitory CBM workers. Staff agrees with the licensee's statements that historical exposures support the assessment that potential radiation dose to CBM personnel would be below a threshold for required external radiation monitoring by 10 CFR Part 20.

The NRC staff reviewed NRC inspection reports dating from 1998 to 2012. During several inspections, NRC inspectors reviewed the controls and access to licensed radioactive materials. NRC inspectors determined that controls or security for licensed radioactive materials were being implemented as specified in the NRC requirements and license conditions. The NRC inspection reports did not identify any issues with the security and storage of licensed radioactive materials. Except as noted below, staff has not identified any information to invalidate or call into question its previous findings in this area.

The NRC staff LRA review indicates that the licensee's security measures demonstrate acceptable constraints on entry to the licensed and restricted areas. The licensee has installed acceptable passive controls (e.g., fencing, locked gates, and warning signage for site control and active security systems for buildings.)

The NRC staff notes that the LRA Section 5.6 does not address the security of radioactive materials being transported between licensed projects, which is required by 10 CFR Part 71. A license condition, discussed in more detail below, will address this requirement.

5.6.4 Evaluation Findings

The staff reviewed the security aspects of the Willow Creek Project in accordance with the standard review plan (NRC, 2003). The licensee describes security measures for stored material and control measures for material within the restricted area. Based on the information provided in the LRA and the detailed review conducted of the security measures for the Willow Creek Project, the staff concludes that the security measures are acceptable with the following exceptions. The NRC staff determined that the LRA Section 5.6 does not describe the security of licensed radioactive materials being transported by the licensee on public roads or otherwise located outside a restricted area as required by 10 CFR 71.5. The NRC staff determined that the LRA Section 5.6 does not adequately describe the security of material and control of material not in storage as required by 10 CFR Part 20, Subpart I. The staff proposes the following license condition to address this situation.

> The security requirements and control of radioactive materials located outside restricted areas and during transportation activities by the licensee shall conform to the requirements of 10 CFR Part 20, Subpart I and 10 CFR 71.5. The licensee will develop SOPs or other plans to comply with 10 CFR Part 20, Subpart I and 10 CFR 71.5 requirements.

Based on the review conducted by the staff as indicated above, the information provided in the LRA, as augmented by the proposed license condition, meets the acceptance criteria in Section 5.6.3 of the standard review plan and the requirements in 10 CFR Part 20, Subpart I.

5.7 RADIATION SAFETY CONTROLS AND MONITORING

LRA Section 5.7 describes the techniques the licensee proposes to use to monitor and minimize radiation exposures. As part of its assessment, the NRC staff will discuss regulations and standards with which the licensee must comply and NRC guidance for implementing the regulations and standards. These regulations, standards and guidance are listed below and referenced throughout the remaining portion of Section 5.7, as follows:

<u>Regulations</u>

- 10 CFR 19.12, Instructions to Workers;
- 10 CFR Part 20, Subpart B - Radiation Protection Programs, § 20.1101;
- 10 CFR Part 20, Subpart C – Occupational Dose Limits, §§ 20.1201 – 1208;
- 10 CFR Part 20, Subpart F – Surveys and Monitoring, §§ 20.1501 and 20.1502;
- 10 CFR Part 20, Subpart L – Records, §§ 20.2101 – 20.2110; and
- 10 CFR Part 20, Subpart M – Reports, §§ 20.2201 – 20.2207.

<u>Numerical Standards</u>

- 10 CFR Part 20, Appendix B, Table 1 - Annual Limits on Intake and Derived Air Concentrations of Radionuclides for Occupational Exposure: Natural Uranium Class W

DAC: 3.0E-10 microcuries per milliliter (µCi/mL); Natural Uranium Class D DAC: 5E -10 µCi/mL;

- 10 CFR Part 20, Appendix B, Table 2 – Effluent Concentration Values for Air and Water (see10 CFR Part 20, Appendix B, Table 2 for concentration values);
- 10 CFR 20.1201 – Total Effective Dose Equivalent (TEDE): 5 rem, or the sum of the Deep-Dose Equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 50 rem;
- 10 CFR 20.1201 - Annual Limit to the Eye Lens: 15 rem;
- 10 CFR 20.1201 - Annual Limits to the Skin of the Whole Body and Extremity: 50 rem; and
- 10 CFR 20.1201(e) – Limit on the Soluble Uranium Intake by an Individual: 10 mg per week.

Guidance

- Regulatory Guide 4.14, “Radiological Effluent and Environmental Monitoring at Uranium Mills,” Revision 1, April 1980 (NRC, 1980);

- Regulatory Guide 4.15, “Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination) - Effluent Streams and the Environment,” Revision 2, July 2007 (NRC, 2007);

- Regulatory Guide 8.7, “Instructions for Recording and Reporting Occupational Radiation Exposure Data,” Revision 2, November 2002 (NRC, 2005);

- Regulatory Guide 8.13, “Instruction Concerning Prenatal Radiation Exposure,” Revision 3, June 1999 (NRC, 1999);

- Regulatory Guide 8.15, “Acceptable Programs for Respiratory Protection,” Revision 1, October 1999 (NRC, 1999);

- Regulatory Guide 8.22, “Bioassay at Uranium Mills,” Revision 1, August 1988 (NRC, 1988b);

- Regulatory Guide 8.25, “Air Sampling in the Workplace,” Revision 1, June 1992 (NRC, 1992c);

- Regulatory Guide 8.29, “Instruction Concerning Risks from Occupational Radiation Exposure,” Revision1, February 1996 (NRC, 1996);

- Regulatory Guide 8.30, “Health Physics Surveys in Uranium Recovery Facilities,” Revision 1, May 2002 (NRC, 2002b);

- Regulatory Guide 8.31, “Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable,” Revision 1, May 2002. (NRC, 2002a);

- Regulatory Guide 8.34, “Monitoring Criteria and Methods To Calculate Occupational Radiation Doses,” July 1992 (NRC, 1992b);

- Regulatory Guide 8.36, “Radiation Dose to the Embryo/Fetus,” Revision 0, July 1992 (NRC, 1992a); and

- Regulatory Guide 8.37, “ALARA Levels for Effluents from Materials Facilities,” July 1993 (NRC, 1993a).

5.7.1 Effluent Control Techniques

During the course of the review, the NRC staff determined that areas of review and acceptance criteria presented in Section 5.7.1 of NUREG-1569 (NRC, 2003), which addresses effluent control techniques, were covered in Section 4.1 of this SER, and therefore, are not discussed here.

5.7.2 External Radiation Exposure Monitoring Program

This section discusses the external radiation exposure, monitoring program. The purpose of this section is to describe the devices and methods the licensee will use to detect, measure, calculate, and/or monitor external radiation exposures to workers.

5.7.2.1 Regulatory Requirements

The NRC staff determines if the licensee has demonstrated that the proposed external radiation exposure monitoring program for the Willow Creek Project described in LRA Section 5.7.2 meets the requirements of 10 CFR Part 20, Subpart C, 10 CFR 20.1501(c), 10 CFR 20.1502, 10 CFR Part 20, Subpart L, 10 CFR Part 20, Subpart M, and 10 CFR 40.61.

5.7.2.2 Regulatory Acceptance Criteria

The LRA was reviewed for compliance with the applicable requirements of 10 CFR Parts 20 and 40 using the acceptance criteria presented in standard review plan Section 5.7.2.3. Also, Regulatory Guides 8.30 (NRC, 2002b) and 8.31 (NRC, 2002a) provide guidance on how compliance with the regulations can be demonstrated.

5.7.2.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information submitted by the licensee in its LRA. The NRC staff has conducted periodic inspections of licensed activities and also conducted inspections of operations to initiate restart of operations in 2010 and 2011that aided in staff confirmation of information presented in the LRA.

5.7.2.3.1 Surveys

The licensee states in LRA Section 5.7.2 that external gamma radiation surveys are performed on a quarterly basis, and on a monthly basis for areas exceeding the 2 mrem/hr administrative limit. The survey locations are identified in LRA Figures 5.2 and 5.3. Surveys are performed at potential gamma sources such as tanks and filters. The Willow Creek Project maintains an administrative action level of 2.0 mrem/hr. When the action level is exceeded at any survey location, the survey frequency for areas exceeding the action level is increased to weekly. In

cases of unusual gamma radiation increases, investigations are conducted and records are maintained of each investigation and the corrective action taken.

The licensee states in LRA Section 5.7.2.1 that gamma surveys will be performed in accordance with the guidance in Regulatory Guide 8.30 and will be conducted using instructions provided in a SOP. The staff agrees that these are acceptable practices and are consistent with survey requirements in 10 CFR Part 20. The licensee states in LRA Section 5.7.2.1 that if the results of a gamma survey identify areas where gamma radiation is in excess of levels that delineate a "radiation area", access to the area is restricted and the area is posted as required in 10 CFR 20.1902 (a). The licensee states in LRA Section 5.7.2.1 that the gamma surveys conducted since 1987, as indicated in LRA Table 5.1, show the average annual exposure rates at the Willow Creek Project have not exceeded 1.0 mrem/hr. The NRC staff agrees with this assessment.

The licensee proposes in LRA Section 5.7.2.1 a quarterly survey frequency, and a monthly survey frequency, for areas exceeding the administrative level of 2 mrem/hr. The licensee states that the historical survey data demonstrates that these frequencies are adequate to detect changes in plant conditions and are adequate for radiological safety. The NRC staff notes that these survey frequencies differ from the recommendations in Regulatory Guide 8.30, but the staff has determined that the survey information provided supports the licensee's proposed survey frequency and concurs with the proposed survey frequency.

The NRC staff reviewed NRC inspection reports dating 1998 to 2012. During these inspections, NRC inspectors reviewed records associated with this health physics program area. As a result of these inspections, NRC inspectors determined that the licensee met applicable regulations and license conditions. Except as noted below under Evaluation Findings of this SER section, the staff has not found anything to invalidate or call into question its previous findings of adequate implementation of this health physics program area.

5.7.2.3.2 Personnel Monitoring

The licensee states in LRA Section 5.7.2.2 that all employees working full-time in a process facility or laboratory area at the Willow Creek Project are issued personnel dosimeters (i.e., Thermoluminescent Dosimeters (TLD's)). The NRC staff review of the personnel dosimetry results provided in LRA Table 5.2 for 1995 through 2007 finds the proposed monitoring approach consistent with the requirements of10 CFR 20.1502 for the monitoring of the occupational exposure of employees.

The NRC staff reviewed NRC inspection reports dating from 1998 to 2012. During these inspections, NRC inspectors reviewed records associated with this health physics program area. As a result of these inspections, NRC inspectors determined that the licensee met applicable regulations and license conditions. The staff has not found anything to invalidate or call into question its previous findings of adequate implementation of this health physics program area.

5.7.2.3.3 Historical Survey Results

The licensee describes the gamma survey instrumentation in LRA Section 5.7.2.1 and indicates the frequency of calibrations. The licensee indicates that daily source checks are used to assess existing instrument operation. The licensee considered Regulatory Guide 8.30 on health physics instrumentation and states that the manufacturer or a qualified accredited vendor will

calibrate portable survey instruments and radiation counters. The NRC staff agrees that these practices are consistent with the recommended practices in Regulatory Guide 8.30 to ensure that the 10 CFR 20.1501 requirements for surveys are met.

The NRC staff reviewed the annual results of external monitoring provided in LRA Table 5.2 that was conducted at the Willow Creek Project. The average annual doses were relatively constant for the period from 1995 through 2004. The average doses to workers were in the 25 to 60 mrem/yr range during periods of operation from 1995 to 2002. LRA Table 5.2 indicates for the period from 2005 to 2007 that lower gamma exposure rates were measured at both Irigaray and Christensen Ranch due to the lack of process activities and, in the case of Irigaray, as a result of decommissioning portions of the plant, which eliminated significant gamma sources such as the ion exchange cells. Despite historical dose results that have been below the 10 percent criterion for required monitoring, the licensee will continue to implement its external radiation, monitoring program. The licensee uses TLD or optically stimulated luminescent dosimeters for monitoring external exposure to radiation at the Willow Creek Project. The dosimeters are processed quarterly by TMA Eberline Corporation. In accordance with 10 CFR 20.1501(c) requirements, TMA Eberline Corporation is an accredited provider under the National Voluntary Laboratory Accreditation Program administered by the National Institute of Standards and Technology. The NRC staff finds the licensee's personal dosimetry program consistent with 10 CFR 20.1502 requirements and acceptable.

5.7.2.3.4 Records and Reporting

The licensee states in LRA Section 5.7.2.2 that it documented radiation exposures to individual workers. The NRC staff reviewed NRC inspection reports dating 1998 to 2012. During these inspections, NRC inspectors reviewed records associated with this health physics program area. As a result of these inspections, NRC inspectors determined that the licensee met applicable regulations and license conditions. Except as noted below, the staff has not found anything to invalidate or call into question its previous findings of adequate implementation of this health physics program area.

The licensee provided information in LRA Section 5.7.6 on its plans to conduct an annual beta dose rate surveys at the Willow Creek Project in areas where large quantities of aged uranium are expected to accumulate. These areas are identified as the Irigaray Project precipitation and drying and packaging areas.

The licensee has not provided results of gamma survey and radon daughter surveys in LRA Section 5.7.2.1 or 5.7.3.2 for the header houses or provided a basis that gamma surveys or radon daughter surveys are not warranted. The NRC's regulations at 10 CFR 20.1501 require licensees to conduct surveys to determine potential radiological hazards. The licensee has not provided any data for the Willow Creek Project or provided any other information to demonstrate that radiation hazards have been quantified in header houses. The staff notes that NRC inspection survey results at other ISR uranium recovery projects have indicated that periodic gamma surveys have been warranted in header houses. The staff will require a license condition related to gamma surveying in header houses in SER section 5.7.2.4.

5.7.2.4 Evaluation Findings

Based on the information in the LRA and the detailed review of the external radiation exposure monitoring program at the Willow Creek Project, the NRC staff concludes that the external

radiation exposure monitoring program is acceptable and meets the applicable acceptance criteria of Section 5.7.2.3 of NUREG-1569 (NRC, 2003) and is in compliance with the following regulations, except as noted below:

- 10 CFR 20.1101, which defines radiation protection program and ALARA requirements;
- 10 CFR 20.1201(a), which provides occupational dose limits;
- 10 CFR 20.1501, which provides survey and radiation monitoring requirements;
- 10 CFR Part 20, Subpart L, which specifies record keeping requirements; and
- 10 CFR Part 20, Subpart M, which defines reporting requirements.

The NRC staff concludes that the licensee's LRA has not demonstrated that some aspects of the external radiation exposure monitoring program are adequate and in compliance with 10 CFR Part 20, Appendix F, "Surveying and Monitoring." The LRA Section 5.7.2 does not provide information on surveys in header houses or adequately address the need for gamma surveys in header houses. The staff proposes the following license condition to require the licensee to conduct appropriate surveys in header houses and to determine if shallow-dose assessments are warranted in accordance with 10 CFR 20.1501.

> The licensee shall conduct surveys in accordance with 10 CFR 20.1501 in header houses to evaluate the magnitude and extent of radiation levels and to determine the presence of potential radiological hazards present.

5.7.3 In-Plant Airborne Radiation Monitoring Program

5.7.3.1 Regulatory Requirements

The NRC staff determines if the licensee has demonstrated that the in-plant airborne radiation monitoring program for the Willow Creek Project meets the requirements of 10 CFR Part 20, Subpart B and Subpart C, 10 CFR 20.1501, and 10 CFR 20.1702.

5.7.3.2 Regulatory Acceptance Criteria

Unless otherwise specified, the LRA was reviewed for compliance with the applicable requirements of 10 CFR Part 20 using the acceptance criteria in standard review plan Section 5.7.3.3 (NRC, 2003) and for conformance with Regulatory Guide 8.30 (NRC, 2002b) that provides guidance on how to demonstrate compliance with the regulations.

5.7.3.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from the LRA submitted by the licensee. The NRC staff has visited the Willow Creek Project on several occasions from 2008 to 2012 during the conduct of inspections that assisted staff in the LRA review.

The following sections describe and evaluate the in-plant airborne radiation, monitoring program proposed by the licensee. The program consists of airborne uranium particulate monitoring,

radon daughter concentration monitoring, and the respiratory protection program. The purpose of the in-plant airborne radiation monitoring program is to characterize the airborne uranium and radon daughter levels at various locations in the plant to ensure that workers are adequately monitored for internal radiation exposures and areas are adequately posted in accordance with the applicable sections of 10 CFR Part 20.

5.7.3.3.1 Airborne Particulate Uranium Monitoring

The licensee describes its in-plant airborne monitoring program in LRA Section 5.7.3 and discusses area sampling and individual breathing zone sampling for airborne uranium particulates and area sampling for airborne concentrations of radon decay products. The licensee states in LRA Section 5.7.4.1 it considers the chemical toxicity of uranium and limits individual intakes of soluble uranium to 10 mg in a week. The licensee states in LRA Section 5.7.3.1 that if an individual exposure exceeds 25 percent of the DAC for soluble uranium, an investigation is performed and sampling frequency is increased to weekly.

The licensee indicates in LRA Table 5.6 that it considers the uranium in the yellowcake dryer, drum packaging areas, and control room area to be 85 percent class D and 15 percent class W. LRA Table 5.6 lists natural uranium associated with processes before the dryer as solubility Class D. The licensee also provided the results of its uranium solubility testing in LRA Table 5.2a, and classifies the uranium solubility in the stack, control room, filter press area, and dryer/packaging area.

The staff has determined that the DAC values determined by the licensee based on solubility sampling results and process knowledge are reasonable and supported by the data provided, except as noted below. The staff cannot agree that the same DAC values are warranted for the control room and dry/pack areas based on the data presented in LRA Section 5.7.3.1 and listed in LRA Table 5.6. The data provided shows different amounts of Class D and Class W uranium in airborne uranium concentrations for these areas. Specifically, the staff does not agree that the LRA information in Section 5.7.3.1 supports a control room DAC of 4.7 E-10 µCi/mL based on the 77 percent Class D and 23 percent Class W uranium compounds when the same DAC value of 4.7E-10 µCi/mL in Table 5.6 is assigned to a mixture of 85 percent Class D and 15 percent Class W uranium compounds. The licensee explained these differences in uranium airborne concentrations in LRA Section 5.7.3.1, and indicates that the control room area (outside the dryer enclosure) airborne uranium concentrations results from yellowcake dryer stack effluents being pulled into the control room due to a negative pressure gradient in the dryer, and from yellowcake dryer releases into the general area of the dryer. The staff does not agree that the LRA information in Section 5.7.3.1 supports a control room DAC of 4.7 E-10 µCi/mL based on the 77 percent Class D and 23 percent Class W uranium compounds. A license condition in SER Section 5.7.3.4 will address this deficiency.

The licensee states in LRA Section 5.7.3.1 that the air sample volume is adequate to achieve the lower limits of detection (LLD) for uranium in air or the counting time is adjusted to assure the needed LLD. The staff agrees that this approach is consistent with Regulatory Guide 8.30 and is acceptable to determine the LLD.

The licensee states in LRA Section 5.7.3.1 (as shown in LRA Figure 5.4) that it performs area sampling for airborne natural uranium weekly at three locations inside the dryer room and three locations just outside of the dryer room. Monthly in-plant monitoring is performed at other airborne particulate monitoring stations, including four stations shown in LRA Figure 5.3 at Irigaray and one additional location shown in LRA Figure 5.2 at Christensen Ranch. The

licensee uses sampling results for determining airborne radioactivity areas and monitors personal exposure during operations. The licensee proposes in LRA Section 5.7.3.1 to continue the same airborne uranium monitoring program at Irigaray and Christensen Ranch that has been performed to date. The NRC staff determined that the location and frequency of surveys for airborne radiation are consistent with Regulatory Guide 8.30 and radiation exposure documentation is acceptable.

The NRC staff does not agree with the licensee's statements in LRA Section 5.7.3.1 that all gross alpha activity on air samples can be attributed to uranium, and does not agree that a DAC based only on gross alpha activity is adequate. Based on its knowledge of the ISR process at Irigaray, the staff agrees that radioactivity in air samples in the dryer/packaging area is natural uranium, but information in the LRA does not support the licensee's assumption that all gross alpha activity is natural uranium in all processing areas. The NRC staff notes that the licensee may calculate a uranium DAC for all process areas based on its solubility testing, but the licensee should not assume that radium-226 or thorium-230 are not present in airborne samples for process areas upstream of the IX columns. The licensee has not provided radiological characterization data to demonstrate that radium-226 and thorium-230 are not present in processing areas and information to support its assumption that all gross alpha activity is due to natural uranium. A license condition in SER Section 5.7.3.4 will address this deficiency.

The NRC staff reviewed in-plant air sampling results for gross alpha activity provided in LRA Table 5.3. The licensee compared the airborne concentrations to a DAC of 5×10^{-10} µCi/ml for solubility class D natural uranium. The licensee uses this DAC to establish an administrative action level, equal to 25 percent of its value. The licensee states that an investigation would be performed and the sampling frequency for airborne monitoring would increase from monthly to weekly if a monthly airborne particulate sample exceeded the action level of 25 percent of the DAC for soluble natural uranium. Sampling frequency would return to monthly only after four consecutive weeks of sampling results below the action level. Staff has determined that this approach is generally acceptable since the calculated DAC for processing areas is 4.7×10^{-10} to 5.0×10^{-10} µCi/mL.

The NRC staff reviewed data taken between 1995 and 2007 that showed that annual average air concentrations ranged from 0.08 to 0.64 percent of the DAC for Irigaray and 0.11 to 0.86 percent of the DAC at Christensen Ranch. Maximum monthly air concentrations ranged from 0.52 to 2.04 percent of the DAC for Irigaray and 0.26 to 3.2 percent of the DAC for Christensen Ranch.

The staff reviewed NRC inspection reports dating 1998 to 2012. During these inspections, NRC inspectors reviewed records associated with this health physics program area. As a result of these inspections, NRC inspectors determined that the licensee met applicable regulations and license conditions. Except as noted below in SER Section 5.7.3.4, the staff has not found anything to invalidate previous findings of adequate implementation of this health physics program area.

5.7.3.3.2 Radon Daughter Concentration Monitoring

Radon daughter surveys at the locations shown in LRA Figures 5.2 and 5.3 have been conducted on a monthly basis at five locations inside the Irigaray CPP and at four locations inside the Christensen Ranch satellite plant. Results of radon progeny sampling are expressed in working levels and are shown in LRA Table 5.4. The licensee notes in LRA Figure 5.4 that the DAC for radon with progeny present is 0.33 working levels. Monitoring is conducted using

the modified Kusnetz method. Air samplers are calibrated annually or as recommended by the manufacturer.

The licensee has established an action level of 25 percent of the derived air concentration or 0.08 working levels. Radon progeny results in excess of the action level result in an investigation of the cause and an increase in the sampling frequency to weekly until the radon progeny levels do not exceed the action level. The NRC staff reviewed data in LRA Table 5.4 between 1995 and 2007 that showed annual average air concentrations ranged from 1.8 to 6.7 percent of the DAC for Irigaray and 1.5 to 6.4 percent of the DAC at Christensen Ranch; maximum monthly air concentrations ranged from 5.2 to 30.3 percent of the DAC for Irigaray and 9.1 to 237.9 percent of the DAC for Christensen Ranch. The NRC staff considers the licensee's established action level to be an ALARA goal that is consistent with Regulatory Guide 8.31 and to be acceptable.

The licensee states in LRA Section 4.1.1 that radon progeny monitoring occurs monthly at locations within Christensen Ranch header houses. The licensee states that during the last period of sustained production from 1990 to 1998 there were only four instances when header house radon daughter levels exceeded the 25 percent action level, indicating that elevated radon daughter levels in active header houses are relatively rare occurrences. The NRC staff agrees that the licensee's analysis shows that radon exceedances at header houses are infrequent and demonstrate that the licensee's ventilation in the header houses is adequate.

The staff reviewed NRC inspection reports dating from1998 to 2012. During these inspections, the NRC staff reviewed records associated with radon daughter concentration monitoring. As a result of these inspections, the NRC staff determined that the licensee met applicable regulations and license conditions.

The NRC staff reviewed the airborne concentrations of radon progeny the licensee measured in the operating areas shown in Figures 5.2 and 5.3. The data from 1995 through 2007 in LRA Table 5.4 shows that the average radon progeny activity concentration at Irigaray and Christensen Ranch Projects were generally less than 5 percent of the regulatory limit. The NRC staff found that the licensee's airborne radiation, monitoring program provides adequate protection for the health and safety of workers during operations. The licensee's radon progeny monitoring is consistent with the Regulatory Guide 8.30 recommended practices and is acceptable to the staff. The staff has not found anything to invalidate previous findings of adequate implementation associated with radon daughter concentration monitoring.

5.7.3.3.3 Respiratory Protection Program

The licensee describes its respiratory protection program in LRA Section 5.7.4.4. The licensee states that the program has been designed to implement the guidance in Regulatory Guide 8.15. The licensee proposes to provide respiratory protective equipment to workers when engineering controls may not be adequate to maintain acceptable levels of airborne radioactive materials or toxic materials. The respirator program is administered by the RSO.

The staff reviewed NRC inspection reports dating from 1998 to 2012. During these inspections, NRC staff reviewed records associated with the respiratory protection program. As a result of these inspections, NRC inspectors determined that the licensee met applicable regulations and license conditions. Staff has not found anything to invalidate or call into question its previous findings of adequate implementation associated with the respiratory protection program.

5.7.3.4 Evaluation Findings

NRC staff reviewed the in-plant airborne radiation, monitoring program of the Willow Creek Project in accordance with NUREG-1569 (NRC, 2003). The licensee did not propose any changes to its in-plant air sampling program from its previously approved in-plant air sampling program. The licensee plans to conduct in-plant airborne monitoring consistent with Subpart B, "Radiation Protection Programs," of 10 CFR Part 20, which defines the radiation protection program. This program includes monitoring for the two primary contaminants and the instruments that it will use to collect and analyze the results of the air samples. The licensee has demonstrated that adequate methods are being used to fully evaluate the in plant airborne radiation monitoring. Based on the review conducted by the NRC staff as indicated above, the information provided in the Willow Creek Project LRA meets the applicable acceptance criteria of the standard review plan and the applicable 10 CFR Part 20 requirements, with the following exception.

The staff concludes that the licensee has not demonstrated that all gross alpha activity is natural uranium and that radium-226 and thorium-230 do not pose airborne hazards. As discussed in more detail above, NRC staff finds that the in-plant airborne monitoring program does not meet the requirements of 10 CFR 20.1501, which specifies that surveys and monitoring for potential radiological hazards be conducted. The licensee will need to determine if airborne radioactivity contains radium-226 and other radionuclides. The staff proposes a license condition to require radiological characterization of airborne radioactivity in air samples as follows:

> The licensee shall conduct airborne samples for natural uranium, Ra-226, Po-210, Th- 230 and Pb-210 at each in-plant air particulate sampling location at a frequency of once every 6 months for 2 years, and annually thereafter, to ensure compliance with 10 CFR 20.1204. The licensee shall also evaluate changes to plant operations to determine if more frequent radionuclide analyses are required to demonstrate compliance with 10 CFR 20.1204. The licensee may demonstrate compliance or provide alternative procedures specific to in-plant air particulate sampling to show compliance with 10 CFR 20.1204 to the NRC for review and verification within 6 months of license renewal.

5.7.4 Exposure Calculations

This section discusses the exposure calculation to be performed by the licensee. Workers may be exposed to external radiation and also may inhale or ingest or otherwise take into their bodies radioactive materials that may result in internal dose. The determination of internal dose is principally by calculations from bioassay data or from measured airborne concentrations of radioactive materials. In addition, this section also discusses exposure calculations for female workers who declare pregnancy and the calculation of the embryo/fetus dose.

5.7.4.1 Regulatory Requirements

The staff determines if the licensee has demonstrated that the exposure calculations for the Willow Creek Project meet the requirements of Subparts C, F, L, and M of 10 CFR Part 20. Specific regulations that must be followed include: 10 CFR 20.1201(e), 10 CFR 20.1204(f), 10 CFR 20.1204(g), and 10 CFR 20.1502.

5.7.4.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 20 using the acceptance criteria presented in Section 5.7.4.3 of the standard review plan (NRC, 2003).

5.7.4.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by the licensee in its LRA. The NRC staff has visited the project on several occasions during the course of this review to confirm information presented in the LRA.

The following sections discuss the exposure calculations, which include internal and external occupational radiation dose as well as radiation doses to the embryo/fetus. Occupational workers may be exposed externally and internally to radioactive material in a number of ways. Exposures may include radioactive material in the air, loose surface contamination, or radioactive material that may be stored or processed inside equipment or components. In addition to exposure calculations applicable to the occupational workers, this section also addresses exposure calculations for female workers who declare pregnancy in accordance with 10 CFR 20.1208(a) and the calculation of radiation dose to the embryo/fetus.

5.7.4.3.1 Natural Uranium Exposure Calculations

The NRC staff reviewed the licensee's methods in LRA Section 5.7.4.1 for calculating intakes of uranium to determine individual doses from airborne concentrations of natural uranium. The licensee uses the average concentration of uranium in the air near the worker's breathing zone and uses either the actual exposure time or the results of a semiannual time study that is conducted at the Irigaray and Christensen Ranch plants. The semiannual time study determines worker-occupied locations and occupancy times. Airborne uranium activity is determined from surveys. The NRC staff finds this approach for intake of radioactive materials to be consistent with Regulatory Guide 8.30 and acceptable.

The licensee calculates the intake of soluble uranium in milligrams using the average concentration of uranium in the air near the worker's breathing zone. The licensee states in LRA Section 5.7.4.1 that the maximum individual internal exposure to airborne uranium during the period from 1995 through 2007 was 1 percent of the allowable regulatory limit of 10 mg per week. The licensee proposes in LRA Section 5.7.4.1 to continue using the same airborne uranium exposure calculation methods at Irigaray and Christensen Ranch that have been used to date, including summing the percentages in an area that has mixed DACs. The NRC staff finds this approach consistent with Regulatory Guide 8.30 and acceptable.

The staff reviewed NRC inspection reports dating from 1998 to 2012. During these inspections, NRC inspectors reviewed records associated with uranium exposure calculations. As a result of these inspections, the NRC staff determined that the licensee met applicable regulations and license conditions. The staff has found nothing to invalidate or call into question its previous findings of adequate implementation related to natural uranium exposure calculations; therefore, the original findings and staff's prior conclusions remain valid.

5.7.4.3.2 Radon Daughters Exposure Calculations

NRC staff reviewed the licensee's methods for calculating intakes of radon in LRA Section 5.7.4.2 to determine individual doses from airborne concentrations of radon decay products. The licensee uses the average number of working levels in the air near the worker's breathing zone and the results of a semiannual time study that is conducted at Irigaray and Christensen Ranch. The semiannual time study determines worker-occupied locations and occupancy times. Radon progeny concentrations are determined from in-plant surveys. LRA Table 5.7 shows that the maximum individual internal exposure to radon progeny during the period from 1995 through 2007 was 48 DAC-hours, or 2.4 percent of the annual limit. The licensee proposes to continue internal radon progeny exposure calculation methods at Irigaray and Christensen Ranch that have been used to date. The NRC staff finds this approach consistent with Regulatory Guide 8.30 and acceptable.

The licensee calculates the TEDE for exposed workers in LRA Section 5.7.4.3. TEDE results from 1995 through 2007 for Irigaray and Christensen Ranch are shown in LRA Table 5.8 and indicate that the average dose was generally less than 2 percent of the regulatory limit of 5 rem.

The staff reviewed NRC inspection reports dating from 1998 to 2012. During these inspections, NRC inspectors reviewed records associated with radon daughter exposure calculations. As a result of these inspections, NRC inspectors determined that the licensee met applicable regulations and license conditions. The staff has found nothing to invalidate or call into question its previous findings of adequate implementation related to radon daughter exposure calculations; therefore, the original findings and staff's prior conclusions remain valid.

5.7 4.3.3 Prenatal and Fetal Exposure Calculations

The licensee provided its methods for determination of fetal and prenatal exposures in LRA Section 5.7.4. The license states that the requirements in 10 CFR 20.1208 will be followed regarding limitation of the dose to an embryo/fetus to 500 mrem during the entire pregnancy and that the licensee will make efforts to avoid substantial variation from a uniform monthly exposure to a declared pregnant woman. The licensee addresses the determination of the deep-dose and internal dose to the embryo/fetus. The licensee states that exposure calculations will be performed as recommended in Regulatory Guide 8.36 (NRC, 1992a). The NRC staff finds that performing exposure calculations as recommended in Regulatory Guide 8.36 is acceptable.

5.7.4.3.4 Historical Exposure Results

The licensee provided its historical exposure results for airborne uranium exposures in LRA Table 5.5 and for radon daughter exposure results in LRA Table 5.7 for the period 1995 to 2007. During this period, the highest uranium intake or exposure was approximately 20 DAC-hours or 50 mrem per year and the highest radon daughter intake or exposure was approximately 48 DAC-hours or 120 mrem per year. LRA Table 5.8 reports the maximum TEDE for the period from1995 to 2007. The highest TEDE reported was 830 mrem/year in 1995. The TEDE has not exceeded 500 mrem per year or 10 percent of the occupational worker dose limit in the period from 1996 to 2007.

The staff reviewed NRC inspection reports dating from 1998 to 2012. During these inspections, NRC inspectors reviewed records associated with historical exposure rates. As a result of these inspections, NRC inspectors determined that the licensee met applicable regulations and license conditions. The staff has found nothing to invalidate or call into question its previous

findings of adequate implementation related to historical exposure results; therefore, the original findings and staff's prior conclusions remain valid.

5.7.4.4 Evaluation Findings

Based on the information in the LRA and the detailed review of exposure calculations at the Willow Creek Project, the NRC staff concludes that the exposure calculations are in compliance with:

- 10 CFR 20.1101, which defines radiation protection program and ALARA requirements;
- 10 CFR 20.1201(a), which provides occupational dose limits;
- 10 CFR 20.1201(e), which specifies the limit on intake of soluble uranium;
- 10 CFR 20.1202, which describes the means of compliance when summing internal and external exposures;
- 10 CFR 20.1203 for determination of external dose from airborne radioactive material;
- 10 CFR 20.1204, which provides requirements for determining internal exposure; and
- 10 CFR 20.1208, which specifies the dose to an embryo/fetus during pregnancy.

The NRC staff finds that the exposure calculations in the revised LRA Section 5.7.4 (Uranium One, 2010a) are in compliance with 10 CFR 20.1204, 20.1208, and 20.1502. Therefore, the NRC staff concludes that exposure calculations are consistent with Regulatory Guide 8.36 and are acceptable.

5.7.5 Bioassay Program

This section discusses the licensee's bioassay program. The bioassay program monitors and documents potential intakes of radioactive materials, and confirms the results of airborne monitoring and to demonstrate adequate controls for airborne radioactive materials.

5.7.5.1 Regulatory Requirements

The staff determines if the licensee has demonstrated that the bioassay program for the Willow Creek Project meets the applicable 10 CFR Part 20 Subpart C, L and M requirements.

5.7.5.2 Regulatory Acceptance Criteria

Unless specified otherwise, the LRA was reviewed for compliance with the applicable requirements of 10 CFR Part 20, using the acceptance criteria in standard review plan Section 5.7.5.3 (NRC, 2003) and for conformance with Regulatory Guide 8.22 (NRC, 1988b) that provides guidance on how to demonstrate compliance with the regulations.

5.7.5.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from the LRA submitted by the licensee. The NRC staff has visited the Willow Creek Project on several occasions from 1998 to 2012, during the conduct of NRC inspections to confirm information presented in the LRA.

The licensee proposes in LRA Section 5.7.5 to continue to implement a bioassay program in accordance with the guidance in Regulatory Guide 8.22 (NRC, 1988b) and commits to use the action levels for urinalysis based on Regulatory Guide 8.22, Table 1.

The NRC staff reviewed the bioassay program at the Willow Creek Project described in LRA Section 5.7.5. The licensee implements its program in accordance with Regulatory Guide 8.22. A bioassay program that requires baseline urinalysis and exit bioassays is in place according to LRA Section 5.7.5. Individuals routinely entering areas where there is a potential for yellowcake inhalation are required to participate in the bioassay program. Bioassay samples for these workers are collected and analyzed monthly.

The licensee commits to submit blanks and spikes to the outside analytical laboratory that processes the bioassay samples as part of its quality assurance program based on guidelines in Regulatory Guide 8.22 (NRC, 1988b). The licensee reports in LRA Section 5.7.5 that analytical results have fallen within the ± 30 percent of spiked sample value specified in Regulatory Guide 8.22, and all uranium recovery values have been within ± 30 percent of the expected results. Willow Creek Project license SUA-1341 license condition 10.12 requires the licensee to follow the bioassay program in Regulatory Guide 8.22.

5.7.5.3.1 Records and Reporting

The licensee does not specifically address record keeping and reporting requirements in the LRA for its bioassay program. In LRA Section 5.11, Records Maintenance and Retention Policy, the licensee states that records maintenance and retention shall comply with 10 CFR Part 20, Subpart L. The NRC staff finds the licensee's commitment to maintain records in accordance with 10 CFR Part 20, Subpart L acceptable. In LRA Section 5.10.2, Non-Routine Reports, the licensee states that NRC is notified by e-mail and telephone within 24 or 48 hours for any incident that would trigger the reporting requirements provided in 10 CFR Part 20, Subpart M. NRC staff finds the licensee's commitment to report in accordance with 10 CFR Part 20, Subpart M acceptable.

5.7.5.3.2 Historic Bioassay Program Results

The NRC staff reviewed the licensee's presentation of historical bioassay results in LRA Section 5.7.5 for the period from 1995 to 2007 and finds that appropriate evaluations, actions, and analyses were performed. These results indicate that the occupational intakes of radioactive material did not exceed regulatory limits. The NRC staff determined that the licensee's bioassay program is consistent with NRC Regulatory Guide 8.22 (NRC, 1988b) and is acceptable.

The staff reviewed NRC inspection reports dating from 1998 to 2012. During these inspections, NRC inspectors reviewed records associated with the bioassay program. As a result of these inspections, NRC inspectors determined that the licensee met applicable regulations and

license conditions. The staff has not found anything to invalidate previous findings related to historical exposure results; therefore, the original findings stand and previous staff conclusions remain valid.

5.7.5.4 Evaluation Findings

LRA Section 5.7.5, Bioassay Program, does not specifically address record retention as required in 10 CFR Part 20, Subpart L. However, LRA Section 5.11, Records Maintenance and Retention Policy, states that records maintenance and retention shall comply with 10 CFR Part 20, Subpart L. The NRC staff finds the licensee's commitment to comply with 10 CFR Part 20, Subpart L acceptable. The licensee commits to implementing the bioassay program discussed in Regulatory Guide 8.22. Based on the information in the LRA and the detailed review of the bioassay program at the Willow Creek Project, the NRC staff concludes that the bioassay program is acceptable and is in compliance with 10 CFR Part 20, Subpart C, which provides requirements for determining internal exposure and occupational does limits; 10 CFR Part 20, Subpart L, which specifies record keeping requirements; and 10 CFR Part 20 Subpart M, which specifies reporting requirements.

5.7.6 Contamination Control Program

The following sections discuss and evaluate the licensee's proposed contamination control program. This program is designed to prevent employees from entering clean areas or from leaving the site while contaminated with radioactive materials. Contamination can take the form of loose surface contamination and may be found on structures, materials, or personnel. The purpose of the program is to ensure that contamination is identified, confined, and monitored in known areas and prevent movement of contamination to unrestricted areas.

5.7.6.1 Regulatory Requirements

The NRC staff determines if the licensee has demonstrated that the contamination control program for the Willow Creek Project meets the requirements of 10 CFR Part 20, Subparts B, C, and F.

5.7.6.2 Regulatory Acceptance Criteria

Unless otherwise stated, the LRA was reviewed for compliance with the applicable requirements of 10 CFR Part 20, using the acceptance criteria in standard review plan Section 5.7.6.3 (NRC, 2003) and for conformance with Regulatory Guide 8.30 (NRC, 2002b) that provides guidance on how to demonstrate compliance with the regulations.

5.7.6.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from the LRA submitted by the licensee. The NRC staff has visited the Willow Creek Project on several occasions from 1998 through 2012, to conduct NRC inspections and to confirm information presented in the LRA.

The NRC staff reviewed the description of the licensee's contamination control program in LRA Section 5.7.6 for the Willow Creek Project. The licensee's contamination control program consists of three elements: (1) surveys for surface contamination; (2) alpha contamination surveys for contamination of skin and personal clothing; and (3) contamination surveys of equipment prior to release to an unrestricted area. The licensee states in LRA Section 5.7.6 that the contamination control program will be conducted in accordance with the guidelines in Regulatory Guide 8.30 (NRC, 2002b).

5.7.6.3.1 Area Contamination Surveys

The licensee states in LRA Section 5.7.6 that it performs surveys for surface contamination in operating and clean areas of the Irigaray and Christensen Ranch Projects in accordance with the guidelines contained in Regulatory Guide 8.30. Staff finds the commitment to follow Regulatory Guide 8.30 acceptable. The licensee further specifies that alpha and beta contamination surveys will be conducted to assure that contamination is not released to unrestricted areas that exceed NRC contamination guidelines contained in Regulatory Guide 8.30 (NRC, 2002b).

In addition, the licensee states that an annual beta survey will be conducted in areas that typically would be subject to large quantities to residual uranium concentrate contamination. Specially, these areas are the precipitation, and drying and packaging areas of the Irigaray plant.

The NRC staff notes that the licensee states in one paragraph of LRA Section 5.7.6 that surveys for alpha contamination are conducted weekly and in another paragraph that alpha and beta-gamma contamination surveys will be conducted. The staff notes that the licensee revised the LRA to include beta-gamma contamination, but did not revise the previous statement that specifies that alpha contamination surveys would be conducted. A modification to license condition 9.8 is proposed in SER Section 5.7.6.4 to clarify the NRC requirements and guidance for alpha and beta-gamma contamination surveys.

The staff reviewed NRC inspection reports dating 1998 to 2012. During these inspections, NRC inspectors reviewed records associated with area contamination surveys. As a result of these inspections, NRC inspectors determined that the licensee met applicable regulations and license conditions. Except as noted below, the staff has not found anything to invalidate or call into question its previous findings of adequate implementation of the licensee's contamination control program.

5.7.6.3.2 Contamination Surveys of Skin and Personal Clothing

The licensee states in LRA Section 5.7.6 that SOPs will be used that include provisions for contamination control, such as a requirement for personal alpha radiation monitoring for all employees who do not shower prior to leaving the restricted area. All personnel leaving the restricted area are required to perform and document alpha contamination monitoring. In addition, personnel who could come in contact with potentially contaminated solutions outside a restricted area, such as in the wellfields are required to monitor themselves prior to leaving that worksite. The licensee states that all personnel receive training in the performance of surveys for skin and personal contamination.

The staff reviewed NRC inspection reports dating from 1998 to 2012. During these inspections, NRC inspectors reviewed records associated with contamination surveys. As a result of these

inspections, NRC inspectors determined that the licensee met applicable regulations and license conditions. Except as noted below under Evaluation Findings of this SER section, the staff has not found anything to invalidate previous findings of adequate implementation related to the licensee's conduct of contamination surveys of skin and personal clothing.

5.7.6.3.3 Contamination Surveys for Items Released from Restricted Areas

The licensee states in LRA Section 5.7.6 that surveys for beta contamination will be performed consistent with the recommendations of Regulatory Guide 8.30. The licensee states in LRA Section 5.7.6 that RSO, RST, or properly trained employees may survey all items removed from the restricted areas with the exception of small, hand-carried items. The licensee states that release surveys are performed with appropriate equipment and in conformance with the NRC surface contamination guidance dated September 1984. The licensee states that unannounced spot checks of personnel will be conducted quarterly to verify that the contamination control program is effective. Willow Creek Project license SUA-1341 license condition 9.8 requires the licensee to follow NRC decommissioning guidance, suitable alternative procedures approved by the NRC, or the approved Decommissioning Plan. The NRC staff finds this acceptable except for the use of the approved Decommissioning Plan. The reference in license condition 9.8 to Section 5.1 of the approved Decommissioning Plan will be removed since the Willow Creek Project is now in operational status. The NRC staff notes that the decommissioning guidance currently referenced in license condition 9.8 has been updated since the last license renewal. As discussed in SER Section 5.7.6.4, license condition 9.8 will be modified to reference this updated guidance. Additionally, as discussed in SER Section 5.4.4, the NRC staff is proposing to include a reference to Regulatory Guide 8.30, or an NRC-approved equivalent, as a license condition to ensure that surveys necessary for compliance with the NRC's regulations are performed at the Willow Creek Project.

NRC staff has determined that Uranium One may be removing equipment, materials, and equipment that has the potential for accessible radiological surface contamination levels above background from restricted or controlled areas (wellfields and header houses) without surveying equipment prior to its removal from these areas and travelling through unrestricted areas, before being returned to a restricted or controlled area. This practice is common in the ISR industry where wellfields are located remotely to the CPP or satellite plant. NRC staff has developed a license condition that will require Uranium One to follow the recommendations of Regulatory Guide 8.30, as revised, Table 2 when removing equipment, materials, or packages that have the potential for accessible radiological surface contamination levels above background to unrestricted areas. Additionally, the license condition will require Uranium One to develop a contamination control program and provide sufficient detail to demonstrate how the licensee will maintain control over the equipment, materials, or packages that have the potential for accessible radiological surface contamination levels above background, until they have been released for unrestricted use. The staff proposed a license condition in SER Section 5.7.6.4 to address this issue.

The NRC staff reviewed NRC inspection reports dating from 1998 to 2012. During these inspections, NRC inspectors reviewed records associated with this health physics program area. As a result of these inspections, NRC inspectors determined that the licensee met applicable regulations and license conditions. Except as noted below under Evaluation Findings of this SER section, the staff has not found anything to invalidate previous findings of adequate implementation of the licensee's conduct of contamination surveys for items released from restricted areas.

The NRC staff has determined that the training provided by the licensee to personnel termed "properly trained employees" that will be allowed to release materials from restricted areas is not adequately described by the licensee. The staff proposes a license condition in SER Section 5.4.4 to address this issue.

5.7.6.3.4 Instrumentation for Contamination Surveys

The licensee identified the following equipment for the conduct of contamination surveys.

- Ludlum model 3 portable survey meter with scintillation detectors for alpha contamination surveys
- Eberline model E-120 portable survey meter with an end-window GM detector for beta – gamma contamination surveys

The licensee describes the alpha and beta/gamma radiation survey instrumentation to be used for contamination surveys in LRA Section 5.7.6, but has not specified the scan minimum detectable concentration (MDC) or survey capability for this instrumentation. The NRC staff has determined that the survey instrumentation may not detect contamination for all required contamination surveys, and has determined that contamination control program may not be sufficient for detecting and quantifying contamination to prevent it from leaving unrestricted and controlled areas, and subsequently entering unrestricted areas or from leaving the site. A license condition is proposed in Section 5.7.6.4 to specify that the licensee determine the scan MDC for the portable radiation survey instrumentation described above and to provide this information to the NRC.

The licensee specifies in LRA Section 5.7.6 that the contamination control program will be implemented in accordance with SOPs that describe instrument calibration, and equipment check requirements.

5.7.6.3.5 Historical Survey Program Results

The licensee provided in LRA Table 5.9 the results of removable surface contamination surveys from 1995 to 2007. This information provided is for alpha contamination obtained during weekly surveys and indicates that the removable contamination levels are significantly below the 1,000 dpm/100-cm^2 limit in Regulatory Guide 8.30. The NRC staff notes that the survey documentation indicates that the contamination levels have been below 100 dpm/100-cm^2 for the last 10 years.

5.7.6.4 Evaluation Findings

Based on the information in the LRA and the detailed review of the contamination control program at the Willow Creek Project, the NRC staff concludes that the program is in compliance with:

- 10 CFR 20.1101, which defines radiation protection program and ALARA requirements;

- 10 CFR 20.1702, which identifies other licensee controls, such as controlling access, limiting exposure times, and prescribing use of respiratory protection equipment, to limit individual doses; and

- 10 CFR 20.1501, which provides survey and radiation monitoring requirements.

However, some elements of the contamination control program do not appear to comply with guidance pertaining to the scanning capability and training of personnel other than the RSO or RST. Accordingly, a license condition is proposed in SER Section 5.4.4 to address the training issues associated with employee other than the RSO or RSTs that may perform alpha and beta contamination surveys and, will not be further discussed in this Section of the SER.

The licensee identified the radiation instrumentation used to conduct contamination control; however, the NRC staff could not determine the sensitivity of these instruments. Therefore, the staff is requiring the following license condition to ensure that the instrumentation used to conduct contamination control is adequate:

> The licensee shall provide for NRC review the surface contamination detection capability (minimum detectable concentration (MDC)) for radiation survey instruments, including scan MDC for portable instruments, used for contamination surveys to release equipment and materials for unrestricted use and for personnel contamination surveys. The detection capability in the scanning mode for the alpha and beta radiation expected shall be provided in terms of dpm per 100 cm^2.

As discussed in SER Section 5.7.6.3.3, the staff will require that license condition 9.8 be modified to reference current NRC guidance:

> ~~Release of equipment, materials, or packages from the restricted area shall be in accordance with the NRC guidance document entitled, "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," dated August 1987, or suitable alternative procedures approved by the NRC prior to any such release, or in accordance with Section 5.1 of the approved Decommissioning Plan.~~
>
> Release of surface contaminated equipment, materials, or packages from restricted areas shall be in accordance with the NRC guidance document "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," (the Guidelines) dated April 1993 (ADAMS Accession No. ML003745526), a suitable alternative procedures approved by NRC prior to any such release.

Additionally, as discussed in SER Section 5.7.6.3.1, a license condition requiring surveying for alpha and beta contamination will be added to license condition 9.8:

> Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides shall apply independently.

As discussed in SER Section 5.7.6.3.3, an additional element of the contamination control program related to surveying of potentially contamination equipment, materials, or packages leaving restricted or controlled areas may not comply with current NRC guidance. A license condition requiring that Uranium One apply Regulatory Guide 8.30, as revised, Table 2, to

removal of potentially contaminated equipment, materials, or packages from restricted areas and that a contamination control program be submitted to the NRC for verification will be added to license condition 9.8:

> Regulatory Guide 8.30 (as revised), Table 2, shall apply to the removal of equipment, materials, or packages that have the potential for accessible radiological surface contamination levels above background to unrestricted areas. The licensee shall submit to the NRC for review and written verification a contamination control program within 90 days of license renewal. The program shall provide sufficient detail to demonstrate how the licensee will maintain control over the equipment, materials, or packages that have the potential for accessible radiological surface contamination levels above background, until they have been released for unrestricted use as specified in the Guidelines, and what methods will be used to limit the spread of contamination to unrestricted areas. The contamination control program shall demonstrate how the licensee will limit the spread of contamination when moving or transporting potentially contaminated equipment, materials, or packages (i.e. pumps, valves, piping, filters, etc.) from wellfield areas (restricted or controlled areas) through uncontrolled areas. The licensee shall receive written verification of the licensee's contamination control program prior to its implementation.

Based on the review conducted by the NRC staff as indicated above, the information provided in the LRA, and in accordance with the noted license conditions, the NRC staff concludes that the licensee meets the applicable acceptance criteria of Section 5.7.6.3 of NUREG-1569 (NRC, 2003) and the requirements of 10 CFR Part 20, Subparts B, C, and F.

5.7.7 Airborne Effluent and Environmental Monitoring Program

The following sections discuss and evaluate the licensee's proposed airborne effluent and environmental monitoring program. This program includes radiation monitoring outside of the plant area during operations and environmental monitoring around the Willow Creek Project.

5.7.7.1 Regulatory Requirements

The NRC staff determines if the licensee has demonstrated that the airborne effluent and environmental monitoring program for the Willow Creek Project meets the requirements of 10 CFR Part 20, Subparts B, C, and D, 10 CFR 20.1501, 10 CFR Part 20.1702, and 10 CFR Part 40, Appendix A, Criterion 7 and 8.

5.7.7.2 Regulatory Acceptance Criteria

Unless otherwise stated, the LRA was reviewed for compliance with the applicable requirements of 10 CFR Parts 20 and 40 using the acceptance criteria in standard review plan Section 5.7.3.3 (NRC, 2003) and for conformance with Regulatory Guide 4.14 (NRC, 1980) that provides guidance on how to demonstrate compliance with the regulations.

5.7.7.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from the LRA submitted by the licensee. The NRC staff has visited the Willow Creek Project on several occasions from 1998 through 2012 during the conduct of inspections and to confirm information presented in the LRA.

The NRC staff reviewed the description of the licensee's airborne effluent and environmental monitoring program in the LRA at the Willow Creek Project and reviewed semiannual effluent reports. The licensee identifies the restricted areas in LRA Section 5.8.1 for its Irigaray and Christensen Ranch operations. The restricted areas at Irigaray are the process portions of the plant building, approximately two-thirds of the fenced storage area adjacent to the plant building, and the ponds. The restricted areas at Christensen Ranch are the plant building, ponds, and the wellfield module (header) buildings.

The NRC staff has determined that the licensee has not identified the controlled and unrestricted areas in the licensed areas consistent with the definitions of those terms in10 CFR 20.1003. LRA Section 5.8 only discusses restricted areas and does not discuss controlled areas. The licensee has not demonstrated compliance with the NRC public dose limits in 10 CFR 20.1301 consistent with the requirements of 10 CFR 20.1302 relative to the restricted, controlled, and unrestricted areas. The staff will require a license condition in SER Section 5.7.7.4 to address these deficiencies.

The NRC staff has determined that the licensee has not adequately described the locations of the current environmental monitoring stations relative to the controlled and unrestricted areas. The 10 CFR 20.1302 requirements specify that the licensee needs to make surveys (survey as defined in 10 CFR 20.1003) at the unrestricted area boundaries. Surveys also should be conducted in any controlled areas if the public is allowed access to these areas. Consequently, a license condition is proposed in SER Section 5.7.7.4 that specifies the information needed by NRC staff to determine if the licensee's surveys verify that radioactive materials releases and direct radiation surveys do not result in exposures that exceed public dose limits and are ALARA. The licensee should consider showing the environmental monitoring locations and the restricted, controlled and unrestricted areas together on a map.

5.7.7.3.1 Airborne Effluent and Environmental Radon Monitoring

The licensee measures direct radiation levels and samples radon gas and airborne particulates at several monitoring locations. Locations of monitoring stations were reviewed and approved by NRC in past licensing reviews (NRC, 1998). LRA Tables 5.21 and 5.22 provide a summary of environmental monitoring program sampling locations and media sampled. Track-etch detectors supplied by the Landauer Corporation are used to monitor the radon concentrations at nine locations and are exchanged quarterly. Five radon environmental monitoring locations are at Irigaray and four radon environmental monitoring locations are at Christensen Ranch.

The NRC staff reviewed the licensee's presentation and discussion of historical monitoring results in LRA Section 5.8. The results of radon monitoring in LRA Table 5.11 and 5.12 are for environmental measurements at Irigaray and Christensen Ranch from 1995 through 2001, and the staff observes that radon levels were consistent with background levels and also highly variable from quarter to quarter. The staff observes that the average radon quarterly monitoring results were approximately 1.2 to 1.5 pCi/L, but the radon results have varied by a factor of 2 at

any given location. The licensee states that the environmental monitoring was suspended, in part, after 2001 because the project was placed in restoration and decommissioning status.

NRC staff has reviewed the licensee's request to increase its flow rate from 15,140 Lpm (4,000 gpm) to 34,070 Lpm (9,000 gpm) (Uranium One, 2012c; 2012b) as it relates to airborne effluent and radon monitoring. Uranium One used MILDOS-AREA, a dispersion model approved by the NRC, to estimate the dose commitments received by individuals and the general population from the operation of the Christensen Ranch satellite plant, including both the existing and proposed IX circuits. An NRC staff review of the results indicated that increasing the Christensen Ranch satellite plant throughput would result in a TEDE of 3.4 mrem/yr at AS-5A located adjacent to the Christensen Ranch satellite plant as reported in LRA Table 7.3-5. The results from location AS-5A and AS-6 (locations shown in LRA Figure 5.5) indicate that the estimated dose to the nearest resident and members of the public is significantly below the 100-mrem/yr public dose limit specified in 10 CFR 20.1301, "Dose Limits for Individual Members of the Public." The NRC staff determined that the increase in flow rate would not significantly impact air quality or occupational and public health and safety.

The staff reviewed NRC inspection reports dating from 1998 to 2012. During these inspections, NRC inspectors reviewed records associated with radon monitoring. As a result of these inspections, NRC inspectors determined that the licensee met applicable regulations and license conditions. Except as noted below, the staff has not found anything to invalidate previous findings of adequate implementation related to radon monitoring.

The NRC staff has determined that the licensee had not made an adequate determination of compliance with 10 CFR 20.1301. Specifically, the radon progeny contributions to the public dose may not have been calculated. The licensee has used the radon with radon progeny removed for the determination of compliance with the 10 CFR Part 20, Appendix B, Table 2 effluent concentration value. Accordingly, the NRC staff proposes a license condition in SER Section 5.7.7.4 to address this situation.

5.7.7.3.2 Airborne Effluent and Environmental Air Particulate Monitoring

The licensee states in LRA Section 5.8.1 that environmental air particulate monitoring is conducted on a continuous basis during yellowcake drying operations at the Irigaray plant. Air sampler filters are exchanged weekly and then are composited for a quarterly analysis. LRA Table 5.14 provides particulate air sampling results from 1995 to 2001 and for 2005. The licensee states that the last sustained yellowcake production run ended by June 2000. The staff notes that the data does not exceed the 10 CFR Part 20, Appendix B, effluent concentration values for the radionuclides analyzed (natural uranium, thorium-230, radium-226 and lead-210), and the reported concentrations are typically less than 10 to 20 percent of the effluent concentration values.

The NRC staff previously evaluated the air particulate monitoring program at the Irigaray Project and found it acceptable (NRC, 1998). The staff has found nothing to invalidate or call into question its previous findings; therefore, the original findings and staff's prior conclusions remain valid.

The licensee proposed no airborne effluent and environmental air particulate monitoring at Christensen Ranch. The NRC staff approved the licensee's air particulate monitoring program at Christensen Ranch (NRC, 1998), and the licensee did not propose any changes in this LRA. However, the NRC staff has determined that the current lack of airborne effluent and

environmental air particulate monitoring at Christensen Ranch does not meet the requirements of 10 CFR 40.31(h), which states that applications "must clearly demonstrate how the requirements and objectives set forth in Appendix A of this part have been addressed." Appendix A, Criterion 7 states, "[t]hroughout the construction and operating phases of the mill, an operational monitoring program must be conducted to measure or evaluate compliance with applicable standards and regulations; to evaluate performance of control systems and procedures; to evaluate environmental impacts of operation; and to detect potential long-term effects." Additionally, 10 CFR 40.65(a)(1) requires the licensee to report every 6 months the quantity of each of the principal radionuclides released to unrestricted areas in liquid and in gaseous effluents during the previous six months of operation.

The NRC staff has determined that Uranium One's airborne effluent and environmental monitoring program is acceptable with one exception to be addressed by the license conditions required by the NRC staff. The NRC staff has determined that the licensee's airborne effluent and environmental monitoring program is not acceptable at the Christensen Ranch Project with respect to environmental air particulate sampling. Therefore, the NRC is requiring a license condition, as stated in SER Section 5.7.7.4, that air particulate sampling be required at the environmental monitoring stations at Christensen Ranch.

The NRC staff has reviewed the Irigaray air particulate monitoring results in LRA Table 5.14 from 1995 through 2001 and for 2005. The NRC staff did not identify any significant impacts from operations at Irigaray, and based on the staff's experience and knowledge the air particulates releases, air particulate impacts at Christensen Ranch should be lower than for Irigaray operations. The primary reason for the staff's determination is that yellowcake is produced at Irigaray and not at Christensen Ranch. Notwithstanding the staff determination, the licensee is required by 10 CFR 40.31(h) to demonstrate compliance at Christensen Ranch.

5.7.7.3.3 Soil and Vegetation Monitoring

The licensee provided the annual soil sampling results for Irigaray Project in LRA Table 5.15 and for Christensen Ranch Project in LRA Table 5.16. The annual soil sampling results for the Irigaray Project, sample IR-3, upwind of the restricted area, as shown in LRA Table 5.15, were significantly higher than other locations for the period from 1995 through 2000. The licensee explained, during a 2010 meeting with NRC staff, that these soil sampling results are consistent with the area of the Irigaray Project in which a yellowcake tank collapsed and spilled yellowcake in this area in 1994.

The licensee states the annual environmental soil and vegetation sampling was suspended after the Willow Creek Project went exclusively into restoration. Soil and vegetation sampling will continue as noted in LRA Tables 5.21 (Christensen) and 5.22 (Irigaray) that shows annual soil and vegetation sampling occurring at four Christensen Ranch locations and five Irigaray locations now that the Willow Creek Project has returned to operational status. The NRC staff previously approved these locations (NRC, 1998). The staff has found nothing to invalidate or call into question its previous findings; therefore, the original findings and staff's prior conclusions remain valid.

The annual vegetation sampling results for Irigaray are provided for five locations in LRA Table 5.17. The Christensen Ranch vegetation sampling results are provided for four locations in LRA Table 5.18. The staff notes that no discernible long-term trends are apparent for the period 1995 to 2000.

5.7.7.3.4 Direct Radiation Monitoring

Direct radiation monitoring was conducted at nine locations shown in LRA Figures 5.19 and 5.20 for Irigaray and Christensen Ranch, respectively. Dosimeters (TLDs) that are provided by the Eberline Instrument Corporation are used and exchanged monthly. The licensee notes that no direct radiation trends are apparent. The NRC staff notes that the quarterly results are variable but consistent at each monitoring location.

5.7.7.3.5 Semi-Annual Monitoring Report Results

The licensee has provided semi-annual monitoring reports to the NRC as required by license condition 12.1 and the information required by 10 CFR 40.65. The NRC staff has determined that additional information should be provided in the report including injection rates, recovery rates and injection manifold pressure, status of wellfields in operation (including last date of lixiviant injection), status of wellfields in restoration and restoration progress, status of any long term excursions, and a summary of mechanical integrity tests during the reporting period. A modification to license condition 12.1 will be required in SER Section 5.7.7.4 to include these items.

5.7.7.4 Evaluation Findings

Based on the information in the LRA and the detailed review of the airborne effluent and environmental monitoring program at the Willow Creek Project, the NRC staff concludes that the airborne effluent and environmental monitoring program is acceptable and is in compliance with the following regulations, except as otherwise noted below:

- 10 CFR 20.1302, which requires compliance with dose limits for individual members of the public;
- 10 CFR Part 20, Subpart L, which specifies record keeping requirements;
- 10 CFR 40.65, which specifies effluent and environmental monitoring requirements;
- 10 CFR 20.1501, which specifies survey and monitoring requirements; and
- 10 CFR Part 40 Appendix A, Criterion 7, which specifies operational monitoring program requirements.

The staff has determined that the licensee has not demonstrated that its airborne effluent and environmental radon and air particulate monitoring program for releases from the Irigaray Project provide sufficient information for staff to determine regulatory compliance for effluent releases and occupational and public doses. Specifically, the radon progeny associated with the measured radon concentrations had not been used in dose assessments. Additionally, no monitoring of air particulate effluent releases is conducted at the Christensen Ranch Project and therefore, there is insufficient information for staff to determine regulatory compliance for effluent releases and occupational and public doses. The staff is including the following license conditions to ensure that the licensee's effluent and environmental monitoring program is adequate and consistent with 10 CFR Part 20, 10 CFR Part 40, Appendix A, and Regulatory Guide 4.14 (NRC, 1980).

The licensee shall provide the following information for the airborne effluent and environmental monitoring program in which it shall develop written procedures, that shall be submitted to NRC for verification prior to implementation, to:

A) Discuss, in accordance with 10 CFR 40.65, how the quantity of the principal radionuclides from all point and diffuse sources will be accounted for, and verified by, surveys and/or monitoring.

B) Evaluate, consistent with 10 CFR 20.1301 and 10 CFR 20.1302, the highest exposures likely for member(s) of the public from licensee operations.

C) Discuss how radon (radon-222) progeny will be factored into the determination of potential public dose from the licensee's operations consistent with 10 CFR Part 20, Appendix B, Table 2.

D) Discuss, in accordance with 10 CFR 20.1501, how the occupational dose (gaseous and particulate) received throughout the entire License Area from licensee operations will be accounted for, and verified by surveys and/or monitoring.

The licensee shall conduct airborne samples for natural uranium, Ra-226, Po-210, and Pb-210 at each Christensen Ranch environmental monitoring location at a frequency of once every 6 months for 2 years, and annually thereafter to ensure compliance with 10 CFR 20.1301. The licensee shall also evaluate changes to plant operations to determine if more frequent radionuclide analyses are required to demonstrate compliance with 10 CFR 20.1301. The licensee may demonstrate compliance or provide alternative procedures specific to environmental monitoring for natural uranium, Ra-226, Po-210, and Pb-210 to show compliance with 10 CFR 20.1301 to the NRC for review and verification within 6 months of license renewal.

The licensee shall describe how the environmental monitoring program demonstrates that 10 CFR Part 20 public dose limits in controlled and unrestricted areas are met. The documentation of the areas designated as restricted, controlled and unrestricted areas and the environmental monitoring station locations shall be updated periodically, as needed.

The NRC staff has determined that additional information should be provided in the semi-annual monitoring report and will require the following license condition:

Effluent and environmental monitoring program results provided in the semi-annual report and in accordance with 10 CFR 40.65, "Effluent monitoring reporting requirements," shall be reported in the format shown in Table 3 of Regulatory Guide 4.14, (Rev. 1) entitled, "Sample Format for Reporting Monitoring Data." The report shall also include injection rates, recovery rates and injection manifold pressure, status of well fields in operation (including last date of lixiviant injection), status of well fields in restoration and restoration progress, status of any long term excursions, and a summary of mechanical integrity tests during the reporting period.

5.7.8 Ground Water and Surface Water Monitoring

5.7.8.1 Regulatory Requirements

The staff determines if the licensee has demonstrated that the ground water and surface water monitoring program for the Willow Creek Project meets the requirements of 10 CFR 40.32(c), 10 CFR 40.41(c), 10 CFR Part 40, Appendix A, Criterion 5B(5), and 10 CFR Part 40, Appendix A, Criterion 5D.

5.7.8.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria for wellfield monitoring presented in Section 5.7.8.3 and for environmental monitoring in Section 5.7.7.3 of NUREG-1569 (NRC, 2003).

5.7.8.3 Staff Review and Analysis

Unless otherwise stated, information reviewed in this section is from information, data, and maps submitted by the licensee in its LRA. NRC staff visited the site on several occasions during the course of this review to confirm information presented in the LRA.

In the LRA, the licensee describes the ground water and surface water monitoring programs implemented at the Willow Creek Project during operations. Preoperational monitoring, which was conducted as part of the site characterization or MU baseline data acquisition, is discussed in SER Chapter 2. Restoration monitoring, which is conducted during ground water restoration of a MU, is discussed in SER Section 6.1. During past operations, the licensee had established a ground water and surface water monitoring program that the NRC staff reviewed and accepted. The staff has found nothing to invalidate or call into question its previous findings; therefore, the original findings and staff's prior conclusions remain valid. The following sections address MU operational ground water monitoring, new MU hydrologic packages, and the Willow Creek Project ground water and surface water environmental monitoring programs.

5.7.8.3.1 Mine Unit Operational Ground Water Monitoring

The licensee states in LRA Section 5.8.2.2 that the Christensen Ranch ground water monitor wells were completed in a minimum of three different stratigraphic horizons for monitoring the containment of ISR solutions in the wellfields during operations. The licensee's perimeter ore zone monitoring wells have the same completed ore-zone interval within the host sandstone as the adjacent production and injection wells to intercept and detect any migration of ISR solutions. The licensee also installed monitor wells in the overlying and underlying aquifers directly above and below the ore-zone sandstone for detection of any vertical migration of ISR solutions. The licensee installed deep monitor wells in the first continuous underlying aquifer that exhibits at least 3 m [10 ft] of thickness and a permeability that allows the production of enough water for sampling. The licensee states in LRA Section 3.3.1.2 that deep monitor wells are not installed if there is no appropriate aquifer to monitor 15 m [50 ft] below the top of the confining shale underlying the production zone. The licensee might adjust the monitoring well completion intervals in areas with very thin or no confining layers. The NRC staff finds the monitoring well locations acceptable as they conform to the guidance criteria in Section 5.7.8.3

in the standard review plan (NRC, 2003). The staff previously evaluated the licensee's methodology for installing and locating monitoring wells and has found nothing to invalidate previous findings; therefore, the original findings and previous staff conclusions remain valid.

SER Table 5.1 lists the spacing and number of monitor wells at Christensen Ranch as proposed by the licensee in LRA Section 5.8.2.2. The spacing and number of the monitor wells were determined acceptable in previous NRC license reviews and the staff has found nothing to invalidate or call into question its previous findings; therefore, the original findings and staff's prior conclusions remain valid. The licensee states in LRA Section 5.8.2.2 that the minimum spatial density of monitor wells for production or injection wells is one per 0.012 km^2 [3 acre]. The staff notes that the installation of monitor wells in both overlying and underlying aquifers may be used to detect vertical excursions caused by ore zone excursions or contamination caused by CBM-produced water as discussed in SER Section 2.4.1. The NRC staff found the evaluation of the spacing and number of monitoring wells acceptable, as it conforms to the guidance criteria in Section 5.7.8.3 of the standard review plan (NRC, 2003). SUA-1341, license condition 10.3, will be amended to be consistent with commitments in the LRA in SER Section 5.7.8.4. The density of wells per acre for overlying and underlying monitoring wells will be changed from one well per 3.5 acres to one well per 4 acres. The staff notes that this also will make license SUA-1341 consistent with license SUA-1596 for the Uranium One Moore Ranch Project that was issued in 2010 (NRC, 2010c) and consistent with the guidance in NUREG-1569 (NRC, 2003). Additionally, the staff will remove all references to baseline water quality for Irigaray from SUA-1341, since the Irigaray wellfields have been restored and approved by the WDEQ and NRC (NRC, 2006).

The licensee is required to establish the baseline water quality in aquifers within, above, below, and surrounding the ore zone within the wellfields to establish the ground water protection standards in 10 CFR Part 40 Appendix A, Criterion 5B(5), which are required to be met after restoration. The licensee states that the monitoring wells chosen for baseline water quality are located in the ore zone, in the overlying and underlying aquifers, and in perimeter ore zone monitoring wells surrounding the wellfield area. The licensee will screen water quality data for outliers by first examining the data visually and identifying obvious outliers, and then performing a statistical analysis.

The licensee states that monitor well baseline water quality will be established by collecting four samples at least two weeks apart from each monitoring well in each wellfield. The licensee states that the first sample will be analyzed for a full suite of parameters (LRA Table 5.24, Assay Suite A) and the last three samples will be analyzed for a short list of parameters (LRA Table 5.24, Assay Suite B).

The licensee states that MU baseline water quality will be established by collecting four samples at least two weeks apart from each monitoring well in the wellfield. The licensee states that the first two samples will be analyzed for a full suite of parameters (LRA Table 5.24, Assay Suite A) and the last two samples will be analyzed for a short list of parameters (LRA Table 5.24, Assay Suite B).

The NRC staff finds that this sampling plan, which measures a reduced list of parameters in the last two or three sampling events, is statistically unacceptable for establishing the monitor well baseline or MU baseline which is used to establish the ground water protection standards required in 10 CFR Part 40, Appendix A, Criterion 5B(5). Therefore, by license condition, the NRC will require the licensee to measure a full suite of parameters for all samples to determine the baseline water quality of a MU aquifer and its monitoring wells. However, the NRC will allow

for parameters that are determined to be non-detects in the first two samples to be eliminated from testing in the last two samples. A license condition will be required in SER Section 5.7.8.4 to address this issue.

The licensee's semiannual environmental monitoring reports summarized the required operational and environmental monitoring conducted at the Willow Creek Project. The licensee monitors ground water quality at both sites by sampling 327 monitor and/or trend wells within and/or surrounding the wellfields. During operations, all monitoring wells are sampled every two weeks for excursion parameters. Monitor wells on excursion status are sampled weekly. During restoration and stabilization monitoring, monitoring wells not on excursion and trend wells are sampled quarterly. A 2007 NRC inspection report determined that the licensee's ground water monitoring program was in compliance with license requirements (NRC, 2007a).

Table 5.1 Specifications of the ground water monitor well network at Christensen Ranch

Well Location	Distance from wellfield (m) [ft]	Spacing between monitoring wells (m) [ft]
Ore Zone, Downgradient	91 [300]	91 [300]
Ore Zone, Sides	152 [500]	152 [500]
Ore Zone, Upgradient	152 [500]	152 [500]
Overlying Monitor Wells		1 per 0.016-km^2 [4-acre] wellfield
Underlying Monitor Wells		1 per 0.016-km^2 [4-acre] wellfield

5.7.8.3.2 Historical Excursion Monitoring Program and Data

The NRC staff reviewed the history of horizontal and vertical excursions since 1998 at Christensen Ranch and compiled the information in SER Table 5.2. The Christensen Ranch Project had several excursions over this time period. Seven wells experienced a total of 20 horizontal excursion events. Two wells experienced three separate vertical excursion events. The majority of the excursion events were terminated in less than a year. However, two horizontal excursions, one at well 2MW89 and one at well 5MW66, have lasted for more than a year.

In its Quarterly Progress Report of Monitor Wells on Excursion Status submitted to NRC in April 2009, the licensee indicated there were two wells on excursion status at Christensen Ranch (COGEMA, 2009b). Well 5MW66, which had been put on excursion status since July 21, 2004, remained on excursion status through March 2009. The licensee indicated that the elevated chemical concentrations in 5MW66 appeared to be an isolated case and no other monitor wells in the area exhibited similar trends (COGEMA, 2005a). To avoid reactivation of wells within this unit, the licensee requested, and was granted, special sampling and evaluation parameters until the excursion could be fully evaluated (COGEMA, 2009b). As a result, the licensee will continue monitoring 5MW66 on a quarterly basis until the MU 5 restoration package is submitted to, and approved by, the WDEQ and NRC. Updates of the well will be submitted to the WDEQ and NRC quarterly. The staff previously evaluated the licensee's request to remove this monitoring well from weekly excursion status reporting and currently agrees with the quarterly monitoring agreement. The licensee states the final status of 5MW66 will be addressed in the agency approval of the restoration for MU 5 (COGEMA, 2005a). The NRC staff observes that the final evaluation and decision regarding this well and MU and any additional actions that may be required will not be determined in this SER. As of December 31,

2012, the licensee reported there were no monitoring wells on excursion status (Uranium One, 2013a).

Table 5.2 Excursions at Willow Creek Project since 2000

Location	Well	Mine Unit	Aquifer	Excursion Initiation	Excursion Termination	Duration (days)	Comments	Document Accession Number
Horizontal Excursion								
CHRIST-ENSEN RANCH								
	2MW89	2	P	3/27/2012	4/16/2012	21		ML12104A092; ML12212A371
	2MW89	2	P	3/17/2011	7/1/2011	106		ML110890315; ML11200A315
	2MW89	2	P	12/21/2009	2/19/2010	60		Ml100040336; ML101670013
	2MW89	2	P	3/9/2009	8/4/2009	148		ML091070501; ML090860759; ML092310625
	2MW89	2	P	3/11/2008	6/10/2008	91		ML081770164; ML080860386
	2MW89	2	P	10/5/1999	6/26/2000	265		ML003701242
	2MW108	2	P	8/25/2011	10/17/2011	53		ML112420008; ML12031A154
	4MW1	4	P	6/16/2010	7/1/2011	380		ML101750038; ML11200A315
	4MW1	4	P	9/16/2009	10/16/2009	30		ML092600301; ML093090050
	4MW1	4	P	3/10/2008	2QTR	<112		ML080860386
	4MW1	4	P	9/5/2007	9/27/2007	22		ML072910167; ML072530266
	5MW43	5	P	3/22/2001	3/28/2001	6	Due to sampling not excursion	ML011000073
	5MW48	5	P	4/15/2008	5/15/2008	30		ML082050100; ML081300467
	5MW48	5	P	4/25/2007	5/23/2007	28		ML071650412; ML071500149
	5MW54	5	P	5/21/2003	9/30/2003	132		ML032870412
	5MW54	5	P	11/19/2002	3/25/2003	126		ML031180040
	5MW66	5	P	7/21/2004	4/19/2011	2463		ML050940190; ML1116A144
	5MW66	5	P	8/21/2001	1/14/2002	146		ML020440362
	5MW66	5	P	3/28/12	4/23/12	27		ML12104A092; ML12212A371
	5AH57-1	5	P	4/2/1012	6/27/2012	86		ML12212A371
	5AV46-1	5	P	4/2/1012	6/27/2012	86		ML12212A371

	5AG70-1	5	P	4/2/1012	6/27/2012	86		ML12212A371
	5MW8	5	P	5/2/2011	6/6/2011	35		ML11129A160; ML1196A051
	5MW8	5	P	12/16/2002	7/16/2003	212		ML032170553
	6MW21	6	P	10/5/1999	12/7/1999	63		ML003724052
	7MW32	7	P	1/3/2012	1/23/2012	20		ML12104A092
	7MW41	7	P	10/15/2012	12/10/2012	55		ML12312A075 ML13037A321
IRIGARAY								
	M2	PU5	P	8/5/2001	10/7/2001	63		ML023650426; ML012400330
	M2	PU5	P	5/31/2001	7/3/2001	33		ML012040298
	M2	PU5	P	2/5/2001	4/12/2001	66		ML010540243
	M2	PU5	P	8/7/2000	9/28/2000	52		ML003761033
	M2	PU5	P	5/9/2000	6/5/2000	27		ML003724952
	RS27	PU5	P	6/6/2001	11/26/2001	173		ML020300116
Vertical Excursion								
CHRIST-ENSEN RANCH	MW46S	3	O	9/1/1998	7/17/1999	319		ML003679994
	MW68S	2	O	12/1/2003	2/12/2004	73		ML041060385
	MW68S	2	O	3/3/2003	4/14/2003	42		ML031130386; ML042400144
IRIGARAY								
	DM10	PU6	U	7/5/1989	7/28/2003 WDEQ 11/4/2003 NRC	5235	To Class of Use; Improperly abandoned or Cracked Casing; BPT; NRC Concurrence	ML033160637; ML031410120
	SSM18	PU8	O	9/11/1996	7/28/2003 WDEQ 11/4/2003 NRC	2610	To Class of Use; Improperly abandoned or Cracked Casing; BPT; NRC Concurrence	ML033160637
	SSM3	PU2	O	8/28/1996	7/28/2003 WDEQ 11/4/2003 NRC	2624	To Class of Use; Improperly abandoned or Cracked Casing; BPT; NRC Concurrence	ML033160637

	SSM40	PU8	O	3/6/1994	7/28/2003 WDEQ 11/4/2003 NRC	3530	To Class of Use; Improperly abandoned or Cracked Casing; BPT; NRC Concurrence	ML033160637
	SSM41	PU4	O	11/17/1998	7/28/2003 WDEQ 11/4/2003 NRC	1813	To Class of Use; Improperly abandoned or Cracked Casing; BPT; NRC Concurrence	ML033160637
	SSM42	PU3	O	10/10/1990	7/28/2003 WDEQ 11/4/2003 NRC	4773	To Class of Use; Improperly abandoned or Cracked Casing; BPT; NRC Concurrence	ML033160637
	SSM43	PU1	O	10/11/1989	7/28/2003 WDEQ 11/4/2003 NRC	5137	To Class of Use; Improperly abandoned or Cracked Casing; BPT; NRC Concurrence	ML033160637
	SSM8	PU5	O	12/10/2003	1/14/2004	35	Post Stabilization	ML041060385
	Source: ADAMS as of December 31, 2012							
	P - Production Zone Monitoring Well							
	O - Overlying Aquifer Monitoring Well							
	U - Underlying Aquifer Monitoring Well							

The NRC staff observes that CBM production at the surface may affect excursion indicators in overlying aquifer monitoring wells. The licensee identifies in LRA Appendix B-1b the existence of an aquitard above the J unit (COGEMA, 2008a), and states it would be able to use chloride concentration to differentiate impacts from the CBM production water from ISR production spillage. The NRC staff agrees with the licensee's assessment that chloride would be an adequate marker to differentiate CBM water from ISR fluids in determining an ISR excursion versus an increase in contaminant levels due to CBM fluids.

5.7.8.3.3 Surface Water Monitoring Programs

The licensee has established a surface water quality monitoring program which the NRC reviewed and accepted during past licensing reviews. The licensee states in LRA Section 5.8.2.4 that the pre-operational water quality monitoring program assessed water quality and quantity for the Willow Creek drainage and tributaries within and immediately adjacent to the Irigaray and Christensen Ranch boundaries. During its previous operations, the licensee took quarterly grab samples from upstream and downstream Willow Creek monitoring stations at Irigaray. In addition, the licensee states in the LRA it collected samples quarterly and annually from a number of predefined surface sampling locations as shown in SER Figure 5.7. The licensee reports in LRA Table 5.25 results of surface water sampling from 1995 until 2007. The NRC staff observes there are no easily identifiable trends in the data.

The NRC staff has determined that the licensee's sampling location GS-01 is upstream of the Heldt Draw drainage basin, and likely will not capture runoff from the Heldt Draw area resulting in runoff from operations not being sampled at the license boundary, as stated previously by the

licensee. During inspections at the site, the NRC staff determined that there are no sampling points on Willow Creek suitable for water sampling at the license boundary. Staff also notes sampling point IR-14 is approximately 3 km downstream of the license boundary and will provide continued sampling of all runoff from Christensen Ranch. The NRC staff finds the licensee's surface water program acceptable as it conforms to the guidance criteria in standard review plan Section 5.7.8.3 (NRC, 2003).

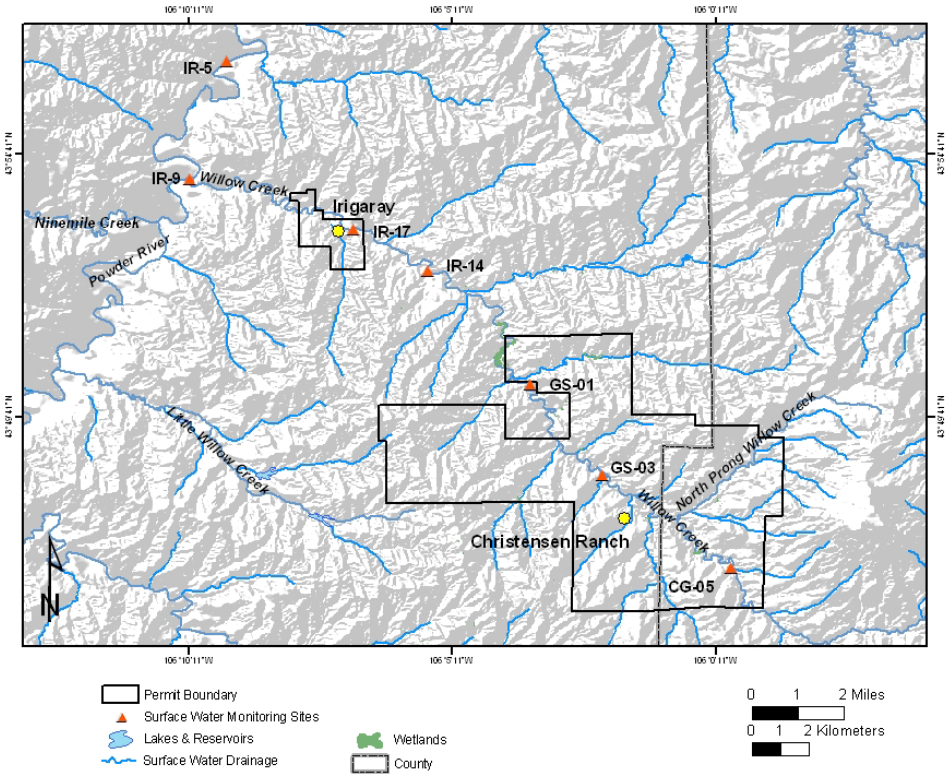

Figure 5.7 Willow Creek Project surface monitoring locations

5.7.8.4 Evaluation Findings

The staff reviewed the ground water and surface water monitoring programs of the Willow Creek Project in accordance with Sections 5.7.8.3 and 5.7.7.3 of NUREG-1569 (NRC, 2003). The NRC staff has determined:

- Operational ground water monitoring programs are consistent with those already approved and established, including the appropriate location and spacing of monitoring wells, monitoring frequency, and criteria for determining the presence of an excursion.

- The licensee has selected acceptable excursion indicator constituents and an approach for establishing upper control limits that are consistent with those already approved and established.

- The licensee will sample previously established and previously accepted surface water locations that lie within the Willow Creek Project boundary, including downstream sampling locations.

- The licensee has defined acceptable approaches for surface water monitoring using established and previously accepted and approved surface water monitoring programs.

Based upon the review conducted by the staff as indicated above, the information provided in the LRA meets the applicable acceptance criteria of Section 5.7.8.3 of NUREG-1569 and are in compliance with the following regulations:

- 10 CFR 40.32(c), which requires the applicant's proposed equipment, facilities, and procedures to be adequate to protect health and minimize danger to life and property;

- 10 CFR 40.41(c), which requires the applicant to confine source or byproduct material to the location and purposes authorized in the license;

- 10 CFR Part 40, Appendix A, Criterion 5B(5), which provide concentration limits for hazardous constituents;

- 10 CFR Part 40, Appendix A, Criterion 5D, which requires a ground water corrective action program; and

- 10 CFR Part 40, Appendix A. Criteria 7 and 7A, which require ground water monitoring.

As stated above, the following license condition will be modified to be consistent with the requirements in the Moore Ranch license SUA-1596 and consistent with NUREG-1569. Additionally, references to restoration ground water quality at the Irigaray Project will be deleted since MU restoration is complete.

> The licensee shall establish pre-operational baseline water quality data for all production units. Baseline water quality sampling shall provide representative pre-mining ground water quality data and restoration criteria as described in the approved license application. The data shall be from wells established in the mining zone, the mining zone perimeter, the upper aquifer and the lower aquifer where present, with spacing and locations as specified in the approved license application. The data shall, at a minimum, consist of the sample analyses shown in Table 5.24 of Section 5.8.2.2 of the approved license renewal application, unless superseded by this license condition.
>
> The wells used for obtaining baseline ground water quality in current and future production areas shall be established at the following minimal density:

Monitored Unit	Density
Ore Zone Monitors	All
Ore Zone Baseline (restoration)	1 well per 3 acres of pattern area
Shallow Zone Monitors	1 well per 4 acres of pattern area
Deep Zone Monitors (where zone present)	1 well per 4 acres of pattern area

~~Wells utilized to establish baseline ground water quality for past Irigaray production areas were as follows:~~

~~Monitored Unit~~	~~Wells per Monitored Unit~~
~~Irigaray Unit 1 Sandstone~~	~~2~~
~~Irigaray deep monitor zone~~	~~2~~
~~Irigaray perimeter and trend monitor wells (Units 1-9)~~	~~70 percent of installed wells~~

Baseline ground water quality in previously approved production areas shall be the mean data values (well field average) from the following submittals:

~~Irigaray~~	
~~Units 1-5~~	~~April 16, 1990 (refers to WDEQ permit 478)~~
~~Unit 6~~	~~April 4, 1988~~
~~Unit 7~~	~~November 2, 1987 (Table 4)~~
~~Units 8-9~~	~~January 28, 1988~~
Christensen Ranch	
Unit 3 and Module 2 expansion	December 1, 1988 (Table 2)
Unit 3 expansion and Module 4A expansion	August 8, 1991 (Table 6)
Unit 2 south portion	November 27, 1992 (Table 2)
Unit 2 north portion	April 16, 1992 (Table 2)
Unit 4	April 1, 1994 (Table 6)
Unit 5	February 28, 1995 (Table 7)

The NRC staff has determined that the licensee has not established an acceptable wellfield baseline water quality sampling program that will provide an adequate statistical population to determine baseline water quality, including the number of samples and constituents sampled, and appropriate statistical methods to remove outliers. Therefore a license condition will be established to ensure baseline ground water sampling is done in a statistically acceptable manner for all aquifers in the wellfield.

Four samples shall be collected and analyzed for Assay Suite A from each monitor well to establish baseline water quality parameters including the ore zone perimeter, overlying and underlying monitor wells, and mine unit baseline wells. Consecutive sampling events shall be at least 14 calendar days apart. The third and fourth sample events may be analyzed for a reduced list of parameters. The parameters that may be deleted from the third and fourth sampling events are those that are below the minimum analytical detection limits during the first and second sampling events.

5.7.9 Quality Assurance

5.7.9.1 Regulatory Requirements

The staff determines if the licensee has demonstrated that the proposed quality assurance program for the Willow Creek Project meets the requirements of 10 CFR 20.1101 and 10 CFR Part 20, Subparts L and M.

5.7.9.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 20, using the acceptance criteria presented in Section 5.7.9.3 of NUREG-1569 (NRC, 2003). Regulatory Guide 4.15 (NRC, 2007) provides guidance on demonstrating compliance with the applicable regulations.

5.7.9.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by the licensee in its LRA. The NRC staff visited the site on several occasions during the course of this review to confirm information presented in the LRA.

The NRC staff reviewed the description of the licensee's quality assurance (QA) program, the findings from numerous NRC inspections, and the licensee's ALARA audit reports. The licensee applies its QA program to all relevant operational monitoring and analytical procedures, which NRC staff finds is consistent with Regulatory Guide 4.14, Rev. 1 (NRC, 1980). Regulatory Guide 4.15, Rev. 2 (NRC, 2007b) specifically applies to other NRC-licensed facilities. Although Regulatory Guide 4.15, Rev. 2, may be applicable to 10 CFR Part 40 licensees, Regulatory Guide 4.15, Rev. 2, Section D, states that nonreactor licensees (i.e., facilities other than nuclear power reactors) may continue to use Regulatory Guide 4.15, Rev. 1, "Quality Assurance for Radiological Monitoring Programs (Normal Operations)—Effluent Streams and the Environment," (NRC, 1979), or may adopt other procedures or practices that reflect generally accepted standards for ensuring quality in environmental data collected for effluent monitoring purposes.

The NRC staff finds that the QA program in place at the Willow Creek Project for all relevant operational monitoring and analytical procedures is acceptable. The objective of the program has been to identify any deficiencies in the sampling techniques and measurement processes so that corrective action could be taken. The QA program includes organizational structure and management responsibilities, minimum qualifications and training, written procedures, quality control, and management audits.

NRC reviewed the quality assurance program at the Irigaray and Christensen Ranch Projects during prior application reviews. The NRC staff compared LRA Section 5.9 with the 1995 LRA (COGEMA, 1996). There was no significant difference in the licensee's description of the QA program. Because significant changes have not been made to the QA program, a detailed review was not warranted for this LRA and prior NRC findings remain valid. The QA program is consistent with NRC guidance (NRC, 1979).

5.7.9.4 Evaluation Findings

Based on the information in the LRA and the detailed review of the QA program at the Willow Creek Project, the NRC staff concludes that the QA program is acceptable, is consistent with NRC guidance (NRC, 1979), and is in compliance with:

- 10 CFR 20.1101, which provides radiation protection program requirements;
- 10 CFR Part 20, Subpart L, which specifies record keeping requirements; and
- 10 CFR Part 20, Subpart M, which defines reporting requirements.

The NRC staff concludes that the licensee's QA program is adequate to protect health and minimize danger to life or property.

6 GROUND WATER QUALITY RESTORATION, SURFACE WATER RECLAMATION, AND FACILITY DECOMMISSIONING

6.1 PLANS AND SCHEDULES FOR GROUND WATER QUALITY RESTORATION

6.1.1 Regulatory Requirements

The staff determines if the licensee has demonstrated that the proposed plans and schedules for ground water quality restoration meet the requirements of 10 CFR 40.32(c), 10 CFR 40.42, and 10 CFR Part 40, Appendix A, Criterion 5B(5).

6.1.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria presented in Section 6.1.3 of NUREG-1569 (NRC, 2003).

6.1.3 Staff Review and Analysis

This section discusses plans for the ground water quality restoration activities at the Willow Creek Project. The plans include proposed restoration standards, baseline water quality evaluation, restoration methods, restoration stability monitoring, historical activities, and the proposed restoration schedule. Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by the licensee in its LRA. The staff also visited the project on several occasions during the course of this review to confirm information presented in the LRA.

The NRC staff has completed the review of the plans and schedules for ground water quality, restoration at the Christensen Ranch Project contained in the LRA. This review included an evaluation of the methods used in the ground water restoration program and schedules using the review procedures and the acceptance criteria listed in NUREG-1569, Section 6.1 (NRC, 2003) and 10 CFR Part 40, Appendix A. Restoring the ground water quality in all aquifers in a wellfield after uranium extraction operations are complete ensures the protection of public health and the environment.

The licensee completed restoration of all MU's (1 through 9) at the Irigaray Project in 2001, and submitted its final wellfield Restoration Report to WDEQ on July 26, 2004 (COGEMA, 2005b). WDEQ approved the Irigaray wellfields restoration in 2005 (WDEQ, 2005). WDEQ determined that although ground water has not returned to baseline conditions, ground water quality within the wellfield, based on the mean concentrations, would not endanger the class of use. WDEQ also determined that residual contaminant concentrations would not exceed U.S. EPA maximum contaminant levels for the ground water outside the aquifer exemption boundary. Because of the restoration efforts made by the licensee and the use of best practicable technology, NRC considered the WDEQ secondary restoration standards and the NRC pre-mining use category as the applicable restoration standards in lieu of the primary goal of restoration in license condition 10.16. Thus, the NRC staff concurred with the WDEQ approval of the Irigaray wellfield restoration (NRC, 2006).

In 2008, the licensee submitted a Restoration Report of ground water restoration at Christensen Ranch MU's 2 through 6 to NRC for approval (COGEMA, 2008b). The NRC completed its review in October 2012 and requested the licensee complete additional actions at MU's 2 through 6 (NRC, 2012a).

The licensee established ground water baseline water quality for each MU by collecting samples from representative injection or recovery wells within that unit and arithmetically averaging the sample results, after outlier removal. NRC previously approved the list of analytical parameters as shown in Table 6.1 of the Restoration Report (COGEMA, 2008b). The target restoration values were set as a function of the average baseline concentrations, the range of results found in the baseline samples, and the variability between sample results as WDEQ defined by statistical methods. Target values were then set as the baseline mean with an acceptable range provided by tolerance limit as shown in LRA Section 6.1.1. The licensee states that WDEQ is currently reviewing this method for establishing target restoration values, and it may be modified in the future to use statistical confidence limits for the mean instead of tolerance limits. The NRC staff finds the evaluation of the baseline water quality for each MU acceptable as it conforms to the guidance criteria in NUREG-1569 Section 6.1.3 (NRC, 2003). However, the NRC staff is requiring a license condition in SER Section 5.7.8.4 to ensure an adequate number of samples are used to produce a statistically valid baseline determination.

The licensee noted in its LRA that the primary goal of ground water restoration is to return the quality of ground water at the Irigaray and Christensen Ranch wellfields to baseline concentrations. If the primary goal cannot be achieved for a specific constituent, the wellfield restoration will meet an alternate NRC-approved standard, consistent with the requirements of 10 CFR Part 40, Appendix A, Criterion 5B(5). The NRC staff finds the evaluation of the restoration standards acceptable as it conforms to the guidance criteria in NUREG-1569, Section 6.1.3 (NRC, 2003) and to 10 CFR Part 40, Appendix A, Criterion 5.

6.1.3.1 Restoration Plan

The licensee will adopt the restoration plan it used in past operations, which was previously reviewed and approved by NRC. The restoration process will consist of three main stages (i.e., ground water sweep, RO with permeate injection, and ground water recirculation) followed by a stabilization monitoring period. The licensee had applied this restoration plan to the wellfield restoration of Irigaray MU's 1 through 9 and Christensen Ranch MU's 2 through 6.

The licensee discusses in LRA Section 6.1.2.1 that in the ground water sweep phase, all injection and production wells are pumped (total water withdrawal) with the goal of returning all mining solution back to the wellfield that may have been affected by horizontal flare. This may be up to one pore volume of fluid withdrawal. The licensee also states that due to the limited success and excessive consumptive removal of ground water in this phase, it anticipates that use of ground water sweep will be very limited or not used at all for Christensen Ranch wellfields.

The licensee states in LRA Section 6.1.2.2 that the goals of the RO and permeate injection phase are to: reduce the total dissolved solids within the wellfield to baseline conditions; reduce trace metals and uranium concentrations to baseline condition; and return the aquifer pH to the baseline level of approximately 9.0. Operation of the RO unit requires chemical additions before and after processing. Prior to processing, antiscalants are required to prevent fouling of the RO

membranes, and sulfuric acid is added to create an acidic condition for processing. After processing, the addition of sodium hydroxide is needed to raise the pH to that of the baseline level (i.e., pH control). The licensee states in LRA Section 6.1.2 that during restoration, certain reductants may be added to precipitate metal compounds.

The licensee states in LRA Section 6.1.2.3 that during the recirculation phase, wellfield water is drawn from the recovery wells and injected into the injection wells. The licensee states that recirculation is not planned for future MUs due to the minimal effectiveness of this step and the opportunity to reintroduce oxygen into the mining zone. The licensee states that circulation of one pore volume of reductant may be utilized, if necessary. The NRC staff finds that elimination of the recirculation phase, for the reasons noted by the licensee, is acceptable.

The pore volumes and flow rates that the licensee proposed in the previous LRA (COGEMA, 1996) and current LRA for different restoration phases shown in SER Table 6.1. SER Figure 6.1 shows the historical pore volumes used during the RO/permeate injection phase, where the average is about 10. On the basis of the past restoration experience, the licensee increased the number of pore volumes to be used during the RO/permeate injection phase to 10 (COGEMA, 2009a), leading to a total of 12 pore volumes used during restoration. The licensee also indicates that the relatively larger number of pore volumes used for Christensen Ranch MU's 2 and 3 were related to the larger impacted mining zones associated with those wellfields, whereas the planned wellfields at Christensen Ranch will be more in line with Christensen Ranch MU's 5 and 6.

Table 6.1 Pore volumes and flow rates in restoration plan.

Stage	Pore Volume (previous LRA)	Pore Volume (current LRA)	Max Flow Rate Lpm [gpm]
Ground water sweep	1	1	1136 [300]
RO/permeate injection	5	10	1893 [500]
Ground water recirculation	1	1	1893 [500]
Stabilization monitoring	NA	NA	0

The NRC staff agrees with the licensee's proposal of using up to 10 pore volumes for RO/permeate injection phase for restoration and 10 pore volumes for RO/permeate injection for the calculation of surety. The staff previously has approved the Willow Creek Project restoration process (NRC, 1998) and the staff has found nothing to invalidate or call into question its previous findings; therefore, the original findings and staff's prior conclusions remain valid.

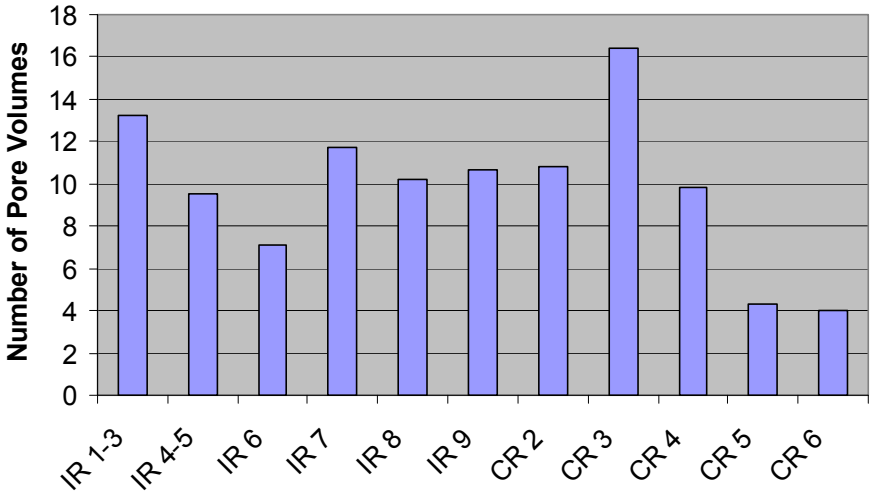

Figure 6.1 Historical reverse osmosis/permeate injection pore volumes (IR–Irigaray, CR–Christensen Ranch) (COGEMA, 2005b; 2008b).

Uranium One is required by license condition to restore ground water to its primary goal, and if primary goal cannot be achieved, the ground water will, at a minimum, be returned to an alternate standard approved by the NRC. NRC staff has determined that additional clarification is needed to require that the licensee first show that it has first made practicable efforts to restore specified hazardous constituents to primary goals before requesting consideration of alternate concentration limits in lieu of the primary restoration goals. Therefore, the NRC staff will require a license condition in SER Section 6.1.4 to address this issue.

6.1.3.2 Restoration Monitoring

The licensee will use the production monitoring well network to perform restoration monitoring. The sampling frequency during various stages of restoration is listed in SER Table 6.2.

Table 6.2 Sampling frequencies for different restoration stages (LRA, Table 6.1).

Restoration Stage	Sample Origin	Frequency
Post mining	Designated wells/Ore zone	Once
	Monitor/trend wells	Biweekly
Restoration	Designated wells/Ore zone	End of each restoration phase
	Monitor/trend wells	Monthly
Post-restoration	Designated wells/Ore zone	Four times

The licensee states that the duration of stability monitoring is at least 9 months. During stability monitoring, the designated restoration wells are sampled at the beginning, then at the end of every 3-month period, providing a total of four samples during the 9-month period. The NRC staff finds the sampling should occur over a year period and should not necessarily end after four samples if the analysis show statistically significant increasing trends for individual constituents. Therefore, the NRC staff will require a license condition in SER Section 6.1.4 to address this situation.

6.1.3.3 Restoration Schedule

The licensee states in LRA Section 6.1.3.1 that restoration of each MU will be accomplished within a 2 to 3 year period to keep up with its production schedules. If a MU is located adjacent to an active production area or shares a trunkline with an active production area, restoration may be delayed until the production is accomplished in the adjacent unit or the trunk line is available for restoration. The licensee states in LRA Section 6.1.3.1 that the average historical time span to complete wellfield restoration at Christensen Ranch is about 4 years. Therefore, it is likely that the licensee would request extensions to complete restoration of individual wellfields. The licensee shows a Christensen and Irigaray, Life of Mine, Development, Mining, Restoration, and Reclamation Schedule on a Gantt chart in LRA Section 3.7. The NRC staff finds the proposed schedule set forth in the Gantt chart to be acceptable. However, the schedule in the proposed Gantt chart is not consistent with the licensee's description of the restoration schedule in LRA Section 6.1.3.1 that states:

> For Christensen Ranch, using the above assumptions and limitations, production in mine unit 7 would begin in month zero and end in month 32. Restoration operations in mine unit 7 would initiate in month 34, and restoration would continue unabated through the sequence of mine units until the completion of restoration for mine unit 12 in month 200. In other words, the restoration process would continue uninterrupted for the project from month 34 onward.

The NRC staff has determined that the LRA language stating that restoration of MU 7 would continue uninterrupted for the project from month 34 onward through month 200 is inconsistent with the requirements in 10 CFR 40.42. The wording in the LRA is not clear if restoration in MU 7 would begin in month 34, including RO/permeate injection, or shortly after month 34. The staff could interpret the licensee's statement to mean that only a bleed would be maintained on MU 7 from month 34 onward until all production is completed in MUs 7 through 12 in month 200, and at that time, restoration would begin, including RO/permeate injection. If this second scenario occurs, this is a period from month 34 through month 200, a total of 166 months or 13.8 years with no active restoration, which is not acceptable to NRC staff. Therefore, the NRC staff will require a license condition in SER Section 6.1.4 to address this issue.

The licensee discusses the production bleed in LRA Section 6.1.6. The production bleed is defined as the difference between the amount of fluid produced and the amount of fluid injected in the wellfield. It should always have a positive value, such that more fluid is produced than injected. By producing more fluid than is injected, an inward hydraulic gradient into the wellfield is created. This inward hydraulic gradient draws fluids into the wellfield that enables the operator to maintain hydraulic control and limit or prevent excursions outside of the wellfield. The NRC staff concludes it is essential for the licensee to sustain an inward gradient during the entire operational life of a wellfield until restoration is completed so as to maintain control of fluids and ensure the safety of the operation.

The licensee has committed in LRA Section 6.1.3.1 that during the interim time period between the end of production of a wellfield and the onset of active restoration of the wellfield, the equivalent of a one percent bleed will be maintained in the wellfield to ensure the maintenance of hydraulic control. However, while the licensee has committed to maintain a one percent bleed during operations and during the interim time period between the end of production of a wellfield and the onset of active restoration of the wellfield, the NRC staff finds there is insufficient clarity in the LRA to ensure bleed is maintained at all times until the wellfields are

restored and stability monitoring has begun. Therefore, the staff is imposing a license condition in SER Section 6.1.4 to address this issue.

6.1.4 Evaluation Findings

After reviewing the licensee's plans and schedules for ground water restoration, the NRC staff concludes that the licensee has established an acceptable plan for wellfield restoration, which is a three-stage process including ground water sweep, reverse osmosis with permeate injection, and ground water recirculation. The licensee has proposed a reasonable number of pore volumes for achieving restoration targets based on its past operation experiences. The licensee has shown an acceptable schedule for complete restoration for its wellfields in LRA Section 3.7. However, staff finds the licensee's discussion that states restoration would continue uninterrupted for the project from month 34 through month 200, a total of 166 months or 13.8 years, to be unacceptable. Therefore, the NRC staff will require the following license condition:

> The licensee shall conduct ground water restoration activities in accordance with the approved license renewal application. Permanent cessation of lixiviant injection in a production area would signify the licensee's intent to shift from the principal activity of uranium production to the initiation of ground water restoration and decommissioning for any particular production area. If the licensee determines that these activities are expected to exceed 24 months for any particular production area, then the licensee shall submit an alternate schedule request that meets the requirements of 10 CFR 40.42.

The NRC staff finds there is insufficient clarity in the LRA to ensure bleed is maintained at all times until the wellfields are restored and stability monitoring has begun. Therefore, the staff is imposing the following license condition:

> The licensee shall maintain an inward hydraulic gradient by maintaining a bleed in each individual wellfield starting when lixiviant is first injected into the production zone and continuing until the ground water restoration stability monitoring has begun.

NRC staff has determined that additional clarification is needed to require that the licensee first show that it has first made practicable efforts to restore specified hazardous constituents to primary goals before requesting consideration of alternate concentration limits in lieu of the primary restoration goals. Therefore, the staff is imposing the following license condition:

> The licensee shall conduct ground water restoration and post-restoration monitoring as described in Section 6.1 of the approved license application. The primary goal of restoration shall be to return the ground water quality, on a production-unit average, to baseline concentrations on a parameter-by-parameter basis. If the primary goal cannot be achieved, the ground water will, at a minimum, be returned to an alternate standard approved by the NRC. In submitting any license amendment application requesting review of proposed alternate concentration limits pursuant to 10 CFR 40, Appendix A, Criterion 5(B)(6), the licensee must also show that it has first made practicable efforts to restore the specified hazardous constituents to the background or maximum contaminant levels (whichever is greater).

The NRC staff has determined that restoration stability monitoring sampling should occur over a year period and should continue if the analysis show statistically significant increasing trends for individual constituents. Therefore, the NRC staff will require a license condition in SER section 6.1.4 to address this situation.

> The licensee shall conduct four rounds of sampling of all WDEQ-LQD Guideline 8, Assay Suite A constituents during stabilization monitoring, with each well sample being at least three months apart. The applicant shall continue the stability monitoring until the data show the most recent four consecutive samples indicate no statistically significant increasing trend for individual constituents which would lead to an exceedance above the approved target restoration values.

6.2 PLANS FOR RECLAIMING DISTURBED LANDS

6.2.1 Regulatory Requirements

The staff determines if the licensee has demonstrated that the proposed plans for reclaiming disturbed lands for the Willow Creek Project meet the requirements of 10 CFR 40.42 and 10 CFR Part 40, Appendix A, Criterion 6(6).

6.2.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria presented in NUREG-1569 Section 6.2.3 (NRC, 2003).

6.2.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by the licensee in its LRA.

The licensee states in LRA Section 6.2 that it will use the decommissioning and surface reclamation plans (COGEMA, 2000; 2001) approved by the NRC for the Irigaray and Christensen Ranch Project in License Amendment 6 (NRC, 2001a). The NRC Technical Evaluation of the Decommissioning Plan dated December 12, 2001, provided an assessment and an acceptance of the adequacy of the plan. Prior to final decommissioning, the licensee will submit to NRC and WDEQ, for further review and approval, any revision or update to the approved Decommissioning Plan necessary to reflect project changes and compliance with any changes in applicable regulatory requirements. Based upon its review of the LRA, the staff has found nothing to invalidate or call into question its previous findings related to the Decommissioning Plan; therefore, the original findings and staff's prior conclusions remain valid.

The licensee states in LRA Section 6.2.2 that it will submit a decommissioning report to the NRC and WDEQ within 6 months of the conclusion of project decommissioning and surface reclamation. Records of all contaminated materials transported to a licensed disposal site will be maintained for a period of 5 years or as otherwise required by applicable regulations at the time of decommissioning. Staff finds the licensee's commitments acceptable.

The staff reviewed NRC inspection reports dating from 1998 to 2012. During these inspections, NRC inspectors reviewed records associated with the licensee's decommissioning program. As a result of these inspections, NRC inspectors determined that the licensee met applicable regulations and license conditions. The staff has not found anything to invalidate or call into question its previous findings of adequate implementation related to plans for reclamation of disturbed lands.

The LRA Section 6.3 refers to the licensee's January 5, 1996, LRA (COGEMA, 1996) and revisions, for a full discussion of the surface reclamation planned. The NRC staff notes that the Decommissioning Plan dated December 2000, as revised (COGEMA, 2000; 2001; 2003), addresses the required elements of a decommissioning plan including radiological clean-up criteria and verification survey planned. Based upon its review of the LRA, the staff has found nothing to invalidate or call into question its previous findings related to the Decommissioning Plan; therefore, the original findings and staff's prior conclusions remain valid.

6.2.4 Evaluation Findings

The licensee has addressed the decommissioning and reclamation requirements of 10 CFR 40.42 and 10 CFR Part 40, Appendix A's radiological cleanup criteria in the Decommissioning Plan dated December 2000, as revised. This Decommissioning Plan is the principal source of information for this section and is referenced in LRA Section 6.2. Based upon its review of the LRA, the staff has found nothing to invalidate or call into question its previous findings for Plans for Reclaiming Disturbed Lands; therefore, the original findings and staff's prior conclusions remain valid.

Based on the detailed review of plans for decommissioning and for reclaiming disturbed lands at the Willow Creek Project, the NRC staff concludes that the licensee's characterization of reclaiming disturbed lands is in compliance with:

- 10 CFR 40.32(c), which requires licensee-proposed equipment, facilities, and procedures to be adequate to protect health and minimize danger to life or property;
- 10 CFR 40.42(g)(4), which provides requirements for final decommissioning plans;
- 10 CFR 40.41(c), which requires the licensee to confine the possession and use of source or byproduct material to the locations and purposes authorized in the license; and
- 10 CFR Part 40, Appendix A, Criterion 6(6), which identifies cleanup requirements.

6.3. REMOVAL AND DISPOSAL OF STRUCTURES, WASTE MATERIAL AND EQUIPMENT

6.3.1 Regulatory Requirements

The staff determines if the licensee has demonstrated that the proposed plans for removal and disposal of structures, waste material and equipment for the Willow Creek Project meet the requirements of 10 CFR 40.32(c).

6.3.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria presented in NUREG-1569, Section 6.3.3 (NRC, 2003).

6.3.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by the licensee in its LRA.

The licensee proposes in LRA Section 6.2.1 to abandon all wells no longer used for production or restoration operations, including all injection and recovery wells, monitor wells, and any other wells within the MU used to collect hydrologic or water quality data or incidental monitoring purposes. The licensee states in LRA Section 6.2.1 that it plans to comply with the well abandonment requirements in Wyoming Statute 35–11–404 and applicable regulations of the WDEQ Land and Water Quality Division, and the Wyoming State Engineers Office. The licensee states in LRA Section 6.2.1 that upon completion of the decommissioning of all wellfields, the licensee will file a well abandonment report consistent with the requirements of Wyoming Statute 35–11–404(e) with the Administrator of the Land Quality Division and the State Engineer's Office. The NRC staff finds the proposed procedures for well abandonment to be acceptable and consistent with guidance in NUREG-1569, Section 6.1.3 (7).

The NRC staff reviewed the licensee's description of the process for removing and disposing structures and equipment in the NRC-approved Decommissioning Plan for the Irigaray and Christensen Ranch Project (COGEMA, 2000; 2001; 2003). The licensee has committed to submitting to NRC prior to final decommissioning any revision or update of the approved process for removing and disposing of structures and equipment to reflect compliance with any changes in applicable regulatory requirements.

The licensee lists several options for disposal of waste materials and/or equipment in the NRC-approved Decommissioning Plan. The licensee specifies that materials will be surveyed and released if radiological criteria for unrestricted use are met. Equipment and materials may be recycled and transferred to a licensed user or materials may be transferred to a licensed disposal facility. The staff finds that this proposal is acceptable and consistent with NRC surface contamination control guidance (NRC, 1993b).

The staff reviewed NRC inspection reports dating from 1998 to 2012. During these inspections, NRC inspectors reviewed records associated with this program area. As a result of these inspections, NRC inspectors determined that the licensee met applicable regulations and license conditions. The staff has not found anything to invalidate or call into question its previous findings of adequate implementation related to the removal and disposal of structures, waste material, and equipment.

Because a process for removing and disposing of structures and equipment is described in the licensee's NRC-approved Decommissioning Plan (COGEMA, 2000; 2001; 2003), staff determined that a detailed review of this area was not warranted for this LRA. The NRC staff concludes that the licensee's commitment to update the plan to reflect regulatory changes is acceptable. Based upon its review, the staff has found nothing to invalidate or call into question

its previous findings for this time period; therefore, the original findings and staff's prior conclusions remain valid.

6.3.4 Evaluation Findings

The licensee has developed a Decommissioning Plan that has been approved by NRC in license amendment No. 6 (NRC, 2001a). This Decommissioning Plan contains the information specified by the standard review plan acceptance criteria 6.3.3 and is included by referenced by the LRA Section 6.2.

The NRC staff concludes that the licensee's characterization of removing and disposing of structures and equipment is consistent with:

- 10 CFR 40.32(c), which provides requirements for final decommissioning plans;
- 10 CFR 40.42(g)(4), which requires the licensee's proposed equipment, facilities, and procedures to be adequate to protect health and minimize danger to life or property;
- 10 CFR 40.41(c), which requires the licensee to confine the possession and use of source or byproduct material to the locations and purposes authorized in the license; and
- 10 CFR Part 40, Appendix A, Criterion 2, which requires that the licensee provide an estimate of the amount of contaminated material that will be generated and objective evidence of an agreement for disposal of 11e.(2) byproduct materials either in a licensed waste disposal site or at a licensed mill tailings facility to demonstrate nonproliferation of waste disposal sites.

6.4 METHODOLOGIES FOR CONDUCTING POST-RECLAMATION AND DECOMMISSIONING RADIOLOGICAL SURVEYS

6.4.1 Regulatory Requirements

The staff determines if the licensee has demonstrated that the proposed methodologies for conducting post reclamation and decommissioning radiological surveys for the Willow Creek Project meet the requirements of 10 CFR Part 40, Appendix A, Criterion 6(6).

6.4.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria presented in NUREG-1569 Section 6.4.3 (NRC, 2003).

6.4.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by the licensee in its LRA. The following section discusses the procedures used by the licensee for establishing radiological cleanup criteria for radium-226 and uranium

contaminated soil in accordance with 10 CFR Part 40, Appendix A, Criterion 6(6). The licensee's NRC-approved Decommissioning Plan specifically addresses the survey methodology recommended by NUREG-1575, Multi-Agency Radiation Survey and Site Investigation Manual (NRC, 2000), and this is consistent with the acceptance criteria in NUREG-1569, Section 6.4.3.

The NRC staff reviewed the licensee's description of decontamination and decommissioning in LRA Section 6.2 and the NRC-approved Decommissioning Plan for the Irigaray and Christensen Ranch Project (COGEMA, 2000; 2001; 2003). The Decommissioning Plan is still applicable to both sites. The licensee states in LRA Section 6.2 that even if operations resumed at Christensen Ranch and Irigaray, the referenced Decommissioning Plan would remain applicable at some future date. The licensee commits in LRA Section 6.2 to submitting to NRC a revision or update of the approved Decommissioning Plan prior to final decommissioning to reflect project changes (such as additional wellfields requiring decommissioning) and compliance with any changes in applicable regulatory requirements. The staff finds this commitment acceptable.

The staff reviewed NRC inspection reports dating from 1998 to 2012. During these inspections, NRC inspectors reviewed records associated with this program area. As a result of these inspections, NRC inspectors determined that the licensee met applicable regulations and license conditions. The staff has not found anything to invalidate previous findings of adequate implementation related to the methodologies for conducting post-reclamation and decommissioning radiological surveys.

Because a decommissioning plan has been developed by the licensee, and approved by NRC, (NRC, 2001a), the staff determined that a detailed review was not warranted for this LRA. The NRC staff conducted a detailed review of the Decommissioning Plan in 2001 (NRC, 2001a). The NRC staff concludes that the licensee's commitment to update the plan to reflect project or regulatory changes is acceptable. The staff has found nothing to invalidate or call into question its previous findings; therefore, the original findings and staff's prior conclusions remain valid.

6.4.4 Evaluation Findings

The licensee has an NRC-approved Decommissioning Plan that was approved by NRC in license amendment No. 6 (NRC, 2001a). The Decommissioning Plan referenced in LRA Section 6.2, provides the information specified by acceptance criteria in section 6.4.3 of the standard review plan.

Based on the information in the LRA and the review of the approved plan for conducting post-reclamation and decommissioning radiological surveys at the Willow Creek Project, the NRC staff concludes that the licensee's proposed methodologies are acceptable and are in compliance with:

- 10 CFR 40.32(c), which requires licensee-proposed equipment, facilities, and procedures to be adequate to protect health and minimize danger to life or property;

- 10 CFR 40.32(d), which requires that the issuance of the license will not be inimical to the common defense and security or to the health and safety of the public;

- 10 CFR 40.41(c), which requires the licensee to confine the possession and use of source or byproduct material to the locations and purposes authorized in the license;

- 10 CFR Part 40, Appendix A, Criterion 6(6), which provides standards for the cleanup of radium; and

- 10 CFR Part 40, Appendix A, Criterion 8, which provides requirements for a decommissioning plan.

6.5 FINANCIAL ASSURANCE

6.5.1 Regulatory Requirements

The staff determines if the licensee has demonstrated that the proposed financial assurance for the Willow Creek Project meets the requirements of Criterion 9 of Appendix A to 10 CFR Part 40.

6.5.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for consistency with applicable regulations of 10 CFR Part 40, using the acceptance criteria presented in NUREG-1569 Section 6.5.3 (NRC, 2003).

6.5.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by the licensee in its LRA.

The licensee provided its latest annual surety estimate for restoration, decommissioning, and surface reclamation at the Willow Creek Project as required by SUA-1341 license condition 9.5. NRC approved the latest surety update on January 24, 2012, for the sum of $16,308,890, which was an increase of $3,380,458 over the previously approved surety (NRC, 2012c).

The cost assessment included ground water restoration, decontamination and decommissioning, and surface reclamation costs for all areas affected to date by the installation and operation of the proposed mine plan through decommissioning. The licensee currently maintains an irrevocable letter of credit in favor of the State of Wyoming for the purpose of complying with 10 CFR Part 40, Appendix A, Criterion 9, regarding restoration and reclamation costs.

6.5.4 Evaluation Findings

The NRC staff concludes that the licensee is maintaining and updating the original surety estimates as required by its license and 10 CFR Part 40, Appendix A, Criterion 9. In addition, the licensee has adequately adjusted its surety amount to account for any increases or decreases in the liability resulting from inflation, changes in engineering plans, or other conditions affecting costs. The NRC will review annually the licensee's surety mechanism to ensure that sufficient funds are available to complete decommissioning and reclamation. The staff has found nothing to invalidate previous findings related to the financial assurance; therefore, the original findings and previous staff conclusions remain valid.

7 ACCIDENTS

7.1 REGULATORY REQUIREMENTS

The staff determines if the licensee has addressed potential accidents at the Willow Creek Project and demonstrated that it will meet the requirements of 10 CFR 40.32(c), that requires the licensee's proposed procedures be adequate to protect public health and minimize danger to life or property should an accident occur.

7.2 REGULATORY ACCEPTANCE CRITERIA

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria presented in NUREG-1569, Section 7.5.3 (NRC, 2003).

7.3 STAFF REVIEW AND ANALYSIS

This section addresses potential accidents that could occur at the Willow Creek Project, the designs and procedures proposed by the licensee to prevent accidents, and the plans and training proposed to cope with accidents. Unless specifically stated otherwise, the information reviewed for this section consists of the narrative and data submitted by the licensee in LRA Section 7.5. The staff review included an evaluation using the review procedures in NUREG–1569, Section 7.5.2, and the acceptance criteria outlined in NUREG–1569, Section 7.5.3 (NRC, 2003).

The staff reviewed NRC inspection reports dating from 1998 to 2012. During these inspections, NRC inspectors reviewed accident records and SOPs related to accident response. As a result of these inspections, NRC inspectors determined that the licensee met applicable regulations and license conditions. Except as noted below in SER Section 7.4 the LRA, the staff has not found anything to invalidate previous findings of adequate implementation related to accidents.

The licensee considered three general categories of accidents: accidents involving radioactivity, transportation accidents, and other accidents. The licensee states that Irigaray and Christensen Ranch Projects are consistent with the operating assumptions, site features, and designs examined in NUREG/CR-6733, "A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licensees," (NRC, 2001b).

7.3.2 Radiological Release Accidents

The licensee identifies tank and plant pipe failures in LRA Section 7.5.1 as potential accidents that could pose radiological risk. The licensee states that the central plant building structure and concrete curb will contain spills from tank failures, tanks, and leaks from pipes. The licensee indicates that the floor sump system will direct liquids back into the plant process circuit or to the evaporation ponds. Additionally, the licensee has emergency response procedures and SOPs in place to address tank and plant pipe failures. The staff has observed the concrete curbing in the Irigaray CPP during inspections and agrees with the licensee it will contain spills within the plant. The staff has also reviewed the licensee's proposed emergency response

procedures and SOPs during inspections and agrees they are adequate to respond to tank and plant pipe failures.

The licensee states in LRA Section 7.5.1.3 that a leak in a solar evaporation pond is detectable via the leak detection system placed beneath the pond liner. The licensee states that if a pond leak does occur, the natural clay content of the soils underlying the liner will mitigate the effects of the seepage. The clays will absorb radium and other constituents contained in the seepage and should not affect the local ground water system due to the large distance from ground surface to the water table.

The NRC staff agrees that while natural clay may absorb radium and other constituents underlying the liner, the licensee is required under 10 CFR Part 40, Appendix A, Criterion 5, to protect ground water. This requires compliance with the primary and secondary ground water protection standards. The primary standard is a design standard for surface impoundments that the licensee has met when the design of evaporation ponds for the Willow Creek Project were approved by the NRC (NRC, 1998). The secondary ground water protection standard requires that hazardous constituents entering the ground water from a licensed site must not exceed the specified concentration limits in the uppermost aquifer beyond the point of compliance during the compliance period. The leak detection system at the Willow Creek Project is designed to limit leaks, and if they occur, the licensee has committed to repairing leaks as discussed in LRA Section 5.8.3. The licensee also must comply with 10 CFR Part 40, Appendix A, Criterion 6(6) that sets the standard for radium-226 in soil upon decommissioning of the ponds and the Willow Creek Project. Based upon its review, the staff has found nothing to invalidate or call into question its previous findings related to radiological release accidents; therefore, the original findings and staff's prior conclusions remain valid.

The licensee states that excursions of lixiviant have a minimal potential to contaminate adjacent aquifers with radioactive and nonradioactive contaminants. The staff has evaluated monitoring and control of excursions in Section 5.7.8.

7.3.3 Transportation Accidents

The licensee considers the potential for transportation accidents involving shipments of dried yellowcake, ion exchange resins, chemicals and fuels, and radioactive wastes in LRA Section 7.5.2. The licensee identifies several procedures and actions to prevent transportation accidents, including maintaining vehicles in good operating condition, using properly trained and licensed drivers, inspecting vehicles prior to shipment, and following Department of Transportation hazardous materials shipping provisions.

The licensee states in LRA Sections 7.5.2 and 7.5.3 that emergency response plans have been developed for transportation accidents. Each resin hauling truck will be equipped with a radio that can communicate with either the Irigaray plant or the Christensen Ranch plant. In the event of an accident and spill, the driver can radio to both sites to obtain help at any location along the route. A check-in and check-out procedure is instituted where the driver will call the receiving plant prior to departure from his or her location. If the resin shipment fails to arrive within a set time, a crew will respond and search for the vehicle. This system will assure reasonably quick response time if the driver is incapacitated in an accident. Each resin transport vehicle will be equipped with an emergency contingency package whereby the driver could use the containment equipment to begin containment of any spilled material. Both the Irigaray and Christensen Ranch plants will be equipped with emergency response packages to quickly

respond to a transportation accident. Personnel at both the Irigaray and Christensen Ranch plants, as well as the designated truck drivers, will have specialized training to handle an emergency response to a transportation accident. The licensee states that these procedures will be used for shipments involving process chemicals and radioactive wastes. Based on its review, the staff concludes that the proposed procedures, actions, and responses addressing potential transportation accidents at the Willow Creek Project are acceptable.

7.3.4 Other Accidents

The licensee identifies in LRA Section 7.5.3 other potential accidents involving non-radiological materials that are associated with the various chemical and fuel storage tanks maintained outside the process plants. Each of the liquid chemical storage tanks is surrounded by earthen berms, and each tank is labeled to identify the solution within the tanks. If a tank should rupture, the licensee will retain solutions using an earthen berm surrounding the tank for that purpose.

The licensee places fuel storage tanks in an area remote from buildings to avoid fire damage to the building or injury to workers in the unlikely event of fuel combustion. A SPCC plan is in place for the Irigaray and Christensen Ranch Projects. Although the EPA only requires this plan for oil or raw petroleum fuel products, the licensee has expanded its plan to include all stored chemicals. Based on its review, the staff concludes that the proposed designs, measures, and responses addressing other accidents at the Willow Creek Project are acceptable.

7.4 EVALUATION FINDINGS

The staff has completed its review of the licensee's description of the effects of accidents for the Willow Creek Project. This review included an evaluation of the methods that will be used by the licensee to evaluate effects of accidents using the review procedures in Section 7.5.2, and acceptance criteria in Section 7.5.3 of the standard review plan (NRC, 2003).

The licensee has acceptably described likely significant effects of accidents from operations by providing an acceptable analysis of probable accidents and their consequences consistent with the project's design, site features, and planned operations. The licensee discussed mitigation measures, preventative procedures, and training for personnel to implement adequate response and remedial measures.

During inspections conducted from 1998 through 2012, the staff reviewed the Willow Creek Project plans for emergency preparedness, fire protection, and emergency procedures. The staff found the licensee had established emergency preparedness procedures that addressed fires, spills, and accidents. The staff determined that the licensee's emergency procedures were adequate for emergencies that could involve radioactive material.

Based on information provided in the LRA, the detailed review conducted by the staff, and the results of inspections, the staff finds that the licensee's proposed equipment, facilities, and procedures will be adequate to protect health and minimize danger to life or property, as required by 10 CFR 40.32(c). The staff has found nothing in its review of the licensee's accident analyses to invalidate or call into question its previous findings; therefore, the original findings and staff's prior conclusions remain valid.

However, the staff has determined that there is a risk of accidents and accident scenarios not contemplated currently by the licensee that could occur within an ISR operation based upon industry experience or that may later be envisioned by the licensee as operations progress. NUREG-1569, Section 7.5.2, states, "[t]he staff should confirm that uranium extraction industry experience is used to support any accident analyses, including consideration of plant design and specific components that are prone to failure or are known to have failed at other facilities."

Accordingly, the NRC staff sees merit in requiring the licensee to annually review its accident scenarios considering accidents that may have occurred elsewhere in the ISR industry, or may be envisioned by the licensee due to a change in process operations or observation by the licensee. This requirement is consistent with 10 CFR 40.32(c), which requires that the applicant's [licensee's] proposed equipment, facilities, and procedures be adequate to protect health and minimize danger to life or property. The licensee does not state in LRA Section 7.5 that annual reviews of accident scenarios occur. Therefore the following license condition will be required:

> The SERP shall review annually LRA Section 7.5, Effects of Accidents, and update the LRA as necessary to reflect newly identified accident analyses based on industry experience or the licensee's lessons-learned.

8 REFERENCES

AEC, 1974. "Source Material License SUA–1204 for Wyoming Mineral Corp Authorizing 1,000 Pounds Equivalent U_3O_8 Per Site as Slurry (ca 50 Without Solids)." Washington, DC: AEC.

ANSI, 1997. "Radiation Protection Instrumentation Test and Calibration, ANSI N323a–1997." Washington, DC: American National Standards Institute.

_____ 1978. "Radiation Protection and Instrumentation Test and Calibration, ANSI N323–1978." Washington, DC: American National Standards Institute.

Case et.al, 2002. Case, J. C., Toner, R. N., and Kirkwood, R., "Basic Seismological Characterization for Johnson County, Wyoming." Wyoming State Geological Survey.

COGEMA, 2009a. "Replacement Pages for Insertion in the Cogema Mining, Inc. License Renewal Application (dated May 2008) and responses to RAI." Mills, Wyoming: COGEMA Mining, Inc., ADAMS Accession Package Number ML092110700, July.

——— 2009b. "COGEMA's Wyoming Operation Wells—Quarterly Progress Report of Monitor Wells on Excursion Status—1st Qtr. 2009." Mills, Wyoming: COGEMA Mining, Inc., ADAMS Accession Number ML091070501, April.

——— 2008a. "Replacement Pages for Insertion in COGEMA Mining, Inc. License Renewal Application Submittal to NRC (dated May, 2008) for License SUA–1341." Mills, Wyoming: COGEMA Mining, Inc., ADAMS Accession Number ML083110405, October.

——— 2008b. "Wellfield Restoration Report: Christensen Ranch Project, Wyoming." Mills, Wyoming: COGEMA Mining, Inc., ADAMS Accession Number ML081060140, March.

——— 2008c. "Irigaray and Christensen Ranch Projects, U.S. NRC License Renewal Application: Source Material License SUA–1341." Mills, Wyoming: COGEMA Mining, Inc., ADAMS Accession Package Number ML081850689, May.

——— 2007a. "Letter from T. Hardgrove to K. McConnell, Request to revert to an operating status, Christensen and Irigaray Ranch Project." Mills, Wyoming: COGEMA Mining, Inc., ADAMS Accession Number. ML071020274, April.

——— 2007b. "Reply to a Notice of Violation Source Material License SUA-1341, Docket Number 40-8502." Mills, Wyoming: COGEMA Mining, Inc., ADAMS Accession Number ML072410019, August.

——— 2005a. "Letter from Licensee, Attaching Christensen Ranch—5MW66 Data Sent to Wyoming DEQ." Mills, Wyoming: COGEMA Mining, Inc., ADAMS Accession Number ML051380433, April.

——— 2005b. "Request for NRC Concurrence, Irigaray Restoration Approval (including July 2004 Wellfield Restoration Report Irigaray Mine." Mills, Wyoming: COGEMA Mining, Inc., ADAMS Accession Package Number ML053270030, November.

——— 2003. “Revised Replacement Pages for 1996 License Renewal Application and December 2000 Decommissioning Plan.” Mills, Wyoming: COGEMA Mining, Inc., ADAMS Accession Number ML030560661, February.

——— 2001. “Submittal of Additional Information for December, 2000 Decommissioning Plan, COGEMA Mining, Inc.” Mills, Wyoming: COGEMA Mining, Inc., NRC ADAMS Accession Number ML011700655, June.

——— 2000. “Letter forwarding COGEMA Mining, Inc.'s decommissioning plan for Irigaray and Christensen Ranch Projects.” Mills, Wyoming: COGEMA Mining, Inc., NRC ADAMS Accession Number ML003781238, December.

——— 1996. “Permit to Mine No. 478, A-2 Update and U.S. NRC License Renewal Application: Source Material License SUA–1341.” Mills, Wyoming: COGEMA Mining, Inc., January.

Curtis, J., and K. Grimes. “Wyoming Climate Atlas.” http://www.wrds.uwyo.edu/sco/climateatlas.

EPA, 2011. Green Book Map, “Counties Designated "Nonattainment" for Clean Air Act's National Ambient Air Quality Standards (NAAQS).” http://www.epa.gov/oaqps001/greenbk/mapnpoll.html.

Harbaugh, A.W., E.R. Banta, M.C. Hill, and M.G. McDonald, 2000. “MODFLOW–2000, the U.S. Geological Survey Modular Groundwater Model User Guide to Modularization Concepts and the Groundwater Flow Process.” U.S. Geological Survey Open-File Report 00-92.

Malapai, 1988. “Application for amend to License SUA-1341,authorizing operation of proposed Christensen Ranch in situ uranium mining operations.” Malapai Resources. NRC Accession Number 8802040260, January.

NRC, 2013a. “E-Mail to B. Kearney and J. Winter, Uranium One, Re: Willow Creek Draft License #2.” Washington, DC: NRC, ADAMS Accession No. ML13023A147, January.

——— 2013b. “Supplemental Environmental Assessment, License Renewal Application, Source Material License SUA-1341.” Washington, DC: NRC, ADAMS Accession Package No. ML12289A332, January.

——— 2012a. “Uranium One Restoration Report Review.” Washington, DC: NRC, ADAMS Accession Package No. ML12174A030, October.

——— 2012b. “Confirmatory Action Letter.” Arlington, TX, NRC, ADAMS Accession Package No. ML12187A734, July.

——— 2012c. “Uranium One USA, Inc., Willow Creek Project, Campbell and Johnson Counties, Wyoming, Source Materials License SUA-1341, Amendment No. 21 – Annual Surety Estimate Adjustment And Operational Surety Adjustment.” Washington, DC: NRC, ADAMS Accession Package ML113540383, January.

——— 2011a. “Uranium One Willow Creek Project (Irigaray And Christensen Ranch), License SUA-1341, Amendment Request to use either Sulfuric Acid or Hydrochloric Acid in the Yellowcake Precipitation Process and to make the Technical Qualifications for the Radiation

Safety Technician Consistent with NRC Regulatory Guide 8.31." License Amendment No. 20. Washington, DC: NRC, ADAMS Accession Package ML111310060, August.

——— 2011b. " Approval for Publication Of the Final Environmental Assessment for the Renewal of U.S. Nuclear Regulatory Commission License No. SUA-1341 for Uranium One Inc. Irigaray and Christiansen Ranch Projects (Willow Creek Project) Wyoming." Washington, DC: NRC, ADAMS Accession Package Number ML103270679, July.

——— 2010a. "NRC Inspection 040-08502/10-001 and Authorization for Restart." Washington, DC: NRC, ADAMS Accession Number ML103540468, December.

——— 2010b. "Order Approving Indirect Change of Control of U.S. Nuclear Regulatory Commission Licenses from Uranium One, Inc., to State Atomic Energy Corporation Rosatom." Washington, DC: NRC, ADAMS Accession Number Package ML103120147, November.

——— 2010c. "Source Materials License, Uranium One Americas, Moore Ranch Uranium Project." Washington, DC: NRC, ADAMS Accession Number Package ML101180487, September.

——— 2009. "Order Approving Change of Control and License Amendment of License SUA-1341, Cogema Mining, Inc., Irigaray and Christensen Ranch Facilities." Washington, DC: NRC, ADAMS Accession Number Package ML093290021, November.

——— 2008. " Approval of License Amendment No. 13, Request to Amend NRC Materials License SUA-1341 to Change from Restoration and Decommissioning Status to Operating Status, Irigaray/ Christensen Ranch Facilities, and Surety Update, Cogema Mining, Inc." Washington, DC: NRC, ADAMS Accession Number ML072840544, September.

——— 2007a. "Inspection Report 40-08502/07-001 and Notice of Violation." Arlington, TX: NRC, ADAMS Accession Number ML072080382, July.

——— 2007b. Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Inception Through Normal Operations to License Termination)—Effluent Streams and the Environment." Rev. 2. Washington, DC: NRC, Accession Number ML071790506, July.

——— 2006. "Review of COGEMA Mining, Inc.'s, Irigaray Mine Restoration Report, Production Units 1 Through 9, Source Materials License SUA-1341." Washington, DC: NRC, ADAMS Accession Package Number ML062570159, September.

——— 2005. Regulatory Guide 8.7, "Instructions for Recording and Reporting Occupational Radiation Exposure Data," Rev. 2, Washington, DC: NRC, Accession Number ML052970092 November.

——— 2003. NUREG–1569. "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report." Washington, DC: NRC, Accession Number ML032250177, June.

——— 2002a. Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable." Rev. 1. Washington, DC: NRC, Accession Number ML021260630, May.

——— 2002b. Regulatory Guide 8.30, “Health Physics Surveys in Uranium Recovery Facilities.” Rev. 1. Washington, DC: NRC, Accession Number ML021260524, May.

——— 2001a. “Amendment 6 for SUA-1341, Irigaray and Christensen Ranch Projects, Surface Decommissioning Plan.” Washington, DC: NRC, ADAMS Accession No. ML020020527, December.

——— 2001b. NUREG/CR–6733, “A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licensees.” Washington, DC: NRC, ADAMS Accession No. ML012840152, September.

——— 2000. NUREG-1575, Rev. 1, “Multi-Agency Radiation Survey and Site Investigation Manual.” Washington, DC: NRC, ADAMS Accession No. ML003761445, August.

——— 1999. Regulatory Guide 8.13, “Instruction Concerning Prenatal Radiation Exposure.” Rev. 3. Washington, DC: NRC, Accession Number ML003739505, June.

——— 1998. “Renewal of Source Material License No. SUA–1341, Irigaray and Christensen Ranch ISL Facility.” Washington, DC: NRC, ADAMS Package Accession Number ML081060061, June.

——— 1996. Regulatory Guide 8.29, “Instruction Concerning Risks from Occupational Radiation Exposure.” Rev. 1. Washington, DC: NRC, Accession Number ML003739438 February.

——— 1993a. Regulatory Guide 8.37, “ALARA Levels for Effluents from Materials Facilities.” Washington, DC: NRC, Accession Number ML003739553, July.

——— 1993b. "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material." Washington, DC: NRC, ADAMS Accession No. ML003745526, April.

——— 1992a. Regulatory Guide 8.36, “Radiation Dose to the Embryo/Fetus.” Washington, DC: NRC, Accession Number ML003739548, July.

——— 1992b. Regulatory Guide 8.34, “Monitoring Criteria and Methods To Calculate Occupational Radiation Doses.” Washington, DC: NRC, Accession Number ML090770221, July.

——— 1992c. Regulatory Guide 8.25, “Air Sampling in the Workplace.” Rev. 1, Washington, DC: NRC, Accession Number ML003739616, June.

——— 1988a. “Safety Evaluation Report (SER) for Malapai Resources, Christensen Ranch In Situ Leach Satellite Operation.” Washington, DC: NRC Accession Number ML12053A170, August.

——— 1988b. Regulatory Guide 8.22. “Bioassay at Uranium Mills.” Rev. 1. Washington, DC: NRC, Accession Number ML003739586, August.

——— 1988c. “Environmental Assessment for Malapai Resources, Christensen Ranch In Situ Leach Satellite Operation.” NRC Accession Number ML090300532, May.

——— 1988d. Regulatory Guide 3.63, "Recovery Facilities-Data Acquisition And Reporting." Washington, DC: NRC, Accession Number ML003739874, March.

——— 1987. "License SUA–1341 for Westinghouse Renewed in Entirety." Washington, DC: NRC, ADAMS Accession Package Number 8703270222A, March.

——— 1981. "IE Circular No. 81-07: Control of Radioactively Contaminated Material," Washington, DC: NRC, ADAMS Accession Number ML082490470, May.

——— 1980. Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills." Rev. 1. Washington, DC: NRC, Accession Number ML003739941, April.

——— 1979. Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Normal Operations)—Effluent Streams and the Environment." Rev. 1. Washington, DC: NRC, Accession Number ML003739945, February.

——— 1978a. "Safety Evaluation Report for Source Material License No. SUA–1341, Wyoming Mineral Corporation." Washington, DC: NRC, ADAMS Accession Number ML091120640, November.

——— 1978b. NUREG-0399, "Draft Environmental Statement Related to Operation of Wyoming Mineral Corporation - Irigaray Solution Mining Project." Washington, DC: NRC, ADAMS Accession Number ML091050582, April.

Power Resources, Inc., 2006. "North Butte ISL Satellite Project, Campbell County, Wyoming, Volume I." Campbell County, WY: Power Resources Inc., ADAMS Accession Package Number ML061740057, March.

Uranium One, 2013a. "Willow Creek Project Quarterly Progress Report of Monitoring Wells on Excursion Status – 4th Quarter, 2012." Casper, Wyoming: Uranium One USA, Inc., ADAMS Accession Number ML13037A321, January.

——— 2013b, "E-mail from Uranium One re Willow Creek License Conditions." Casper, Wyoming: Uranium One USA, Inc., ADAMS Accession Number ML 13028A058, January.

——— 2012a. "Response to Confirmatory Action Letter." Casper, Wyoming: Uranium One USA, Inc., ADAMS Accession No. ML12268A270, September.

——— 2012b. "Uranium One's Response to NRC's RAI's for supplemental information to 2008 License Renewal Application for Willow Creek." Casper, Wyoming: Uranium One USA, Inc., ADAMS Accession No. ML12206A436, July.

——— 2012c. "Supplemental Information to the 2008 License Renewal Application." Casper, Wyoming: Uranium One USA, Inc., ADAMS Accession Package No. ML120820095, March.

——— 2012d. "Uranium One Management Structure for Willow Creek," Casper, Wyoming: Uranium One USA, Inc., ADAMS Accession Number ML120730200, February.

——— 2011. “Irigaray and Christensen Ranch Uranium Project License Amendment Request Materials License No. SUA-1341.” Casper, Wyoming: Uranium One USA, Inc., NRC ADAMS Accession Number ML110400016, February.

——— 2010a. “Replacement Pages for Uranium One’s License Renewal Application SUA-1341, Uranium One USA, Inc.” Casper, Wyoming: Uranium One USA, Inc., ADAMS Accession Number ML103280266, November.

——— 2010b. “Replacement Pages for Uranium One’s License Renewal Application SUA-1341.” Casper, Wyoming: Uranium One USA, Inc., ADAMS Accession Package Number ML103081073, October.

WDEQ, 2012. “Underground Injection Control Permit Issued Under Wyoming Water Quality Rules and Regulations Chapter 13 Class I Injection Well.” Cheyenne, WY: ADAMS Accession Number ML12235A357, August.

——— 2005. “Postmining Groundwater Restoration Demonstration for the Irigaray Mine, Permit No. 478, TFN 4 1/170, Change No. 34.” Cheyenne, WY: ADAMS Accession Number ML060830597, November.

Western Regional Climate Center, http://www.wrcc.dri.edu.

Westinghouse Electric Corporation, 1985. “Revised Application for Renewal of License SUA–1341, Providing Options for Sale of Irigaray Mine Site and Expediting Resumption of Operations on Production Scale.” Midwest, Wyoming: Westinghouse Electric Corporation.

WMC, 1976. “Application for a Source Material License.” Johnson County, Wyoming: Wyoming Mineral Corporation.