UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

LBP-15-3

ATOMIC SAFETY AND LICENSING BOARD PANEL

Before the Licensing Board:

G. Paul Bollwerk, III, Chairman
Dr. Craig M. White

In the Matter of	Docket No. 40-9091-MLA
STRATA ENERGY, INC.	ASLBP No. 12-915-01-MLA-BD01
(Ross In Situ Recovery Uranium Project)	January 23, 2015

INITIAL DECISION
(Ruling on Joint Intervenors' Environmental Contentions 1-3)

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ACRONYMS AND ABBREVIATIONS

ACL	Alternate Concentration Limit
AEA	Atomic Energy Act
AEC	Attenuation Environmental Company
ALARA	As Low As Reasonably Achievable
CAB	Commission-Approved Background
CBR	Crow Butte Resources, Inc.
CD	Compact Disc
CEO	Chief Executive Officer
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CPP	Central Processing Plant
CV	Curriculum Vitae
DM	Deep-Monitoring Zone or Unit
DSEIS	Draft Supplemental Environmental Impact Statement
DVD	Digital Video Disc
EC	Environmental Contention
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ER	Environmental Report
FSEIS	Final Supplemental Environmental Impact Statement
FSME	Office of Federal and State Materials and Environmental Management Programs
GEIS	Generic Environmental Impact Statement
ISR	In Situ Recovery
IX	Ion Exchange
JEC	Johnson Environmental Concepts
JTI	Joint Intervenors
LC	License Condition
MCL	Maximum Contaminant Level
NEPA	National Environmental Policy Act of 1969
NMSS	Office of Nuclear Material Safety and Safeguards
NRC	U.S. Nuclear Regulatory Commission
NRDC	Natural Resources Defense Council
OZ	Ore Zone

.pdf	Portable Document Format
PRBRC	Powder River Basin Resource Council
R&D	Research and Development
RCRA	Resource Conservation and Recovery Act
RES	Office of Nuclear Regulatory Research
SA	Surficial Aquifer
SEI	Strata Energy, Inc.
SM	Shallow-Monitoring
SPQ	Statement of Personal Qualifications
SRP	Standard Review Plan
TCEQ	Texas Commission on Environmental Quality
TDS	Total Dissolved Solids
TR	Technical Report
TWC	Texas Water Commission
UCL	Upper Control Limit
URL	Universal Resource Locator
USDW	Underground Source of Drinking Water
USGS	United States Geological Survey
WDEQ	Wyoming Department of Environmental Quality

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I. INTRODUCTION

1.1 On January 4, 2011, Strata Energy, Inc., (SEI) applied to the Nuclear Regulatory Commission (NRC) for a combined license to possess and use source and Atomic Energy Act (AEA) section 11e(2) byproduct materials pursuant to 10 C.F.R. Part 40 so as to authorize SEI to construct and operate a facility for the in situ recovery (ISR) of uranium at the Ross ISR Uranium Project (Ross Project) site in Crook County, Wyoming. This Initial Decision presents the Licensing Board's findings and conclusions relative to the three remaining admitted contentions in this proceeding, which were the subject of a September 30-October 1, 2014 evidentiary hearing. Those three National Environmental Policy Act (NEPA) environmental contentions (ECs), which were proffered by the Natural Resources Defense Council (NRDC) and the Powder River Basin Resource Council (PRBRC), hereinafter referred to as Joint Intervenors, were titled as follows:

> [EC] 1: The [final supplement to the NRC's generic environmental impact statement on ISR projects (FSEIS)] fails to adequately

> characterize baseline (i.e., original or pre-mining) groundwater quality.
>
> [EC] 2: The FSEIS fails to analyze the environmental impacts that will occur if the applicant cannot restore groundwater to primary or secondary limits.
>
> [EC] 3: The FSEIS fails to include adequate hydrological information to demonstrate SEI's ability to contain groundwater fluid migration.

[Licensing Board] Notice of Hearing (Notice of Evidentiary Hearing and Opportunity To Provide Oral and Written Limited Appearance Statements), 79 Fed. Reg. 44,471, 44,471 (July 31, 2014).

1.2 For the reasons set forth below, in the face of Joint Intervenors' challenges to the FSEIS in EC 1, EC 2, and EC 3, the Board finds that the NRC staff, in conjunction with SEI, has carried its burden of proof to demonstrate the adequacy of the FSEIS in accordance with 10 C.F.R. Part 51. The Board thus concludes that Joint Intervenors' three contentions cannot be sustained and enters a ruling on the merits of each contention in favor of the staff and SEI.

II. BACKGROUND

A. ISR Process

1. General Description

2 .1 As described in the staff's FSEIS, the ISR process extracts uranium from layers of permeable uranium-bearing sandstone (also known as the ore zone (OZ) or ore body) that are hydrologically isolated between layers of shale that prevent the vertical migration of mining fluids beyond the OZ. An injection well is used to insert a lixiviant into an ore body. The lixiviant consists of native groundwater and chemicals, specifically an oxidant such as hydrogen peroxide or oxygen and a complexing agent such as sodium bicarbonate or carbon dioxide. As the lixiviant is pumped through the OZ, the chemicals in the lixiviant dissolve the uranium from

the rock within the aquifer. Groundwater carrying the uranium-rich, or pregnant, lixiviant is then drawn out of the aquifer by pumping the lixiviant back to the surface via a recovery well. The pregnant lixiviant is then transferred to a central processing plant (CPP) where the uranium is extracted from the solution in columns that use an ion-exchange (IX) process by which the uranium is transferred to resin beads. The resulting barren solution is then recharged with complexing and oxidizing agents before being re-injected into the OZ to recover additional uranium. As for the uranium extracted from the lixiviant, it is eluted (i.e., washed) from the resin beads and precipitated into a solid material called yellowcake, which is packaged into NRC/United States Department of Transportation-approved fifty-five gallon steel drums and transported offsite by truck to an NRC-licensed uranium conversion facility. See Ex. SEI009A, at xix, 2-3, 2-9 (Office of Federal and State Materials and Environmental Management Programs (FSME), NRC, [Environmental Impact Statement (EIS)] for the Ross ISR Project in Crook County, Wyoming; Supplement to the Generic [EIS] for In-Situ Leach Uranium Milling Facilities, Final Report, NUREG-1910 (supp. 5 Feb. 2014)) [hereinafter FSEIS 9A].[1]

2 .2 The Ross Project is to consist of fifteen to twenty-five specific groups of wells, or wellfield modules, that in total would encompass 1400 to 2200 injection and recovery wells. The wellfield modules are connected via piping to a central collection facility, referred to as a module building or header house, from which the pregnant lixiviant is transferred to the CPP and from which the lixiviant recharged in the CPP is re-injected into the OZ aquifer. A ring of monitoring wells would surround the perimeter of the wellfields tapping into the OZ aquifer as well as the overlying and underlying aquifers to provide warning if lixiviant is migrating outside the OZ. See id. at xix, 2-9.

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[1] See infra note 5 for an explanation of the exhibit numbering protocol used in this decision.

2. Sampling and Monitoring Wells

2 .3 In addition to the wells employed for production purposes described above, there are a number of other sampling and/or monitoring wells involved in the Ross Project licensing, operations, and restoration/decommissioning processes that are relevant to the issues before the Board. Although we will describe these in more detail below in our discussion of Joint Intervenors' contentions, the following provides an overview:

2 .4 Historical boreholes. Within the Ross Project permit boundary, approximately 1500 boreholes exist that were constructed and abandoned prior to the commencement of SEI's exploration and site characterization studies for the Ross Project. Most of these historical boreholes were drilled in the 1970s in conjunction with ISR exploration, development, and site characterization efforts by the Nubeth Joint Venture (Nubeth). Analyses of groundwater collected by Nubeth in conjunction with its activities were included as part of the Ross site characterization study.[2] See FSEIS 9A, at 2-11, 2-26; see also infra section IV.C.4.2, 3.a.

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[2] In the course of the parties' dispute regarding, in particular, issue statement EC 1, there was some uncertainty about the labels to be applied to the activities associated with, and the data coming from, SEI's pre-licensing groundwater monitoring associated with compliance with the dictates of 10 C.F.R. Part 40, Appendix A, Criterion 7, as contrasted to those SEI activities conducted to comply with the post-licensing dictates of Appendix A, Criteria 5B and 7A. The staff has chosen to label those activities conducted under Criterion 7 prior to license issuance as "pre-licensing, site characterization" and those conducted under Criteria 7A and 5B as "post-licensing, pre-operational." See FEIS 9A, at 2-25. We have attempted to utilize this terminology as well.

Additionally, although the term "baseline" was initially utilized by the staff to describe the data being sought both pre- and post-licensing for regulatorily-significant constituent concentrations, see NRC Staff Response to Petition to Intervene and Request for Hearing by [Joint Intervenors] (Dec. 5, 2011) at 17 n.40 (both pre- and post-operational monitoring programs provide "baseline" data) [hereinafter Staff Intervention Response], in its FSEIS the staff has seemingly eschewed that term, see FSEIS 9A, at 5-28 n.† (tbl. 5.4) (although values identified as "baseline" by Nubeth, "that term is not used" in FSEIS). The same is true for the term "background" as it is used to refer to groundwater monitoring. Compare Staff Intervention Response at 22 ("Criterion 5B(5) thus sets a primary standard of background concentration"), with FSEIS 9A, at B-22 (Criterion 5B(5)(a) "Commission approved background [in this SEIS,

(continued...)

2 .5 Monitoring well clusters. Six monitoring well clusters, each consisting of at least four wells, were constructed for SEI's site characterization study. At least one well in each cluster was completed in the OZ aquifer, one in the deep monitoring (DM) aquifer below the OZ horizon and one each in the shallow monitoring (SM) and surficial (SA) aquifers overlying the OZ horizon. Wells in the six clusters were used to perform pumping tests and for the collection of samples used to characterize the pre-licensing groundwater quality. See FSEIS 9A, at 2-25; see also infra sections IV.A.2, IV.C.4.2, 3.b.

2 .6 Wellfield production and injection wells. A subset of the production and injection wells to be drilled within the boundaries of the ISR wellfield is to be used to sample groundwater from the OZ aquifer prior to the commencement of operations to establish hazardous constituent “Commission approved background” (CAB) concentrations pursuant to Criterion 5B(5)(a) of 10 C.F.R. Part 40, Appendix A. Wells used to establish these background values will be the same ones used to measure post-mining restoration success and stabilization. See FSEIS 9A, at 2-26; see also infra section IV.A.3.

2 .7 Perimeter monitoring wells. As was noted above, perimeter monitoring wells will be constructed post-licensing but prior to the commencement of ISR operations and will be located about 400 feet from the edge of an ISL wellfield but inside the boundary of the exempted aquifer. Perimeter wells will be completed in the SM, OZ and DM aquifers and

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[2](...continued)
‘post-licensing, pre-operational’] concentrations”). But see NRC Staff’s Initial Statement of Position (Aug. 25, 2014) at 16-17 (applicant’s pre-licensing, site-characterization “baseline” water quality information used to describe existing ISR site groundwater conditions while post-licensing, preoperational background water quality information is gathered to generate “background” data before wellfield operations begin) [hereinafter Staff Initial Position Statement]. Nonetheless, given that the term “baseline” is used in Criterion 7 and the term “background” is used in Criterion 5B(5)(a), we have tried to use those descriptors when discussing circumstances involving those criteria. We have not, however, attempted to re-characterize the terms when they were used by the parties in their pleadings and testimony.

samples collected from each aquifer prior to the commencement of ISL mining will be used to establish the groundwater protection upper control limits (UCLs) for detecting excursions of lixiviant after operations have begun. See FSEIS 9A, at 2-26; see also infra section IV.A.3.

B. Contention Admission, Migration, and Summary Disposition

2 .8 On October 27, 2011, Joint Intervenors filed an intervention petition seeking to challenge SEI's Ross Project application and, in particular, certain aspects of its environmental report (ER). SEI and the staff opposed the hearing request on the grounds that Joint Intervenors had failed to establish their standing to intervene and had not submitted an admissible contention. In a February 12, 2012 ruling, the Licensing Board concluded that Joint Intervenors both had standing and had submitted four admissible contentions: EC 1, EC 2, and EC 3, as well as EC 4/5A, which asserted that the ER failed to assess adequately the cumulative impacts of the proposed action and the purportedly planned Lance District expansion project, of which the Ross Project is one part. See LBP-12-3, 75 NRC 164, 210, aff'd in part and review declined, CLI-12-12, 75 NRC 603 (2012). The Commission subsequently affirmed the Board's standing ruling, but declined to accept review of SEI's challenges to the Board's admission of EC 1 and EC 2 because, as is required in 10 C.F.R. § 2.311(d)(1), SEI had failed to perfect its appeal by challenging the validity of the Board's admissibility rulings regarding EC 3 and EC 4/5A as well. See CLI-12-12, 75 NRC at 614.

2 .9 With the staff's March 2013 issuance of its Ross facility-related draft supplement to the agency's generic environmental impact statement on ISR projects (DSEIS), see Ex. SEI006A (FSME, NRC, [EIS] for the Ross ISR Project in Crook County, Wyoming; Supplement to the Generic [EIS] for In-Situ Leach Uranium Milling Facilities, Draft Report for Comment, NUREG-1910 (supp. 5 Mar. 2013)) [hereinafter DSEIS 6A], Joint Intervenors filed a motion seeking to (1) "resubmit" their four pending environmental contentions in light of the staff's

DSEIS; and (2) admit an additional NEPA-related contention, EC 6, challenging the scope of the staff's DSEIS as improperly segmenting the major federal project by not taking into account all planned activities in the larger Lance District. In a July 26, 2013 determination, the Board concluded that (1) new contention EC 6 was not admissible as having failed to meet both the contention admissibility standards of 10 C.F.R. § 2.309(f)(1) and the "good cause" provision of section 2.309(c)(1); (2) EC 4/5A was not eligible to "migrate" to a contention contesting the DSEIS and so, without a new/amended contention, would remain a challenge to the SEI ER; and (3) EC 1, EC 2, and EC 3 were qualified to migrate as challenges to the DSEIS. See LBP-13-10, 78 NRC 117, 151 (2013), reconsideration and motion to admit amended EC 4/5A denied, Licensing Board Memorandum and Order (Denying Motion for Reconsideration of LBP-13-10 Ruling Regarding Environmental Contention 4/5A or, Alternatively, to Admit Amended Contention) (Aug. 23, 2013) (unpublished).

2 .10 The February 2014 issuance of the staff's Ross facility-related FSEIS brought another request by Joint Intervenors to "migrate" their existing DSEIS- or ER-based contentions as challenges to the FSEIS, or to admit new/amended contentions relative to those issue statements, as well as a request to admit another new contention, EC 7, challenging the scope of the staff's FSEIS as improperly segmenting the major federal project by not taking into account all planned activities in the larger Lance District.[3] The Board again found that migration was appropriate for EC 1 and EC 3 and that EC 2 could move forward as an amended

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[3] On April 25, 2014, the staff notified the Board that, in addition to issuing the record of decision associated with its FSEIS, in accord with 10 C.F.R. § 2.1202(a), the SEI license had been issued, effective immediately. See Letter from Christopher C. Hair, NRC Staff Counsel, to Licensing Board (Apr. 25, 2014) at 1–2 & n.1; see also Ex. NRC009 (Andrew Persinko, FSME, NRC, [NRC] Record of Decision for the Ross Uranium [ISR] Project in Crook County, Wyoming (Apr. 24, 2014); Ex. SEI015 (NRC Materials License SUA-1601 (Apr. 24, 2014)) [hereinafter SEI License]. Although section 2.1213(a) afforded Joint Intervenors the opportunity to seek a stay of this staff action, no such request was filed.

contention contesting the FSEIS, but that EC 4/5A could neither migrate nor be amended as challenging the FSEIS and that EC 7 was not admissible as a new contention. See Licensing Board Memorandum and Order (Ruling on Motion to Migrate/Amend Existing Contentions and Admit New Contentions Regarding Final Supplement to Generic Environmental Impact Statement) (May 23, 2014) at 19 (unpublished) [hereinafter FSEIS Order].

2 .11 Under the proceeding's general schedule, the parties then had an opportunity to move for summary disposition regarding any of the four admitted contentions. See Licensing Board Memorandum and Order (Granting Requests to Revise Dispositive Motion Briefing Schedule; Revised General Schedule) (June 2, 2014) attach. A, at 2 (unpublished). By motions dated June 13, 2014, SEI and the staff sought summary disposition of EC 4/5A while Joint Intervenors requested that summary disposition be entered in their favor regarding EC 1. In a July 25 ruling, the Board granted the SEI/staff motions relative to EC 4/5A, but in a separate August 12 determination, the Board concluded that there were material facts in dispute regarding EC 1 so as to preclude the grant of summary disposition. See Licensing Board Memorandum and Order (Ruling on Summary Disposition Motion Regarding Environmental Contention 4/5A) (July 25, 2014) at 14–15 (unpublished); Licensing Board Memorandum and Order (Ruling on Summary Disposition Motion Regarding Environmental Contention 1) (Aug. 12, 2014) at 22–23 (unpublished).

C. Evidentiary Hearing on EC 1, EC 2, and EC 3

2 .12 Thereafter, in preparation for the 10 C.F.R. Part 2, Subpart L simplified evidentiary hearing on EC 1, EC 2, and EC 3, SEI, the staff, and Joint Intervenors filed initial and rebuttal position statements and prefiled direct and rebuttal testimony and supporting

exhibits on August 25 and September 12, 2014, respectively.[4] Relative to this prefiled evidentiary material, however, in a September 10 issuance the Board identified several items that needed clarification and found that one prefiled exhibit provided by Joint Intervenors in support of EC 2, JTI005,[5] would not admissible because it consisted of a listing of four Internet universal resource locator (URL) citations that represented a web-based "storymap" application and the underlying database information.[6] To address the Board's concerns, Joint Intervenors subsequently submitted revised versions of this prefiled exhibit, to which SEI responded with a

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[4] [SEI's] Initial Statement of Position (Aug. 25, 2014) [hereinafter SEI Initial Position Statement]; [SEI] Notice of Errata for Initial Statement of Position (Sept. 5, 2014); Staff Initial Position Statement; [Joint Intervenors'] Statement of Position Supporting [EC] 1, 2 and 3 (Aug. 25, 2014) [hereinafter Joint Intervenors Initial Position Statement]; SEI's Rebuttal Statement of Position (Sept. 12, 2014) [hereinafter SEI Rebuttal Position Statement]; NRC Staff's Rebuttal Statement of Position (Sept. 12, 2014); NRC Staff's Rebuttal Statement of Position[-Revised] (Sept. 18, 2014); [Joint Intervenors'] Response Statement in Support of [EC] 1, 2 and 3 (Sept. 12, 2014); [Joint Intervenors'] Response Statement in Support of [EC] 1, 2 and 3-Revised (Sept. 16, 2014) [hereinafter Joint Intervenors Rebuttal Position Statement].

[5] As entered into the record and incorporated into the agency's ADAMS-associated electronic hearing docket, the official exhibit number for each evidentiary item in this proceeding reflects a three-letter party identifier (i.e, SEI, NRC, JTI); followed by three numeric characters to reflect its number; an additional letter (e.g., A, B, etc.) that, if used, indicates it is one part of a multi-part exhibit; another alpha character (i.e., -R) to indicate whether the exhibit was revised after its original submission as a prefiled exhibit (e.g., admitted exhibit JTI005-R would be a revised version of prefiled exhibit JTI005); followed by a two-character numeric identifier (i.e., 00) that identifies the exhibit as being used in a contested case (as opposed to a mandatory/uncontested proceeding (i.e., MA)); followed by the designation BD01, which indicates that this Licensing Board (i.e., BD01) was involved in its identification and/or admission. Accordingly, the official designation for this prefiled exhibit, as ultimately admitted, is JTI005A-R2-00-BD01, which reflects the fact, as is explained below, see infra note 53, that the prefiled version of this exhibit was refiled as a multi-part exhibit, the "A" portion of which was twice amended by the time of its admission. For ease of reading, however, we will refer to all exhibits admitted in this proceeding without the final six characters that make up their official designation.

[6] The Board advised Joint Intervenors that to have the material from these websites incorporated into the record, Joint Intervenors needed to provide portable document format (.pdf) formatted screen shots of the appropriate pages from these sites. See Licensing Board Memorandum and Order (Clarifying Evidentiary Materials) (Sept. 10, 2014) at 1–3 (unpublished).

motion in limine that the Board advised would be considered at an appropriate time during the evidentiary hearing.[7]

2 .13 Pursuant to the proceeding's general schedule, see Licensing Board Memorandum and Order (Ruling on Motion to Amend General Schedule; Revised General Schedule) (Aug. 7, 2014) app. A, at 2 (unpublished) [hereinafter General Schedule Order], on September 30-October 1, 2014, the Board held an evidentiary hearing regarding contentions

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[7] In response to the Board's September 10, 2014 order, on September 16 Joint Intervenors filed two new prefiled exhibits, JTI005A-R and JTI005B-R, providing storymaps generated via the use of the application websites and the database information underlying those storymaps, along with a motion asking for additional clarification regarding the Board's directives concerning prefiled exhibit JTI005. This included a request that, notwithstanding Joint Intervenors' efforts to submit .pdf screenshots of relevant portions of the information from the application websites, because of the interactive nature of the application websites created by Joint Intervenors' expert witness supporting EC 2, the Board should, as it would with a chart or graph prepared by an expert witness, admit as exhibits the entirety of the storymap applications and the database of information upon which they are based. In a September 19 order, the Board declined to provide the requested relief. The Board instead stated again that the non-static nature of the websites, as illustrated by Joint Intervenors' acknowledgment that its EC 2 witness could modify the information input utilized to generate the storymaps, precluded the Board, in the absence of a stand-alone compact disc/digital video disc (CD/DVD) that would allow the Board or the parties to run a "locked down" version of the applications, from simply allowing the websites and the storymaps they could generate from being considered as evidentiary material. See Licensing Board Memorandum and Order (Responding to Motion for Clarification) (Sept. 19, 2014) at 1–5 (unpublished). The Board did indicate, however, that during the evidentiary hearing, if in response to a Board question it became necessary for Joint Intervenors' EC 2 witness to generate an additional storymap from the website applications, so long as the manner in which the storymap was generated was shown to the parties (which the display technology being employed by the Board for the hearing would permit) and the resulting storymap was rendered into a .pdf document and provided to the other parties and the Board as a marked exhibit, the Board would consider admitting the material into the evidentiary record. See id. at 5–6.

SEI responded with a September 23 in limine motion, which the staff supported, asking that the Board preclude in toto the use of Joint Intervenors' storymap exhibits. In a September 24 issuance, the Board set a schedule for staff and Joint Intervenor motion responses and indicated that the Board would entertain arguments during the evidentiary hearing regarding the admissibility of any storymap-related exhibits. See Licensing Board Memorandum and Order (Additional Prehearing Items) (Sept. 24, 2014) at 4 (unpublished); see also infra note 53.

EC 1, EC 2, and EC 3 in Gillette, Wyoming.[8] See Tr. at 260–794. After providing the parties with an opportunity to submit proposed joint transcript corrections, on October 28, 2014, the Board issued an order adopting transcript corrections and closing the evidentiary record. See Licensing Board Memorandum and Order (Adopting Transcript Corrections and Closing Evidentiary Record) (Oct. 28, 2014) at 1–2 (unpublished) [hereinafter Transcript Corrections Order].[9]

2 .14 In accord with 10 C.F.R. § 2.1209 and this proceeding's general schedule, see General Schedule Order app. A, at 2, on November 3, 2014, the parties filed their proposed findings of fact and conclusions of law, and the parties' reply findings of fact and conclusions of law followed on November 17, 2014.[10]

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[8] In addition, the Board conducted a 10 C.F.R. § 2.315(a) limited appearance session in Sundance, Wyoming, on September 28, 2014, see Tr. at 1–49 (Sept. 28, 2014), and Judges Bollwerk and White participated in site visits to the SEI Ross Project and the Uranerz Energy Corp. Nichols Ranch ISR facilities on September 29 and October 2, respectively.

[9] In citing to the evidentiary hearing transcript in this decision, we are referencing the transcript as modified by the transcript corrections adopted by the Board. See Transcript Corrections Order app. A.

[10] See [SEI's] Proposed Findings of Fact and Conclusions of Law (Nov. 3, 2014) [hereinafter SEI Findings]; [SEI] Notice of Errata for Proposed Findings of Fact and Conclusions of Law (Nov. 12, 2014); NRC Staff's Proposed Findings of Fact and Conclusions of Law (Nov. 3, 2014) [hereinafter Staff Findings]; NRC Staff's Corrected Notice of Erratum to Proposed Findings of Fact and Conclusions of Law (Nov. 20, 2014); [Joint Intervenors'] Proposed Findings of Fact and Conclusions of Law for [EC] 1, 2, and 3 (Nov. 3, 2014) [hereinafter Joint Intervenors Findings]; [SEI's] Reply to NRC Staff's and Joint Intervenors' Proposed Findings of Fact and Conclusions of Law (Nov. 17, 2014) [hereinafter SEI Reply Findings]; NRC Staff's Reply Proposed Findings of Fact and Conclusions of Law (Nov. 17, 2014) [hereinafter Staff Reply Findings]; [Joint Intervenors'] Responses to NRC Staff's and SEI's Proposed Reply Findings of Fact and Conclusions of Law for [EC] 1, 2, and 3 (Nov. 17, 2014) [hereinafter Joint Intervenors Reply Findings].

III. APPLICABLE LEGAL STANDARDS

3 .1 The contentions at issue here — EC 1, EC 2, and EC 3 — arise under the National Environmental Policy Act of 1969 and the NRC regulations implementing the agency's responsibilities pursuant to the Act. See 42 U.S.C. § 4321 et seq.; 10 C.F.R. Pt. 51. Together, this statute and the corresponding agency regulations govern an applicant's and the staff's roles in considering the environmental effects of a proposed agency ISR licensing action under 10 C.F.R. Part 40. Additionally, the Council on Environmental Quality (CEQ) has implemented regulations that provide guidance on agency compliance with NEPA, see 40 C.F.R. Pt. 1500, that, while not binding on the NRC when the agency has not expressly adopted them, are entitled to considerable deference. See Limerick Ecology Action, Inc. v. NRC, 869 F.2d 719, 725, 743 (3d Cir. 1989).

A. NEPA Requirements

3 .2 NEPA requires federal agencies to take a "hard look" at the environmental impacts of a proposed action, as well as reasonable alternatives to that action. See La. Energy Servs., L.P. (Claiborne Enrichment Center), CLI-98-3, 47 NRC 77, 87–88 (1998). This "hard look" is intended to "'foster both informed agency decision-making and informed public participation'" so as to ensure that the agency does not act upon "'incomplete information, only to regret its decision after it is too late to correct.'" Id. at 88 (quoting Marsh v. Or. Natural Res. Council, 490 U.S. 360, 371 (1989)). This "hard look" is, however, subject to a "rule of reason" in that consideration of environmental impacts need not address "all theoretical possibilities," but rather only those that have some "reasonable possibility" of occurring. Long Island Lighting Co. (Shoreham Nuclear Power Station, Unit 1), ALAB-156, 6 AEC 831, 836 (1973).

3 .3 With regard to such reasonably foreseeable impacts, "NEPA does not call for certainty or precision, but an estimate of anticipated (not unduly speculative) impacts." La.

Energy Servs., L.P. (National Enrichment Facility), CLI-05-20, 62 NRC 523, 536 (2005). As a consequence, agencies are given broad discretion "to keep their inquiries within appropriate and manageable boundaries." Claiborne, CLI-98-3, 47 NRC at 103. Therefore, in preparing an EIS, which "is not intended to be 'a research document,'" Entergy Nuclear Generation Co. (Pilgrim Nuclear Power Station), CLI-10-22, 72 NRC 202, 208 (2010) (quoting Town of Winthrop v. FAA, 535 F.3d 1, 13 (1st Cir. 2008)), NEPA does not call upon the staff to make an "'examination of every conceivable aspect of federally licensed projects,'" Private Fuel Storage, L.L.C., CLI-02-25, 56 NRC 340, 349 (2002) (quoting Claiborne, CLI-98-3, 47 NRC at 103). Nor is there a "NEPA requirement to use the best scientific methodology, and NEPA [']"should be construed in the light of reason if it is not to demand"['] virtually infinite study and resources." Entergy Nuclear Generation Co. (Pilgrim Nuclear Power Station), CLI-10-11, 71 NRC 287, 315 (2010) (quoting NRDC v. Hodel, 865 F.2d 288, 294 (D.C. Cir. 1988) (quoting NRDC v. Morton, 458 F.2d 827, 837 (D.C. Cir. 1972))) (footnotes omitted).

3 .4 Finally, "in the context of an NRC adjudicatory proceeding, even if an [EIS] prepared by the Staff is found to be inadequate in certain respects, the Board's findings, as well as the adjudicatory record, 'become, in effect, part of the [final EIS].' Thus, the Board's ultimate NEPA judgments can be made on the basis of the entire adjudicatory record in addition to the Staff's [final EIS]." See S. Nuclear Operating Co. (Early Site Permit for Vogtle ESP Site), LBP-09-7, 69 NRC 613, 632 (2009) (quoting Hydro Res., Inc. (P.O. Box 15190, Rio Rancho, NM 87174), CLI-01-4, 53 NRC 31, 53 (2001), and citing La. Energy Servs., L.P., LBP-05-13, 61 NRC 385, 404 (2005), aff'd, CLI-06-22, 64 NRC 37 (2006), petition for review denied sub nom. Nuclear Infor. & Res. Serv. v. NRC, 509 F.3d 562 (D.C. Cir. 2007)), petition for review denied, CLI-10-5, 71 NRC 90 (2010).

B. 10 C.F.R. Part 51 Requirements Associated with Groundwater Information

3 .5 Under the NRC's Part 51 regulations governing the agency's implementation of NEPA, an applicant for a license to possess and use source and AEA section 11(e)2 byproduct material for the purpose of in situ uranium recovery must submit an ER with its application. See 10 C.F.R. §§ 40.31(f), 51.60(b); see also Office of Nuclear Regulatory Research (RES), NRC Regulatory Guide 3.46 (Task FP 818-4), Standard Format and Content of License Applications, Including Environmental Reports, for In Situ Uranium Solution Mining at vi (June 1982) (ADAMS Accession No. ML003739441) [hereinafter Reg. Guide 3.46].[11] More specifically, the ER must "contain a description of the proposed action, a statement of its purposes, [and] a description of the environment affected," 10 C.F.R. § 51.45(b), and it must discuss:

> (1) The impact[s] of the proposed action on the environment . . . in proportion to their significance;
> (2) Any adverse environmental effects which cannot be avoided should the proposal be implemented;
> (3) Alternatives to the proposed action . . . ;
> (4) The relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity; and
> (5) Any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

Id. § 51.45(b)(1)-(5). Relative to groundwater, the applicant's ER is to provide information that will inform the staff's NEPA analysis of, among other things, environmental effects of the proposed action, and alternatives to the proposed action, including alternatives available to reduce or avoid adverse environmental effects. See Reg. Guide 3.46, at 3.46-7, 3.46-9, 3.46-17 to -20, 3.46-28.

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[11] The Licensing Board takes official notice of this NRC regulatory document in accord with 10 C.F.R. § 2.337(f).

3 .6 The agency's NEPA regulations also require that the staff prepare an EIS in connection with a license to possess and use source and AEA section 11(e)2 byproduct material for the purpose of in situ uranium recovery. See 10 C.F.R. § 51.20(b)(8); see also FSEIS 9A, at iii. In the case of ISR projects, in May 2009, the agency issued NUREG-1910, a generic EIS for ISR uranium recovery facilities that assesses potential ISR facility construction/operation/decommissioning impacts in four specific Western United States regions, including the Nebraska-South Dakota-Wyoming region in which the Ross Project is located, and so provides a starting point for the agency's NEPA analyses for site-specific license applications for new ISR facilities. See FSEIS 9A, at iii. For the initial licensing of each individual ISR facility, however, the staff will first prepare a DSEIS, see 10 C.F.R. § 51.70, see also Ex. NRC007, at 1-29 (1 FSME, NRC, and Land Quality Division, Wyoming Department of Environmental Quality (WDEQ), NUREG-1910, Generic Environmental Impact Statement (GEIS) for In-Situ Leach Uranium Milling Facilities (May 2009)) [hereinafter GEIS], which addresses, among other topics, "the matters specified in [section] 51.45," 10 C.F.R. § 51.71(a). Although a DSEIS may rely in part on the ER, the regulations require the staff to "independently evaluate and be responsible for the reliability of all information used in the [DSEIS]." Id. § 51.70(b). The DSEIS is then distributed for public comment and, based on the comments received, a review of information provided by the applicant, and supplemental independent information and analysis, the staff prepares and issues an FSEIS. See id. §§ 51.73, 51.91; see also GEIS at 1-29 to -30.

3 .7 Relative to an individual ISR facility, when the staff formulates its DSEIS and FSEIS conclusions regarding the environmental impacts of a proposed action or alternative actions, the staff uses as guidance a standard scheme to categorize or quantify the impacts. See, e.g., 10 C.F.R. Pt. 51, App. B, tbl. B-1 n.3. This standard was created using the approach

outlined in CEQ regulations indicating that agencies should consider both the context and intensity of impacts. See Ex. NRC013, at 4-14 (Office of Nuclear Material Safety and Safeguards (NMSS), NRC, NUREG-1748, Environmental Review Guidance for Licensing Actions Associated with NMSS Programs (Aug. 2003)) (citing 1 RES, NRC, NUREG-1437, [GEIS] for License Renewal of Nuclear Plants at 1-4 to -5 (May 1996) (citing 40 C.F.R. § 1508.27)) [hereinafter NUREG-1748]. This standard employs three levels of impacts — SMALL, MODERATE, and LARGE — that are defined as follows:

> SMALL - Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
>
> MODERATE - Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.
>
> LARGE - Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

See FSEIS 9A, at xx-xxi.[12]

C. Burden of Proof in NEPA Context

3 .8 As the proponent of the agency action at issue, an applicant generally has the burden of proof in a licensing proceeding. See 10 C.F.R. § 2.325. The statutory obligation of complying with NEPA, however, rests with the NRC. See, e.g., Duke Power Co. (Catawba Nuclear Station, Units 1 and 2), CLI-83-19, 17 NRC 1041, 1049 (1983). Consequently, when NEPA contentions are involved, the burden shifts to the staff. See Progress Energy Fl., Inc. (Levy County Nuclear Power Plant, Units 1 and 2), CLI-10-2, 71 NRC 27, 34 (2010); see also S. Nuclear Operating Co. (Early Site Permit for Vogtle ESP Site), CLI-07-17, 65 NRC 392, 395 (2007) (stating "NRC hearings on NEPA issues focus entirely on the adequacy of the Staff's

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[12] In describing and analyzing staff environmental impact findings in this decision, we follow the agency's regulatory protocol of denoting these terms in CAPITAL letters.

work”). Nonetheless, because “the Staff, as a practical matter, relies heavily upon the Applicant’s ER in preparing the EIS, should the Applicant become a proponent of a particular challenged position set forth in the EIS, the Applicant, as such a proponent, also has the burden on that matter.” La. Energy Servs., L.P. (Claiborne Enrichment Center), LBP-96-25, 44 NRC 331, 339 (1996) (citing Pub. Serv. Co. of N.H. (Seabrook Station, Units 1 and 2), ALAB-471, 7 NRC 477, 489 n.8 (1978)), rev’d on other grounds, CLI-97-15, 46 NRC 294 (1997). And relative to factual matters, to carry that burden, the staff and/or the applicant must establish that its position is supported by a preponderance of the evidence. See Pac. Gas & Elec. Co. (Diablo Canyon Nuclear Power Plant, Units 1 and 2), ALAB-763, 19 NRC 571, 577 & n.22 (citing cases), rev. declined, CLI-84-14, 20 NRC 285 (1984).

IV. FINDINGS AND CONCLUSIONS

A. Contention EC 1

4 .1 As set forth by the Board in its May 2014 order recognizing the migration of EC 1 as an FSEIS-related contention, that issue statement provides:

> [EC] 1: The FSEIS fails to adequately characterize baseline (i.e., original or pre-mining) groundwater quality.
>
> CONTENTION: The FSEIS fails to comply with 10 C.F.R. §§ 51.90-94, 10 C.F.R. Part 40, Appendix A, and NEPA because it lacks an adequate description of the present baseline (i.e., original or pre-mining) groundwater quality and fails to demonstrate that groundwater samples were collected in a scientifically defensible manner, using proper sampling methodologies. The FSEIS’s departure from NRC guidance serves as additional evidence of these regulatory violations. NRC, NUREG-1569, Standard Review Plan [(SRP)] for In Situ Leach Uranium Extraction License Applications, §§ 2.7.1, 2.7.3, 2.7.4 (2003).

FSEIS Order app. A, at 1.

1. Witnesses and Evidence Presented

4 .2 SEI, the staff, and Joint Intervenors presented a total of eight witnesses in connection with EC 1 during the September 30-October 1 evidentiary hearing in support of their respective positions on the adequacy of the FSEIS as it addresses the baseline groundwater quality at the Ross ISR Project site. Those witnesses presented written direct and rebuttal testimony, with supporting exhibits, and gave oral testimony at the evidentiary hearing.[13]

a. SEI

4 .3 SEI presented four witnesses in support of its position on EC 1 at the evidentiary hearing: Ralph Knode, Hal Demuth, Errol Lawrence, and Ben Schiffer. See Tr. at 298–369, 437–76.

4 .4 Ralph Knode, SEI Chief Executive Officer (CEO), holds a Bachelor of Arts degree in geology from Amherst College. He has previously held ISR mine construction or operations positions with Uranium One, Inc., Joint Venture Inkai, Power Resources, Inc., Crow Butte Resources, Inc., (CBR) and Uranerz Exploration and Mining. At SEI, Mr. Knode oversees all licensing actions as well as the design, engineering, and construction of the wellfields and the ore recovery facilities; financial planning and budgetary matters; land and mineral acquisition; the development and implementation of health and safety programs; and interaction

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[13] See Tr. at 260–476; Ex. SEI001, at 4–9 (Initial Written Testimony of Ralph Knode) [hereinafter Knode Initial Testimony]; Ex. SEI047, at 3–5 (Rebuttal Testimony of Ralph Knode) [hereinafter Knode Rebuttal Testimony]; Ex. SEI005, at 4–22 (Initial Written Testimony of Ben Schiffer) [hereinafter Schiffer Initial Testimony]; Ex. SEI045, at 3–17 (Rebuttal Testimony of Ben Schiffer) [hereinafter Schiffer Rebuttal Testimony]; Ex. SEI0026, at 8–13 (Initial Written Testimony of Hal Demuth and Errol Lawrence) [hereinafter Demuth/Lawrence Initial Testimony]; Ex. SEI046, at 3–6 (Rebuttal Testimony of Hal Demuth and Errol Lawrence) [hereinafter Demuth/Lawrence Rebuttal Testimony]; Ex. NRC001, at 3–27 (NRC Staff's Initial Testimony) [hereinafter Staff Initial Testimony]; Ex. NRC044-R2, at 3–16 (NRC Staff's Rebuttal Testimony) [hereinafter Staff Rebuttal Testimony]; Ex. JTI001-R, at 6–40 (Pre-Filed Direct Testimony of Dr. Richard Abitz Supporting Joint Intervenors' Contentions 1 and 3)) [hereinafter Abitz Initial Testimony]; Ex. JTI051-R, at 2–16 (Pre-Filed Rebuttal Testimony of Dr. Richard Abitz Supporting Joint Intervenors' Contentions 1 and 3) [hereinafter Abitz Rebuttal Testimony].

with landowners and other stakeholders. See Knode Initial Testimony at 3–4; Ex. SEI002, at 1–3 (Ralph Knode Curriculum Vitae (CV)).

4 .5 Ben Schiffer holds a Bachelor of Arts degree in geology from Whitman College and is a licensed professional geologist in the State of Wyoming. Currently, as a senior geologist and project manager at WWC Engineering, he is the coordinator for the team responsible for SEI's ISR permit application with responsibility for all permitting activities, including well installation and instrumentation, aquifer testing, groundwater modeling and geologic characterization. Also, he has served as a geologist/hydrogeologist at EDE Consultants, a geologist at Cogema Mining, Inc., and a field technician with KECK Geologic Consortium. See Schiffer Initial Testimony at 4; Ex. SEI006, at 1 (Ben Schiffer CV).

4 .6 Hal Demuth graduated from the University of Tulsa with a Bachelor of Science degree in petroleum engineering and from the University of Idaho with a Master of Science degree in hydrogeology. He is a senior engineer/hydrologist and principal of Petrotek Engineering Corp. At the Ross Project, he has overseen preparation of the permit application for the deep disposal wells as well as provided peer review of the hydrogeologic sections of the license application. Mr. Demuth was employed previously as a senior engineer/hydrologist at Harlan & Associates, Inc.; as a research assistant at the University of Idaho; and as a drilling/reservoir engineer at Tenneco Exploration & Production, Inc. See Demuth/Lawrence Initial Testimony at 3–4; Ex. SEI027, at 1 (Hal Demuth CV).

4 .7 Errol Lawrence, who has a Bachelor of Science degree in geology from Northern Arizona University and a Master of Science degree in engineering geology from the Colorado School of Mines, is a senior hydrogeologist/permitting specialist employed by Petrotek Engineering Corp. Mr. Lawrence has been employed at HydroSolutions as a hydrogeologic consultant; by Geraghty & Miller, Inc., as a project scientist; by the United States Geologic

Survey as a geologist; by Pogo Producing Company as an exploration geologist; and by Dresser Atlas as a wireline engineer. A registered professional geologist in Wyoming and Texas, Mr. Lawrence participated in the detailed review of the groundwater model for the Ross Project. See Demuth/Lawrence Initial Testimony at 3–4; Ex. SEI028, at 1 (Errol Lawrence CV).

b. NRC Staff

4 .8 At the hearing, evidence regarding staff's position relative to EC 1 was presented by three witnesses: Johari Moore, John Saxton, and Dr. Kathryn Johnson. See Tr. at 371–99, 437–76.

4 .9 Johari Moore has a Bachelor of Science degree in physics from Florida A&M University and a Master of Science degree in nuclear engineering and radiological sciences from the University of Michigan. Ms. Moore was the lead environmental review project manager for the Ross Project in FSME's Division of Waste Management and Environmental Protection, Environmental Review Branch. See Staff Initial Testimony at 1; Ex. NRC002, at 1 (Johari Aziza Moore Statement of Professional Qualifications (SPQ)).

4 .10 John Saxton, who holds a Bachelor of Science degree in geological engineering from the Colorado School of Mines and a Master of Science degree in geology from the University of New Mexico and is a licensed environmental professional in Connecticut, is a hydrogeologist with the FSME Uranium Recovery Licensing Branch, State and Materials and Environmental Management Programs. He was the project manager and technical reviewer in the area of hydrogeology for staff's safety review of the Ross Project license application. See Staff Initial Testimony at 1–2; Ex. NRC003, at 1–2 (John L. Saxton SPQ).

4 .11 Dr. Kathryn Johnson was awarded a Bachelor of Science degree in chemistry and mathematics from Black Hills State, a Master of Science degree in chemistry from Iowa State University, and a Ph.D in geology from the South Dakota School of Mines and

Technology. A geochemist employed by Attenuation Environmental Company (AEC) and the owner/principal of Johnson Environmental Concepts (JEC), Dr. Johnson served as the subject matter expert regarding water quality and as the principal editor of all sections on geology, soils, and hydrology for the Ross Project DSEIS and FSEIS. See Staff Initial Testimony at 2; Ex. NRC004, at 1–2 (Kathryn O. Johnson CV).

c. Joint Intervenors

4 .12 Dr. Richard Abitz testified on behalf of Joint Intervenors at the hearing regarding EC 1. See Tr. at 404–36, 437–76.

4 .13 Dr. Richard Abitz holds a Bachelor of Arts degree in geology from Humboldt State University and Master of Science and Ph.D. degrees in geology from the University of New Mexico. As the principal geochemist and owner of Geochemical Consulting Services, LLC, Dr. Abitz provides analysis of chemical and radiological data, modeling of soil and water systems, and risk assessments relative to projects involving hazardous and radiological materials. Dr. Abitz previously has been retained by Native American tribes and environmental organizations to provide consultation and expert testimony associated with the Church Rock, Crown Point, and Crow Butte ISR facilities, among others. See Abitz Initial Testimony at 1; Ex. JTI002, at 1 (Richard J. Abitz SPQ).

d. Finding Regarding Witness Qualifications

4 .14 Based on the foregoing, and the respective background and experience of the proffered witnesses, the Board finds that each of these individuals is qualified to testify relative to the subject of the adequacy of the FSEIS discussion on the baseline groundwater quality at the Ross Project site.

2. Description of Baseline Groundwater Quality Monitoring Program at Ross Site

4 .15 In accord with 10 C.F.R. § 51.45(b) and the associated staff SRP guidance in NUREG-1569 regarding site hydrology, an applicant for a uranium ISR license is required to provide data from a groundwater monitoring program that is sufficient to establish a pre-licensing site characterization baseline for assessing the potential effects of facility operations on local groundwater quality. See Ex. SEI007, at 2-20 to -26 (NMSS, NRC, [SRP] for In Situ Leach Uranium Extraction License Applications, NUREG-1569 (June 2003)) [hereinafter NUREG-1569]. In this instance, to help provide that baseline, SEI established a pre-licensing groundwater monitoring program that consists of six monitoring well clusters located across the Ross Project area. See FSEIS 9A, at 3-37; Ex. SEI016A, at 3-101 (1 SEI, Ross ISR Project USNRC License Application, Crook County, Wyoming, Environmental Report (Dec. 2010)) [hereinafter ER 16A]. The six well clusters each consisted of at least four wells, with each well completed in a separate, consistent stratigraphic horizon (i.e., rock layer) intended to provide a portion of the data necessary for hydrogeologic characterization of the proposed Ross Project area. The monitored horizons/zones consisted of (beginning with the deepest) (1) the first water-bearing sandstone layer underlying the uranium ore-bearing sands, operationally termed the deep monitoring or DM unit; (2) the uranium ore-bearing sandstone, operationally termed the ore zone or OZ unit, which is separated from the DM unit by a ten- to fifty-foot thick shale layer; (3) the first water-bearing sandstone layer overlying the OZ, operationally termed the shallow monitoring or SM unit, which is separated from the OZ by a twenty- to eighty-foot thick confining shale horizon; and (4) the surficial aquifer, operationally termed the SA unit, which is separated from the SM by a sequence of thin sands, shales, and silts. See FSEIS 9A, at 3-31 to -37; ER 16A, at 3-101. The data generated by this monitoring program, along with data from existing water supply wells and from wells used during the Nubeth research and development

(R&D) operation on the Ross Project site,[14] were the basis for the SEI baseline site characterization effort. See FSEIS 9A, at 3-38.

3. Scope of Regulatory Program Governing Groundwater Quality Monitoring for Purpose of Complying with NEPA

4 .16 Criterion 7 of 10 C.F.R. Part 40, Appendix A, requires that an applicant establish a pre-licensing monitoring program that is used to provide "complete baseline data" on the ISR site and its environs.[15] For the Ross Project, as described in Board Finding 4.15 above, this is the data from the six monitoring well clusters, in conjunction with the existing water supply well and historic Nubeth well data. In addition, to establish the existing hazardous constituent concentrations in the OZ aquifer, which can be used subsequently to set 10 C.F.R. Part 40, Appendix A, Criterion 5B(5) CABs for aquifer restoration performance assessment and Criterion 7A UCLs for excursion detection, in condition 11.3 to the SEI license the staff has

[14] Having received permission from the WDEQ and the NRC in 1976 and 1978, respectively, Nubeth constructed and operated an R&D operation located within what is now the Ross Project area. The operation consisted of a single "five-spot" well pattern, consisting of four injection wells and one recovery well, and a small facility with an IX column/elution/precipitation circuit capable of producing yellowcake slurry. "Buffer" wells, designed to keep the lixiviant within the well pattern, were meant to form a hydraulic control barrier. Nubeth operated between August 1978 and April 1979, recovering small amounts of uranium stored in solution, but was shutdown prematurely because of injection rate limitations that caused a buildup of fine material and organic matter in the wellfield. After recovery testing, restoration activities regarding the "five-spot" were completed in February 1983, with Nubeth receiving WDEQ restoration approval in April 1983 and with the WDEQ and NRC decommissioning approval processes completed by 1986. See FSEIS 9A, at 2-11.

[15] Although the Part 40, Appendix A criteria were developed for conventional uranium milling facilities, they have since been applied in limited fashion to ISR facilities. See Hydro Res., Inc. (2929 Coors Road, Suite 101, Albuquerque, NM 87120), CLI-99-22, 50 NRC 3, 8–9 (1999) ("While, as a general matter, Part 40 applies to [ISR] mining, some of the specific requirements in Part 40, such as many of those found in Appendix A, address hazards posed only by conventional uranium milling operations, and do not carry over to [ISR] mining.") (footnote omitted). The issues in this proceeding arguably make a strong case for a redraft of that appendix to address specifically ISR mining facilities, which involve a very different process. See infra note 21 (recent staff draft SRP addresses separately uranium milling and heap leach facilities).

specified the criteria governing a post-licensing pre-operational well monitoring and analysis program to establish background water quality data for the OZ, DM, and SM aquifers. See FSEIS 9A, at 6-9 to -10. This would include data from wells placed into the OZ and perimeter monitoring wells around each wellfield per SEI license condition (LC) 11.3, and could include data from the wells used to collect the pre-licensing site-characterization data. See id. at 6-10; see also SEI License at 12–13.

4 .17 At the crux of this contention is the issue whether, to comply with NEPA's requirement to make an adequate pre-licensing assessment of environmental impacts, more extensive monitoring of the type (albeit perhaps different from or beyond that) found in the post-licensing, pre-operational system specified in LC 11.3 is required as a part of the SEI Appendix A, Criterion 7 pre-licensing site characterization monitoring program to provide "complete baseline data."[16]

4 .18 In responding to this issue, the staff contends that the baseline groundwater information that an applicant is required to provide pre-licensing to comply with Criterion 7 is not the information that a licensee is required to provide after licensing, but before wellfield

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[16] The staff described the SEI pre-license baseline data collection in section 6.3 of the FSEIS as follows:

> Pre-licensing, site-characterization monitoring of surface water and ground water was completed by the Applicant in 2009, 2010, and 2011. The Applicant also provided supplemental environmental-monitoring data in 2012. The acquired data were then used to characterize the Ross Project area according to the requirements in 10 CFR Part 40, Appendix A, Criterion 7.

FSEIS 9A, at 6–9 (citations omitted). The staff also explained that it followed guidance in section 2.7 of the NUREG-1569 standard review plan, staff Regulatory Guide 4.14, and WDEQ guidelines. See Staff Initial Testimony at 8 (Johnson, Moore, Saxton); Staff Rebuttal Testimony at 3–6 (Saxton). The data from the monitoring well network and the other supply wells are provided in FSEIS appendix C, characterized in FSEIS section 3.5.3.3, and compared to the WDEQ's and EPA's water-quality standards for constituents in table 3.8 of the FSEIS. See Staff Initial Testimony at 7 (Johnson, Moore, Saxton).

operation, to help establish UCLs for excursion monitoring and the Criterion 5B(5) CABs for restoration performance assessment. See Staff Initial Position Statement at 16–17. In addition to citing section 2.7 of its NUREG-1569 standard review plan guidance and Regulatory Guide 4.14 as support for this proposition, see id. at 13, the staff placed significant reliance on the Commission's decision in Hydro Resources, Inc., see id. at 18–19, in which the Commission stated:

> Waiting until after licensing (although before mining operations begin) to establish definitively the groundwater quality baselines and upper control limits is . . . 'consistent with industry practice and NRC methodology,' given the sequential development of in situ leach well fields. The site-specific data to confirm proper baseline quality values, and confirm whether existing rock units provide adequate confinement cannot be collected until an in situ leach well field has been installed . . . .

Hydro Res, Inc., (P.O. Box 777, Crownpoint, New Mexico 87313), CLI-06-1, 63 NRC 1, 6 (2006) (footnote omitted). Also of import, the staff asserts, is that by its terms Appendix A, Criterion 7A, which mandates that (1) a "licensee shall establish a detection monitoring program needed for the Commission to set the site-specific groundwater protection standards in paragraph 5B(1) of this appendix"; and (2) the detection monitoring program "must be in place when specified by the Commission in . . . license conditions," directly connects the Criterion 5B(5) monitoring program to the license condition-based program required by Criterion 7A. See Staff Findings at 18–19. Further, SEI argued that the so-called 10 C.F.R. § 40.32(e) "construction rule" bars an ISR license applicant from installing a complete wellfield and associated monitor well networks, such as that required under SEI's LC 11.3, until after a license is issued. See SEI Initial Position Statement at 17. Ultimately, however, both the staff and SEI agree that under Criterion 5B(5), "Commission-approved background" cannot be established until after an ISR license has been issued, and thus the staff did not err in making its NEPA impacts assessment based on the pre-licensing baseline water quality information provided by SEI. See Staff Findings at 16; SEI Reply Findings at 4–5.

4 .19 In light of the Commission's Hydro Resources decision and the language of Appendix A, Criterion 7A, we are unable to discern a legal basis for concluding that the Appendix A, Criterion 7 pre-licensing monitoring program for the purpose of establishing existing characterization values for certain site groundwater constituents must be co-extensive with the Criterion 7A pre-operational monitoring, license condition-based program intended to provide the information needed for setting Appendix A, Criterion 5B groundwater protection standards and UCLs.[17] At the same time, nothing in Appendix A, Criteria 5B, 7, or 7A precludes an inquiry, based on a well-pled contention, into whether the particular measures used in an applicant's pre-licensing program were adequate to provide the necessary information to characterize properly the environmental impacts of employing an ISR mining process in the aquifers below a proposed site. As a consequence, we turn to Joint Intervenors' specific concerns about the pre-licensing monitoring program employed by SEI and used by the staff in preparing the FSEIS to determine whether the staff's NEPA impact analysis is deficient because inadequate sampling protocols (and the resulting inadequate information) were used and/or additional monitoring information was required.

[17] We find less convincing SEI's argument that the 10 C.F.R. § 40.32(e) "construction rule" requires this result. As we have previously noted, Part 40's definition provision indicates that "construction" does not include "[s]ite exploration, including . . . preconstruction monitoring to establish background information related to . . . the environmental impacts of construction or operation, or the protection of environmental values." See LBP-12-3, 75 NRC at 193–94; see also 10 C.F.R. § 40.4 (definition of "Construction"). To the degree the agency requires certain monitoring procedures to provide the information needed for its NEPA impacts analysis, we find nothing in this definition that would preclude the installation of wells or the use of monitoring protocols as needed to provide that data.

4. Joint Intervenors' Specific Technical Concerns about SEI's Preconstruction Monitoring Program

4 .20 Joint Intervenors posed a number of technical issues that they asserted are implicated by their EC 1 claim regarding the adequacy of the FSEIS discussion of baseline water quality. See Joint Intervenors Findings at 21–34. Citing sampling methods recommended in the 2009 United States Environmental Protection Agency (EPA) Unified Guidance for establishing baseline at sites subject to the Resource Conservation & Recovery Act (RCRA), 42 U.S.C. § 6901 et seq., or the Comprehensive Environmental Compensation and Liabilities Act (CERCLA), id. §§ 9601, 9675, Joint Intervenors witness Dr. Abitz maintained that a proper sampling plan should include (1) collecting a minimum of eight to ten samples per well from sampling wells randomly sited throughout the study area; (2) utilizing proper methods for well drilling and sample collection and analysis; (3) employing sampling wells located up the hydraulic gradient from the OZ; and (4) using proper scientific and statistical methods to establish baseline values. See Abitz Initial Testimony at 6–8 (citing Ex. JTI006 (Office of Resource Conservation and Recovery, EPA, Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance, EPA 530/R-09-007 (Mar. 2009)) [hereinafter EPA Unified Guidance]). According to Dr. Abitz SEI and the staff failed to employ these methods, leaving the FSEIS discussion and analysis significantly wanting.

a. Inadequacies in Monitoring Well Deployment

4 .21 One of Joint Intervenors' concerns was the way in which SEI implemented its groundwater monitoring program, both in terms of the number of wells and their location. See Joint Intervenors Findings at 21–22; see also id. at 33–34 (asserting more accurate quantification of baseline data is possible using standard statistical practices such as random grid sampling, statistically significant number of sampling locations, and proper statistical tests in accord with EPA Unified Guidance and Department of Energy procedures for characterizing

stream and groundwater baseline water quality). In his initial testimony, citing the EPA Unified Guidance, Dr. Abitz asserted that SEI's program was too limited in that SEI and the staff failed to show that the program used "standard statistical practices for the environmental industry." Abitz Initial Testimony at 23. And when coupled with the suggestion that the agency's NEPA process would benefit from such "a scientifically and statistically sound sampling regime," id. at 14, i.e., to adopt what are potentially "best practices," and so thereby avoid what they characterize as reliance on "a statistically invalid, biased set of non-representative groundwater samples," id. at 21, Joint Intervenor's plea to have the applicant and staff employ various revised testing and analysis protocols is not without some attraction.

4 .22 As the Commission has made apparent, however, NEPA does not require the adoption of best practices, particularly in the face of a potentially significant resource commitment, see Pilgrim, CLI-10-11, 71 NRC at 315, a concern that EPA has acknowledged applies to groundwater monitoring, see EPA Unified Guidance at 5-2 ("Due to the cost of management, mobilization, field labor, and especially laboratory analysis, groundwater monitoring can be an expensive endeavor."). Nor does it appear that the EPA RCRA/CERCLA guidelines, which the staff and SEI assert are directed at the need for background water quality data for groundwater monitoring and detection rather than NEPA environmental site characterization, see Staff Findings at 25, SEI Findings at 29–30, have been adopted wholesale for regulatory assessment purposes by other federal or state agencies. See Schiffer Rebuttal Testimony at 11–13 (comparing Bureau of Land Management coal lease application NEPA baseline groundwater characterizations to Ross Project and noting SEI monitoring program was in compliance with WDEQ requirements and guidelines). Further, the six monitoring clusters and the twenty-nine existing water supply wells located within or adjacent to the Ross Project boundary that were used by SEI and the staff, along with the historic Nubeth R&D site

information, to characterize the Appendix A, Criterion 7 baseline for the Ross Project site generated some 362 groundwater samples (with over 16,000 chemical and radiological parameters).[18] See Schiffer Initial Testimony at 8–9; see also Staff Initial Testimony at 6–8 (Johnson, Moore, Saxton). Accordingly, in the absence of some evidence of actual bias (or an attempt to induce a biased result) associated with SEI's well siting or sampling activities,[19] see infra Board Finding 4.107, we find no basis on the evidentiary record before us for declaring those sampling protocols to be so facially deficient as to require that they be redone in accord with Joint Intervenors' preferred methodology.[20]

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[18] In this regard, we note that table 3.6 in the FSEIS states that the complete data set for the monitoring well samples reflected in the table is presented in appendix C. See FSEIS 9A, at 3-40. The 41 pages of data in appendix C from the six monitoring well clusters and several water supply wells include information on groundwater collected from the four aquifers (SA, SM, OZ and DM) in 2010 and 2011. See Ex. SEI009B, at C-1 to -43 (FSME, NRC, [EIS] for the Ross ISR Project in Crook County, Wyoming; Supplement to the Generic [EIS] for In-Situ Leach Uranium Milling Facilities, Final Report, NUREG-1910 (supp. 5 Feb. 2014)) [hereinafter FSEIS 9B]. The collection of eight samples from most of the wells over that period, see id., generally seems consistent with the EPA Unified Guidance on the number of well samples referenced by Joint Intervenors.

[19] Relative to random grid sampling, in addition to the problem of whether such a protocol would be consistent with the baseline groundwater quality evaluation purpose of obtaining representative samples from the uranium ore bodies, see Tr. at 465 (Saxton), there also are indications here that the number and location of cluster wells was based on factors such as WDEQ guidelines (including at least one production zone well per square mile), having consistent/continuous water-bearing intervals above and below mineralization, satisfactory confining layer thickness, proximity to existing drilling data, sufficient spatial distribution for development of potentiometric data, and landowner considerations. See ER 16A, at 3-101; see also Schiffer Rebuttal Testimony at 15. These factors effectively counter any suggestion of an overt intent on the part of SEI to bias well location in an effort to make future reclamation program parameters less onerous.

[20] Dr. Abitz also declared that the number of monitoring wells and samples used by SEI were insufficient to conclude with statistical confidence that the water quality in the OZ does not meet the EPA drinking water maximum concentration limits (MCLs) for uranium and radium-226. See Abitz Initial Testimony at 17. Given that the EPA determination only requires that the aquifer not currently serve as a source of drinking water and that the aquifer must contain a commercially producible mineral resource, see Ex. SEI034, at 2 (Letter from Derrih R. Watchman-Moore, Region 8, EPA, to Kevin Frederick, Water Quality Div., WDEQ (May 15,

(continued...)

4 .23 Also with regard to well placement, citing the staff's NUREG-1569 and Regulatory Guide 4.14 guidance, Dr. Abitz indicated that Joint Intervenors' concern was about the purported need for the staff to obtain and consider data from an upgradient well (i.e., a well located on the upstream side of the regional or local groundwater flow). See Abitz Initial Testimony at 7–8 (citing NUREG-1569, at 2-32; Ex. SEI008, at 4.14-2 (Office of Standards Development, NRC, Radiological Effluent and Environmental Monitoring at Uranium Mills, Regulatory Guide 4.14 (rev. 1 Apr. 1980))). While acknowledging that NUREG-1569 and Regulatory Guide 4.14, as well as EPA's RCRA-implementing regulation 40 C.F.R. § 264.97(a)(1)(I) do contain language indicating that water samples taken from one well located hydrologically upgradient are part of the sampling protocol, the staff nonetheless asserted that these provisions do not require such a sample from an ISR facility, as opposed to a uranium milling operation. See Staff Findings at 28–29.

4 .24 Staff witnesses noted initially that Regulatory Guide 4.14, which implements NUREG-1569 acceptance criteria 2.93, see NUREG-1569, at 2-32 ("Monitoring programs to establish background radiological characteristics, including sampling frequency, sampling methods, and sampling location and density are established in accordance with pre-operational monitoring guidance provided in Regulatory Guide 4.14, Revision 1, Section 1.1 (NRC, 1980)."), addresses radiological effluent and environmental monitoring at uranium mills. See Staff

[20](...continued)
2013)) [hereinafter EPA Exemption Letter], this assertion has no relevance in the context of the agency's licensing of the Ross Project, see Tr. at 465 (Saxton) and so is irrelevant to our resolution of this contention. Moreover, the SEI application, in accordance with NUREG-1569, and the FSEIS each do have a comparison of the water quality measurements from the six cluster wells and the existing private water supply wells vis a vis the EPA MCLs, as well as the EPA secondary standards, and the WDEQ class of use standards, that show some of the cluster well samples and private well samples exceed the EPA MCLs for various parameters such as uranium, radium-226, and gross alpha. See ER 16A, at 3-184 to -195; FSEIS 9A, at 3-42, 3-44; see also Schiffer Rebuttal Testimony at 10, 16–17; Staff Initial Testimony at 26–27 (Johnson, Moore, Saxton).

Rebuttal Testimony at 9 (Johnson, Saxton). According to staff witnesses, although some elements of the guidance, such as well sampling and radiological constituent analysis, can be appropriately applied to ISR facilities, the concept of an upgradient well cannot. See Staff Initial Testimony at 15 (Johnson, Moore, Saxton). Staff witnesses asserted this is because a uranium mill, the original focus of Regulatory Guide 4.14, does not include two key features of an ISR facility. Upgradient water quality, the staff maintained, is not necessarily representative of ISR production zone background water quality because of the way uranium roll-fronts form, i.e., the groundwater upgradient of the ore body contains oxygen and is geochemically distinct from the groundwater in the same horizon through the production zone, which is generally oxygen-deficient. See id. Also, staff witnesses declared, natural hydraulic gradients are not disturbed by the mining process associated with a uranium mill in the way that they are disrupted by the recovery well process used during ISR operation and aquifer restoration. In fact, staff witnesses asserted, as described in FSEIS sections 2.1.1.2 and 4.5.1.2, wellfield groundwater inflow, which is a natural flow gradient disruption, is required at an ISR facility to reduce the likelihood of out-of-the-wellfield excursions. Therefore, staff witnesses concluded, because an upgradient well is not required to establish baseline values at the Ross Project site, the FSEIS does not describe such a well. See Staff Rebuttal Testimony at 9 (Johnson, Saxton).

4 .25 Additionally, according to staff witnesses, even assuming 40 C.F.R. § 264.97(a)(1)(i) has any applicability in a non-RCRA context, that section does not require a determination of background groundwater quality to include sampling of wells that are hydraulically upgradient of the waste management area if non-upgradient well sampling will provide an indication of background groundwater quality that is representative, or more representative, than that provided by upgradient wells. But, staff witnesses maintained, for the same reasons outlined in Board Finding 4.24 above, upgradient wells are not always necessary

and so are not required under this regulation for an ISR project. See Staff Initial Testimony at 15 (Johnson, Moore, Saxton).

4 .26 Although it seems apparent that the agency guidance language in Regulatory Guide 4.14 is misleading and needs to be revised,[21] we agree with the staff that, given the circumstances regarding an ISR facility, an upgradient well is not required for an Appendix A, Criterion 7 site characterization monitoring program for an ISR facility.[22] That being said, we note also that SEI apparently did include an upgradient well (34-7 OZ) among its sampling locations, see Schiffer Rebuttal Testimony at 8 (citing Ex. SEI019 (Ross Ore Zone Potentiometric Surface and Regional Monitor Well Location Map)), and that any concerns about upgradient excursions will be addressed by the system of operational monitoring wells, which will dot the perimeter of the Ross Project wellfields pursuant to condition 11.3(B) of SEI's license. See SEI License at 11; see also Tr. at 327 (Demuth).

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[21] We note also that recently the staff issued for public comment a draft version of NUREG-2126, a standard review plan for conventional uranium mills and heap leach facilities. See [SRP] for Conventional Uranium Mills and Heap Leach Facilities, 79 Fed. Reg. 75,597 (Dec. 18, 2014) (announcing opportunity for comment on draft NUREG-2126). Unlike NUREG-1569, however, draft NUREG-2126 explicitly requires an upgradient monitoring well during site characterization rather than through an unexplicated cross-reference to Regulatory Guide 4.14. Compare NUREG-1569, at 2-32, with NMSS, NRC, [SRP] for Conventional Uranium Mill and Heap Leach Facilities, NUREG-2126, at 2-34 (Draft Report for Comment Nov. 2014) (ADAMS Accession No. ML14325A634). By the same token, in the absence of a revised Regulatory Guide 4.14, some explicit recognition in NUREG-1569 of the non-applicability of the upgradient monitoring well for ISR site characterization purposes seems appropriate.

[22] Given the current language of the staff's NUREG-1569 ISR SRP guidance, although we might well be justified in requiring that, consistent with that guidance, SEI create and utilize such an upgradient monitoring well prior to beginning its operation of the Ross Project, we decline to do so because, in light of the uranium milling-based purpose of the requirement, that action would have no practical impact. Cf. 10 C.F.R. § 2.335(b) (providing for waiver of rule or regulation upon a showing that applying provision at issue "would not serve the purposes for which the rule or regulation was adopted").

b. Aquifer Sampling Intervals

4 .27 In connection with their challenge to the adequacy of the FSEIS water quality data, Joint Intervenors expressed concern about the aquifer sampling intervals used by SEI for its monitor wells. See Joint Intervenors Findings at 22–23. In this regard, Joint Intervenors witness Dr. Abitz asserted that baseline values have been (and will be) biased toward greater concentrations of contaminants because water samples were (and will be) collected from intervals that are "screened only through the part of the [OZ] water horizon that is in contact with the ore zone, rather than the entire column of water in the OZ sand interval."[23] Abitz Initial Testimony at 21. More specifically, Dr. Abitz declared that screen lengths for the six monitor wells in the OZ aquifer were only one-quarter to one-half the thickness of the OZ sand and were centered on the OZ, where water was most likely to have been contaminated by exploration drilling.[24] See id. at 21–22. Asserting that the staff's NUREG-1569 guidance recognizes that "fully screened intervals are more accurate in their representation of the water quality," Dr. Abitz maintained that the SEI data used for the FSEIS analysis was biased given the water samples collected by SEI were not representative of the entire thickness of the OZ aquifer.[25] Id. at 22 (citing NUREG-1569, at 5-43).

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[23] In this context, "well screening" denotes the use, at the intake portion of a well, of a porous filter that allows groundwater to be sampled from a targeted aquifer or a specific horizon within an aquifer. See ER 16A, at 1-54 to -56 (figs. 1.2-8 to -10); see also id. at 3-213 to -218 (figs. 3.4-15 to -20).

[24] According to Dr. Abitz, this screening protocol had "the effect of biasing the groundwater sample to high values for uranium, radium-226 and other uranium progeny and associated ore metals (e.g., arsenic, molybdenum, vanadium, etc[.]) due to the disturbance and oxidation of the ore during well construction and development." Abitz Initial Testimony at 22.

[25] Although Dr. Abitz's testimony references NUREG-1748, the staff's general environmental guidance for licensing actions, see Abitz Initial Testimony at 22 (citing NUREG-1748, at 5-43), as SEI witness Schiffer noted, see Schiffer Rebuttal Testimony at 14–15, it is apparent that what he is referring to is NUREG-1569, the staff's ISR facility SRP.

4 .28 In their initial written testimony, staff witnesses declared that wells used to establish the pre-licensing baseline were "screened over the entire ore-zone aquifer." Staff Initial Testimony at 18 (Johnson, Moore, Saxton). So too, SEI witness Schiffer maintained that no bias has been introduced with respect to the baseline groundwater quality in the mineralized zone because the six pre-license cluster wells in the OZ aquifer were screened in intervals three to twelve times larger than the average mineralized zone thickness and thus represented water quality from a larger interval than the future production and injection wells that will be screened discretely in the mineralized zones. See Schiffer Rebuttal Testimony at 14–15 (citing SEI014A, at 2-200 to -201 (tbl. 2.7-20) (1 SEI, Ross ISR Project USNRC License Application, Crook County, Wyoming, Technical Report (TR) (Dec. 2010)) [hereinafter TR 14A]). In fact, according to SEI witness Schiffer, this screening across intervals larger than the average mineralized zone thickness likely had the effect of diluting some of the constituents, such as uranium and radium-226, as compared to samples from future wells used to establish CAB. See id. at 14.

4 .29 And with regard to post-licensing monitoring, SEI witness Schiffer maintained that the perimeter monitoring wells that are used to sample water from the OZ aquifer for excursion monitoring and that will also be used to provide sampling data to establish UCLs for excursion monitoring will likewise be screened through the entire thickness of the ore-bearing part of the OZ aquifer.[26] See Schiffer Rebuttal Testimony at 15 (citing Ex. SEI014C, at 5-82 (2 SEI, Ross ISR Project USNRC License Application, Crook County, Wyoming, [TR] (rev. Apr. 2012)) [hereinafter TR 14C]). And by way of contrast, SEI witness Schiffer declared that the

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[26] Although staff witness Saxton initially stated that the perimeter monitoring wells will be screened only on the specific ore horizons, similar to the monitoring wells in the production field, he later clarified that for the Ross Project the perimeter monitoring wells will be "fully screened," Tr. at 382, 398–99, by which the Board understands that the screened interval extends continuously through the entire stack of ore horizons, although not necessarily through the entire OZ aquifer.

monitoring wells in the wellfield sampling water from the OZ aquifer that will be used to establish the Appendix A, Criterion 5B(5)(a) constituent CABs will be narrowly screened to sample water from, and establish CABs for, only a specific ore horizon, i.e., because the OZ contains several vertically stacked ore horizons, a specific well will only sample water from one ore horizon in the stack. See Tr. at 473–74 (discussing TR 14C, at 5-107 (Dec. 2010) (fig. 5.7-10)).

4 .30 In considering Joint Intervenors' challenge to the well screening intervals used for site characterization, we note initially that the table in SEI's TR referenced by SEI witness Schiffer as indicative of SEI's well screening coverage has a column labeled "Screened/Aquifer Thickness" that shows values ranging from between 30 and 110 feet for the wells in each of the six clusters that sampled the OZ aquifer. See TR 14A, at 2-200 to -201 (tbl. 2.7-20);[27] see also ER 16A, at 3-156 to -157 (tbl. 3.4-20). In contrast, the total thickness of the OZ aquifer given in the FSEIS is between 90 and 180 feet. See FSEIS 9A, at 3-34. Thus, the information in these tables, along with the screening intervals for monitoring cluster wells as shown in the gamma log figures in the applicant's TR also referenced by SEI witness Schiffer, see Schiffer Rebuttal Testimony at 14 (citing TR 14A, at 2-257 to -262); see also ER 16A, at 3-213 to -218, appear to support Joint Intervenors' assertion that these wells were screened only through the part of the aquifer containing the stacked ore horizons.

4 .31 That being said, we nonetheless find that there is no deficiency associated with the SEI well-screening protocols employed for pre-licensing site characterization that merits requiring any additional sampling efforts. Initially, we note that the NUREG-1569 guidance

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[27] Although the wells labeled OW1B in table 2.7-20 had narrower screen intervals, these wells, which were designed to mimic production wells and were used as part of the aquifer characterization pumping test, nonetheless were not among the six monitoring well clusters and no water samples from them are listed in FSEIS appendix C. See TR 14C, at 5-82 (rev. Apr. 2012)); ER 16A, at 3-157 (tbl. 3.4-20); FSEIS 9B, app. C. Consequently, those wells are not relevant to this screening interval discussion.

relied upon by Joint Intervenors as supporting fully screened wells is, on its face, applicable to the yet-to-be-implemented perimeter monitoring wells rather than the pre-licensing site characterization wells at issue here. See NUREG-1569, at 5-42 to -43 (as part of section 5.7.8.3 acceptance criteria associated with ensuring that groundwater and surface water excursions are timely detected, indicating that "[f]or most situations the staff favors fully screened monitor wells" because "[f]ully screened monitor wells would assure that excursions will eventually be detected"). Moreover, it is apparent that the screening protocol used by SEI for site characterization sampling was appropriate to that task. As SEI witness Schiffer indicated, the six well clusters were located both within and next to mineralized zones, so that some of these wells sampled groundwater from non-mineralized parts of the OZ aquifer.[28] See Schiffer Rebuttal Testimony at 14. As staff witnesses also indicated, wells that penetrated the OZ had screened intervals long enough to collect groundwater from the non-mineralized layers between ore horizons as well as from ore-rich zones.[29] See Staff Initial Testimony at 18 (citing ER 16A, at 3-156 to -157 (tbl. 3.4-20), 3-213 to -218 (figs. 3.4-15 to -20), and FSEIS 9A, at 3-38) (Johnson, Moore, Saxton). By contrast, the protocols that will be implemented for the OZ wells to establish a CAB will have much narrower screening intervals given that they will be located within individual ore bodies that are only about nine feet thick on average.[30] Likewise,

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[28] The term "non-mineralized" used here is not meant to suggest that there were no ore minerals in the sampled zones, but rather that the zones did not contain enough ore minerals to be economically viable.

[29] SEI witness Schiffer did note that due to the nature of the sampling completions used in the cluster wells, Strata does not propose to use those wells for compliance purposes to develop a CAB, so that water samples from these wells will not be used to calculate target restoration values. See Schiffer Rebuttal Testimony at 14.

[30] SEI and staff witnesses justify using this narrow screening interval technique on OZ wells intended initially to collect CAB-setting samples on the basis that (1) because wells used to collect CAB water samples will later be used for mining, the screen interval is optimized for

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the perimeter monitoring wells will, consistent with the staff's NUREG-1569 guidance, be fully screened to sample the entire thickness of the OZ aquifer to maximize the timely detection of lixiviant excursions.[31] See Schiffer Rebuttal Testimony at 14–15. We thus resolve this screening interval matter in favor of the staff and SEI.

c. Averaging Sampling Results

4 .32 Joint Intervenors also challenged the way in which sampling results were presented and analyzed in the FSEIS. See Joint Intervenors Findings at 23–24. Joint Intervenors witness Dr. Abitz stated in his initial testimony that FSEIS tables 3.6 and 3.7 improperly averaged the sampling data collected, grouping together the six cluster wells to report an average and range for each water horizon without describing a proper statistical method for evaluating the individual wells prior to grouping them and calculating an average or range for the aquifer horizon. See Abitz Initial Testimony at 2–23 (citing FSEIS 9A, at 3-40 to -41 (tbls. 3.6 and 3.7)). According to Dr. Abitz, "simple averaging or reporting a range of the values from all wells does not establish baseline unless it can be shown with proper statistical methods that (i) the samples from the individual wells follow a normal or log-normal distribution, and (ii) an analysis of the data variance of each well demonstrates that the wells can be

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mining, see Tr. at 343 (Knode); (2) only the narrow interval containing ore will be impacted by mining, so it is appropriate to use water samples from that interval to set restoration standards, see Tr. at 355 (Knode), 385 (Saxton); (3) it is not practical to install a well with a large screen interval for sampling baseline water, then refit it with a narrow screen interval appropriate for mining, then return it to a large screen interval for post-mining restoration, see Tr. at 356 (Knode); and (4) well construction with long screen intervals inside the production wellfield would allow mining fluids and contaminated groundwater to flow between different ore horizons as well as contaminate groundwater between ore horizons, see Tr. at 361 (Knode).

[31] Although staff witness Saxton noted that there is a "difference of opinion" regarding whether a fully screened or partially screened perimeter monitoring well is better able to detect an excursion, he stated that for the Ross Project, the perimeter monitoring wells will be fully screened. Tr. at 397–98.

combined into a single population for statistical calculations." Abitz Initial Testimony at 23. And regarding the latter point, Dr. Abitz maintains that, in fact, the six cluster wells do not fall into a single population with respect to uranium and radium-226. See id.

4 .33 In response, SEI declared that its application, and the FSEIS, are fully consistent with NUREG-1569's acceptance criterion 2.7.3(4) guidance that states the application should list "'[t]he average water quality for each aquifer zone and the range of each indicator in the zone.'" SEI Reply Findings at 28 (quoting NUREG-1569, at 2-26). Further, according to SEI, SEI and staff testimony establish that all recommendations in NUREG-1569, section 2.7, regarding items such as the listing of the average and range of constituent concentrations in each aquifer zone have been satisfied. See id. Finally, SEI notes that appendix C to the FSEIS presents the actual groundwater quality sampling results from the six cluster wells and the existing water supply wells. See id. at 29; see also FSEIS 9B, at C-1 to -43.

4 .34 As was noted earlier, see supra note 18, appendix C to the FSEIS sets forth forty-one pages of well sampling data from the six well clusters and water supply wells, which are summarized in table 3.6, while table 3.7 summarizes historical sampling data from the Nubeth R&D project, which the FSEIS indicates was taken from a 1978 Nubeth water quality program quarterly report to the NRC, see FSEIS 9A, at 3-41 (citing Letter from Albert F. Stoick, Nubeth, Nuclear Dynamics, to L. C. Rouse, Division of Fuel Cycle and Material Safety, NRC encl. (Aug. 31, 1978) (ADAMS Accession No. ML12135A358)). With regard to these tables, the crux of Dr. Abitz's complaint is that "there is no mention of the proper statistical methods for evaluating individual wells prior to grouping them and calculating an average or range for the aquifer horizon." Abitz Initial Testimony at 22–23. Although Dr. Abitz cited undifferentiated portions of the EPA Unified Guidance in support of this statement, see id. at 23 (citing EPA Unified Guidance "Parts II, III and IV; and references therein"), as far as we are aware there is

no NEPA or NRC requirement that the agency, rather than averaging the sampling data as was done by the staff, adopt the more rigorous statistical methodology Dr. Abitz asserts is needed. Moreover, to the degree that Joint Intervenors are concerned about the way in which the staff used the raw data from appendix C and the Nubeth report in preparing tables 3.6 and 3.7, the source information for those tables was available for analysis and critique if they believed the staff's presentation of the data was materially flawed.[32] Consequently, we find in favor of the staff and SEI on this matter as well.

d. Data Bias from SEI Drilling Techniques

4 .35 Sampling data bias purportedly arising from the well drilling techniques employed by SEI was another of Joint Intervenors' concerns. See Joint Intervenors Findings at 24–29. Based on thermodynamic calculations, Joint Intervenors witness Dr. Abitz determined that the concentration of dissolved uranium in groundwater contacting the minerals pyrite and urananite, and having the iron, carbonate, and sulfate contents as reported in FSEIS appendix C, would be "so low that it cannot be detected with present laboratory methods." Abitz Initial Testimony at 18–19. It thus followed, according to Dr. Abitz, that the uranium values given in FSEIS tables 3.6 and 3.7 were biased by the introduction of oxygen prior to collection of the groundwater samples. See id. at 19. In this regard, according to Dr. Abitz, notwithstanding an FSEIS declaration that uranium concentration data from 2009 and 2010 is consistent with data from 2011, he asserts that data given in FSEIS appendix C shows that uranium values from 2011 have decreased since 2010, while radium-226 remains at 2010 levels, which is consistent with the OZ aquifer returning to reducing conditions following disturbance when sampling wells

[32] In making this statement, we are aware that tables 3.6 and 3.7 in their current, more detailed form were first provided in the FSEIS. Nonetheless, the source information that was the basis for those tables was previously specified in the March 2013 DSEIS in support of that document's more abbreviated tables 3.6 and 3.7, see DSEIS 6A, at 3-40 to -41, and so was available for Joint Intervenors' consideration.

are installed and developed.[33] See id. at 24–25. Nor is this trend a coincidental event, Dr. Abitz maintained, being fully consistent with what occurred at a Goliad, Texas ISR site in which decreasing uranium, but not radium-226, sample values could be attributed to ore zone oxidation caused by improper well installation and development techniques. See id. at 26–28. So too, Dr. Abitz asserted, the Ross Project sample-contaminating oxidation was a result of SEI's rotary-drill techniques utilizing conventional drilling fluids, which Dr. Abitz suggested are likely to contain dissolved oxygen, see Tr. at 423, and the air lifting process, which employs compressed atmospheric air to bring water samples to the surface, see Abitz Initial Testimony at 11, 19. Referencing United States Geological Survey (USGS) guidelines on the selection and installation of wells for groundwater quality surveys, Dr. Abitz maintained that an appropriate drilling method would be to use air-rotary drilling with recirculated nitrogen gas, in lieu of air, and a foam surfactant containing oyxgen-eliminating organic constituents. See id. at 18 (citing Ex. JTI011, at 57 (Wayne W. Lapham, et al., USGS, Dep't of the Interior, Guidelines and Standard Procedures for Studies of Ground-Water Quality: Selection and Installation of Wells, and Supporting Documentation, Water-Resources Investigations Report 96-4233 (1997)) [hereinafter USGS Report]).

4 .36 In response, the staff claimed that the technical basis for Dr. Abitz's concern is misplaced. Staff witnesses questioned the assumption underlying Dr. Abitz's calculations of initial uranium concentrations in the undisturbed aquifer, i.e., that a perfect thermodynamic equilibrium exists between the groundwater and the minerals in the aquifer, asserting that thermodynamic equilibrium is never achieved in aquifers due to water recharge and flow. See

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[33] Dr. Abitz explained that once the ore body is oxidized during well installation, the radium-226 released from the uranium ore will not drop out of solution because it is insensitive to redox changes, so a slow decrease in uranium without a decrease in radium-226 would indicate a return to reducing conditions after contaminants had been released by well construction. See Abitz Initial Testimony at 27.

Staff Rebuttal Testimony at 15 (citing Ex. NRC046 (Werner Stumm & James J. Morgan, Aquatic Chemistry § 2.17 (3d ed. 1996))) (Johnson, Saxton). In addition, staff witnesses testified that, contrary to the premise underlying Dr. Abitz's calculations, the kinetics of pyrite oxidation are slow to the degree that pyrite is commonly found in the presence of oxygenated water. Further, in support of this position, citing a recent study at the Smith Ranch-Highland ISR facility in which wells sampled using methods designed to exclude atmospheric oxygen yielded water from the ore zone containing 0.11 milligrams per liter (mg/L) uranium, staff witnesses maintained that because this concentration was at the high end of the range of uranium values measured in the Ross Project monitoring wells, the uranium concentrations measured by SEI in the OZ monitoring wells clearly are within the range of reasonable uranium concentrations possible under unperturbed conditions. See id. at 15–16 (Johnson, Saxton); Tr. at 391 (citing NRC047, at 22 (Jim Stone, et al., [ISR] Uranium Mining Restoration Challenges (Apr. 9, 2014) (slide presentation))) (Johnson).

4 .37 Also in response to Dr. Abitz's claims, staff witness Dr. Johnson stated that the initial water samples from some of the Ross Project wells showing elevated concentrations of contaminants were not used to calculate baseline values. See Tr. at 388. Additionally, Dr. Johnson pointed to other sampling data showing the presence of ammonia, which she claimed only exists under non-oxidizing conditions, thus indicating that oxidation was not an issue. See Tr. at 388–89. Further, although acknowledging that the range of maximum and minimum uranium concentration values over the SEI sampling period was essentially the same, Dr. Johnson also noted that some wells had a slight concentration decrease, while others, including the well that had the highest uranium concentration, showed an increase instead of the decline over the sampling period that would be expected if it had been compromised by oxidation per Dr. Abitz's claim. All of this data, according to Dr. Johnson, indicated there was

no demonstrated systematic bias due to SEI's use of conventional methods of well installation or sampling. See Tr. at 389.

4 .38 For their part, SEI witnesses emphasized that SEI drilling methods would not introduce oxygen. SEI witness Knode described the air lifting technique cited by Dr. Abitz, which involves lowering a pipe below the static water level in the well, usually 50 to 100 feet, then forcing a burst of air from an air compressor down the pipe. This quickly lifts a 50- to 100-foot water column out of the well casing, creating a vacuum into which fresh water from the bottom of the well rushes through the screened interval and removes any residual drilling fluid and fines in the screened interval. Although this may be done repeatedly over several hours until the water coming out of the well is clean and representative of the native water in the screened interval, SEI witness Knode asserted that it could not cause oxidation in the OZ aquifer since air would only be injected some 200 feet above the screened interval. See Knode Initial Testimony at 5, 7–8.

4 .39 With regard to Dr. Abitz's related concern about oxidation via drilling fluids, SEI witness Knode testified that the drilling fluids in the type of mud rotary drilling system used by SEI are specifically designed to form a thin, impermeable layer, referred to in the drilling industry as filter cake, on the walls of the borehole. According to SEI witness Knode, the filter cake is intended to impede the movement of drilling fluids into the surrounding aquifer. He also testified that drilling fluids can be tailored to specific conditions, which is very effective in minimizing or eliminating the movement of drilling fluid into the aquifer to be monitored or mined. See id. at 5. Further, SEI witness Knode declared, during mud rotary drilling, only drilling fluid is introduced into the borehole and, while it is possible that there could be a small amount of air entrained within the drilling fluid, the filter cake would effectively limit how much air would enter the aquifer. Additionally, SEI witness Knode asserted that the pressure of the aquifer, i.e., the level

of the water in the well above the top of the aquifer, would also serve to limit the introduction of air. See id. at 6.

4 .40 Finally, asked whether air-rotary drilling with recirculated nitrogen gas and a foam surfactant containing oyxgen-eliminating organic constituents would be a viable alternative to the mud rotary drilling employed by SEI, SEI witness Demuth declared that "I have never heard of a well being proposed to be installed with nitrogen or even discussed in any fashion for an ISR operation in the United States or anywhere within the world." Tr. at 366.

4 .41 Based on the evidentiary record before us, the Board is unable to agree with Joint Intervenors' methodology for calculating the uranium concentration in the undisturbed OZ aquifer,[34] or their resulting conclusion, based on this methodology, that the measurable well sampling values in the FSEIS must be the consequence of significant oxidation contamination. Further, although the Board considers it likely that very small amounts of oxygen are introduced into a target aquifer by mud rotary drilling and the associated use of air lifting, and that this may cause spikes in dissolved uranium, nonetheless, given that (1) the borehole-coating design of drilling fluids, in conjunction with aquifer pressure, should largely prevent the movement of these fluids into the aquifer; and (2) air lifting involves introducing air into a well casing far above the screened interval of the OZ aquifer, any oxidation effect resulting from the use of the standard mud rotary drilling method described by SEI, see Knode Initial Testimony at 4–5, is likely to be both very local and very quickly dissipated by dilution or precipitation of uranium as the water moves back into a reducing environment (as even Dr. Abitz indicates is likely for a "mild disturbance," Tr. at 466).

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[34] In this regard, we agree with the staff's observations that thermodynamic equilibrium is unlikely to be achieved in the OZ aquifer. See supra Board Finding 4.36. In this context, Dr. Abitz's use of equations that assume perfect equilibrium seems unrealistic.

4 .42 In addition, regarding the need for agency consideration of the proposed alternative to drilling techniques of air-rotary drilling utilizing recirculated nitrogen gas and a foam surfactant containing oxygen-eliminating organic constituents, we observe that under the NEPA directive to provide a detailed statement of reasonable alternatives to a proposed action, see 42 U.S.C. § 4332(2)(C)(iii), an alternatives discussion need not include "'every possible alternative, but every reasonable alternative.'" Long Island Lighting Co. (Shoreham Nuclear Power Station, Unit 1), CLI-91-2, 33 NRC 61, 71 (1991) (quoting Citizens for a Better Henderson v. Hodel, 768 F.2d 1051, 1057 (9th Cir. 1985) (emphasis added)). Further, reasonable alternatives do not include alternatives that are "impractical[;] . . . that present unique problems; or that cause extraordinary costs." Private Fuel Storage, L.L.C. (Independent Spent Fuel Storage Installation), LBP-03-30, 58 NRC 454, 479 (2003) (citing Airport Neighbors Alliance v. United States, 90 F.3d 426, 432 (10th Cir. 1996); Communities, Inc. v. Busey, 956 F.2d 619, 627 (6th Cir. 1992)). Nor is there a need to consider alternatives that are technologically unproven. See Kelley v. Selin, 42 F.3d 1501, 1521 (6th Cir. 1995); Morton, 458 F.2d at 837 (approving exclusion from alternatives discussion of alternative energy sources that "will be dependent on [future] environmental safeguards and [technological] developments"); Busey, 956 F.2d at 627 (upholding rejection of alternatives that "presented severe engineering requirements" or were "imprudent for reasons including their high cost, safety hazards, [and] operational difficulties").

4 .43 Against this legal backdrop, we note that the 1997 USGS report cited by Dr. Abitz in support of the proposed alternative drilling method states only that "aeration of anoxic ground water can induce local changes in ground-water chemistry," without mentioning the use of nitrogen as a possible drilling fluid. USGS Report at 57. Also, the evidentiary record contains no examples demonstrating (or otherwise supporting) the use of Dr. Abitz's suggested

method. As a consequence, the Board concludes that, in this context, the alternative drilling method proposed by Dr. Abitz is, at least at this juncture, so untested and experimental that it is not a "reasonable alternative" requiring further consideration under NEPA.

e. Data Bias from Additional Wellfield Development

4 .44 In addition to their concerns about the data bias impacts of SEI's pre-licensing drilling activities, the Joint Intervenors questioned as well whether SEI's post-licensing drilling activities will have a negative impact on data collection to establish a post-licensing "true baseline" for excursion control and future remediation. Joint Intervenors Findings at 29–32. As evidence supporting this concern, Dr. Abitz described the circumstances surrounding the Kingsville Dome ISR operation in south Texas, asserting that an improper baseline was established at the Kingsville Dome site for three production areas over a fourteen-year period (1983 to 1998). See Abitz Initial Testimony at 29.

4 .45 According to Dr. Abitz, in August 1983, the initial baseline ranges for uranium and radium-226 were established after the installation of ore zone production wells in the first Kingsville Dome production area. See id. at 30. After additional wellfields were built out, the Texas Water Commission (TWC) (now the Texas Commission on Environmental Quality (TCEQ)) in November 1987 allowed the operator to revise that baseline for the first production area by increasing uranium and radium-226 to maximum values that were approximately ten times higher than the initial 1983 baseline. Thereafter, Dr. Abitz stated, in February 1990, after mining the first production area for approximately 6.5 years, the TWC allowed the operator to establish baseline values at a second adjacent, but downgradient, production area. This TWC action, according to Dr. Abitz, permitted the operator to elevate the uranium baseline value to a maximum value that was 100 times higher than the maximum uranium value used to calculate the production area one initial baseline. Then, in June 1998 the TWC allowed the operator to

establish a baseline for the third production area. Dr. Abitz asserted that this sequence of events clearly shows the deterioration of the baseline values with time when an operator is allowed to develop the baseline for each unit as the wellfields are built out. And as a practical matter, according to Dr. Abitz, this higher baseline allows much higher levels of uranium to pass through the monitor well ring without being reported as an excursion, as is an evident result at Kingsville Dome because of the significant increase in reported uranium levels in 1998 and 2007 at wells just outside and downgradient from the Kingsville Dome facility's monitoring well ring. See Abitz Initial Testimony at 31.

4 .46 In light of the Kingsville Dome situation, Dr. Abitz declared that the Ross facillity FSEIS is deficient for failing to (1) explain how the planned Ross Project post-licensing baseline water quality measurements will not become contaminated by the pre-sampling combined effects of drilling, casing, well development, and testing of hundreds to thousands of injection and recovery wells; and (2) describe the mechanical and chemical effects associated with previous and ongoing exploratory drilling to delineate the boundaries of the other four economically recoverable uranium resources in the Lance District that encompasses the Ross Project. Additionally, Dr. Abitz maintained that the FSEIS is inadequate because it does not address how, in the course of constructing, operating, and restoring numerous individual wellfields in sequence over many years, SEI's license terms will avoid operational wellfields degrading the post-licensing, pre-operational water quality baselines in subsequent adjacent monitoring wells that target the same aquifers. See id. at 28–29. Further, while Dr. Abitz at the hearing conceded that sampling groundwater for post-licensing pre-operational background prior to construction of the entire wellfield is "good," he also re-emphasized that the local environment around newly drilled boreholes will be the site of greatest disturbance and that water collected from that site will be most strongly affected by oxidation. See Tr. at 420. Dr.

Abitz indicated, however, that it would be difficult to estimate how far from a drill hole this oxidation effect might extend. See Tr. at 421.

4 .47 In response to Dr. Abitz's claims regarding wellfield development impacts, the staff asserted his concern is outside the scope of this proceeding because it fails to allege a deficiency in the FSEIS. According to the staff, what Joint Intervenors are contesting is the agency's regulatory scheme that provides for the post-licensing collection of water quality data to establish Appendix A, Criterion 5B(5) constituent CABs. Consequently, the staff declared, Dr. Abitz's claims are in actuality an improper challenge to the agency's regulations. See Staff Reply Findings at 11–12 & n.42 (citing 10 C.F.R. § 2.335(a)).

4 .48 SEI countered by observing that Dr. Abitz's concern about phased wellfield development resulting in degraded water quality in undeveloped wellfields does not account for the requirement in SEI LC 10.7 that a net inward hydraulic gradient be constantly maintained in each operating wellfield or that LC 11.5 requires SEI to perform routine excursion monitoring in each operating wellfield to verify that mining solutions do not migrate away from that wellfield. SEI Reply Findings at 23 (citing SEI License at 8, 13–14). SEI also sought to discount Dr. Abitz's Kingsville Dome example by referencing a 2008 decision regarding the licensing of the Goliad, Texas ISR facility in which the TCEQ executive director stated that he was unaware of a documented case of off-site groundwater contamination within the past thirty years in south Texas. See id. Further, while SEI witness Knode confirmed that for each wellfield the perimeter monitoring ring wells and the monitoring wells in the production field will all be constructed prior to drilling the main suite of injection and recovery wells in a wellfield, see Tr. at 320–21, he also indicated that in his experience, the drilling of numerous monitoring wells and production wells in a wellfield has not caused a noticeable increase in uranium concentration, an observation that was confirmed by SEI witness Demuth based on his

consulting work for other domestic ISR facilities, see Tr. 321–22 (Demuth), 344–45 (Knode, Demuth).

4 .49 In questioning the impact of additional wellfield development on water quality, to the degree that Joint Intervenors are challenging the post-licensing pre-operational water quality testing protocol contemplated by Criterion 5B(5), that would be an improper challenge to the regulation. This Joint Intervenor challenge, however, seems not so much directed at that water quality testing mechanism, as at the fact that the agency's licensing and regulatory process permits phased wellfield development. With this phased development, while monitoring well placement and sampling is completed before production well installation and operation, because well water quality testing for each wellfield is deferred until such time as the licensee decides to initiate wellfield operation, Joint Intervenors nonetheless are concerned that each well drilled for monitoring or production in a particular wellfield will have an impact on subsequent water quality measurements in undeveloped wellfields as they are brought online, resulting in higher constituent CABs for those wellfields.

4 .50 We find this claim unpersuasive for several reasons. First, as we concluded in our ruling regarding the impact of SEI drilling techniques on well sampling, see supra Board Findings 4.41-4.43, we find no basis for Joint Intervenors' concern that such drilling will, in and of itself, create sampling bias. Additionally, to the degree Joint Intervenors' argument, although characterized as about "SEI's well drilling methods," Joint Intervenors Findings at 29, is actually footed in a concern about cross-contamination between operating wellfields and undeveloped wellfields, the inward hydraulic gradient and the perimeter monitoring well network that SEI is required to establish and operate throughout a wellfield's operating life provide the requisite assurance that such contamination will not occur to a degree that it needs to be assessed in the

FSEIS.[35] Therefore, based on the preponderance of the evidence before the Board,[36] this matter is also resolved in favor of the staff and SEI.

f. Data Bias from Nubeth Well Samples

4 .51 Another of Joint Intervenors' claims regarding sampling bias concerned the FSEIS description of Ross Project baseline conditions as that analysis incorporated the results of the previous ISR R&D operations conducted in the late 1970s by Nubeth within the area of the Ross Project. See Joint Intervenors Findings at 32–33 (citing FSEIS 9A, at 3-38). According to testimony by Joint Intervenors witness Dr. Abitz, in 1976 Nubeth initiated a study involving lixiviant injection/extraction into and out of a single well, which was before the first baseline samples were collected in April 1978. The impact some two years later of this 1976 R&D test in the area defined by these baseline monitoring wells is evident, according to Dr. Abitz. Dr. Abitz asserted that some Nubeth wells clearly captured aquifer water samples indicating the lixiviant injection oxidized the OZ, given those samples have high radium-226

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[35] We recognize that, given his assertion that heterogeneity in hydraulic conductivity is a fluvial deposit characteristic, Dr. Abitz disagrees with the efficacy of maintaining an inward hydrologic gradient absent a staff showing that the hydraulic conductivity throughout the aquifer is uniform in all directions, and that he likewise rejects the reliability of excursion monitoring because of what he asserts are the invalid statistical methods used to derive the excursion UCLs and the failure to include uranium as an excursion control parameter that will allow uranium to migrate beyond the monitor-well ring and contaminate the surrounding aquifer prior to build out of the next wellfield. See Abitz Rebuttal Testimony at 13. The Board does not agree with Dr. Abitz's criticisms, however, the former being essentially an assertion that the ISR process is not a viable method for mining uranium, while the latter is based on premises questioning the viability of excursion control monitoring that we do not accept. See infra Board Findings 4.147-4.149.

[36] We also find the Kingsville Dome information provided by Joint Intervenors unpersuasive as a basis of support for this water sampling bias challenge. To the degree Joint Intervenors' concern is that the staff will permit periodic water quality "rebaselining" for an operating wellfield (as Joint Intervenors suggest was permitted relative to the first Kingsfield Dome production area), there is no evidence in the record supporting such an assertion. So too, the conflicting information provided by Joint Intervenors and SEI regarding off-site excursions in south Texas ISR facilities fails to provide sufficient support for a finding that the FSEIS is deficient in some material respect so as to require further supplementation.

values in excess of ten mg/L, while other wells had radium-226 values less than three picocuries per liter, but uranium values as high as wells in the oxidized OZ.[37] See Abitz Initial Testimony at 33 (citing FSEIS 9A, at 3-41 (tbl. 3.7)). Based on this information, Dr. Abitz concluded that because the OZ was injected with lixiviant before baseline water quality samples were collected, a pre-industrial baseline does not exist for the Nubeth pilot-scale study, which leaves the FSEIS without a significant component needed as part of the FSEIS site characterization baseline analysis. See id. at 34.

4 .52 Regarding the specifics of Dr. Abitz's Nubeth-related claims, staff witnesses asserted that 1976 pre-industrial groundwater quality data collected prior to Nubeth's single well test and the 1978 samples collected prior to Nubeth's five-spot R&D test were, based on a staff determination they were collected according to industry standards, (1) compiled in FSEIS table 3.7; and (2) as the only available estimates of pre-industrial water quality, used in FSEIS section 3.5.3.3 to assess differences in water quality from the late 1970s to 2010-11. See Staff Initial Testimony at 19–20 (Johnson, Moore, Saxton) (referencing FSEIS 9A, at 3-41). Further, according to staff witnesses, because the purpose of the FSEIS is to characterize the existing groundwater quality conditions in and adjacent to the Ross Project site and to assess the potential impacts to groundwater quality that may occur as the result of ISR operations, if groundwater quality data reported in the FSEIS table 3.6 is biased to high values as a result of impacts from the former Nubeth operation, these "high values," which represent the existing

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[37] Dr. Abitz's interpretation of this relationship postulated that samples with high radium-226 and uranium are from parts of the aquifer that were oxidized by the lixiviant injected in 1976. In contrast, samples with low radium-226 values, but still evidencing high uranium values, are from parts of the aquifer that, while not being oxidized, were contaminated by excursions of uranium-rich lixiviant. Further, according to Dr. Abitz, the latter samples have low radium-226 values because radium-226 is less mobile than uranium. Therefore, Dr. Abitz concluded, all the baseline samples at Nubeth were contaminated by uranium released during the initial 1976 test. See Abitz Initial Testimony at 33–34; see also Tr. at 451.

groundwater conditions at the site, are what is important, as opposed to the impacts of past uranium mining activities on water quality. See id. at 20; see also Tr. at 452–53 (Moore). Staff witnesses further asserted that, contrary to Dr. Abitz's characterizations, there is no consistent relationship between levels of uranium and radium-226 in the groundwater and, moreover, the high levels of radium in the Ross Project groundwater existed before any mining took place on the site. See Tr. at 449–50 (Johnson).

4 .53 Regarding the Nubeth data, SEI witness Schiffer stated that the Nubeth site's total area was approximately seven acres, or less than one-half of one percent of the total Ross license area, and that none of the SEI monitoring well clusters fell within the Nubeth site footprint. SEI witness Schiffer also stated that around 1982 Nubeth relinquished ownership of the site's production and project water supply wells to an oil company, which thereafter used the water for enhanced oil recovery using water-flood techniques. Further, according to SEI witness Schiffer, Wyoming Oil and Gas Conservation Commission records show that the two Nubeth wells, along with another oil company well close to the Nubeth site, all of which have been in continuous use since that time, created a cone of depression that encompasses the Nubeth R&D site. The cone of depression, SEI witness Schiffer declared, is essentially a groundwater sink that draws water from the surrounding aquifer into these wells. See Schiffer Initial Testimony at 18–19. SEI witness Moores, in his EC 3-related testimony regarding the Nubeth facility,[38] further declared that between 1979 and 2010, nearly 1.2 billion gallons of water was removed from the aquifer via these wells and then re-injected into underlying aquifers to support enhanced oil recovery, an action that SEI witness Schiffer suggested would have removed any potential contaminants that might have biased pre-licensing water quality characterization for

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[38] Because the focus of his testimony concerned EC 3, we describe Mr. Moores' qualifications below in section IV.C.1.a, which we likewise conclude allow us to consider this aspect of his testimony in connection with EC 1.

the Ross site. Moreover, both SEI witnesses Schiffer and Moores agreed that, as a consequence of this groundwater pumping activity, it was virtually impossible that any groundwater had left the immediate vicinity of the Nubeth site to affect Ross site water quality characterization, with SEI witness Moores adding that the large volume of water removed from the aquifer for the past thirty years made it unrealistic to assume that any of the original groundwater from the Nubeth site still existed within the aquifer. See Schiffer Initial Testimony at 19; Ex. SEI042, at 11 (Initial Written Testimony of Ray Moores) [hereinafter Moores Initial Testimony].

4 .54 While Joint Intervenors' concerns about the impact of the Nubeth R&D project on Ross site water quality undoubtedly are a reflection of their position that "baseline" water quality should describe "an aquifer that has not been disturbed by human actions," Joint Intervenors Findings at 13, we conclude that, in this context,[39] the proper role of the NEPA assessment was to characterize the current state of water quality at the Ross site, with whatever Nubeth-related warts that might entail. The staff concluded in that regard that the current water quality of the OZ aquifer is the same as it was during Nubeth's pre-operational sampling. See FSEIS 9A, at 5-29 ("The data presented in Tables 3.6 and 3.7 in SEIS Section 3.5.3 suggest that the current water quality in the ore zone and the SM aquifers are the same as each were at the time of Nubeth's pre-operational sampling."). In our estimation, the preponderance of the evidence in the record, including the 1976 and 1978 data used in creating

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[39] Staff witnesses also noted that in addition to using Nubeth operation historical data as part of staff's characterization of the existing conditions at the Ross Project site, the staff accounted for the impacts of the Nubeth site in the context of the FSEIS section 5.7.2 cumulative impacts analysis, see Staff Initial Testimony at 20–21 (Johnson, Moore, Saxton), an analysis the validity of which, the staff asserted, is not within the scope of EC 1, see Staff Findings at 30.

FSEIS table 3.7,[40] and SEI witnesses' testimony regarding the post-project use of the Nubeth R&D wells, both supports this staff conclusion and resolves this Joint Intervenor challenge in favor of the staff and SEI.

5. Board Conclusions Regarding EC 1

4 .55 The Board concludes that Joint Intervenors have failed to establish the validity of their various challenges, based on alleged noncompliance with 10 C.F.R. §§ 51.90-94, 10 C.F.R. Part 40, Appendix A, and NEPA, to the adequacy of the FSEIS description of the baseline water quality at the Ross ISR site. In this regard, we find initially that the applicant's 10 C.F.R. Part 40, Appendix A, Criterion 7 monitoring program for establishing the existing site characterization baseline values for certain site groundwater constituents prior to the issuance of a Part 40 license for ISR facility construction and operation need not, for the purpose of complying with NEPA and the agency's Part 51 implementing regulations, be conducted so as to also provide the background information needed to set Appendix A, Criterion 5B groundwater protection standards.

4 .56 With respect to Joint Intervenors' specific arguments regarding the purported negative impacts on the FSEIS of the supposed technical inadequacies associated with SEI's monitoring well deployment program (including well numbers and location), SEI's aquifer sampling intervals, the staff's use of sampling results averaging, the sample data bias resulting from SEI's use of standard drilling techniques, the sample data bias resulting from SEI's sequential development of additional wellfields, and the sample data bias associated with using well samples from the Nubeth R&D site, based on a preponderance of the evidence in the record before us, we resolve each of these matters in favor of the staff and SEI.

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[40] In this regard, we do not accept Dr. Abitz's assertions that the uranium and radium-226 values in the 1978 data preclude that data's use by the staff in assessing an appropriate pre-licensing baseline for the Ross Project.

B. Contention EC 2

4 .57 The Board's order regarding the migration of EC 2 as a FSEIS-related contention set forth that issue statement as follows:

> [EC] 2: The FSEIS fails to analyze the environmental impacts that will occur if the applicant cannot restore groundwater to primary or secondary limits.
>
> CONTENTION: The FSEIS fails to meet the requirements of 10 C.F.R. §§ 51.90-94 and NEPA because it fails to evaluate the virtual certainty that the applicant will be unable to restore groundwater to primary or secondary limits in that the FSEIS does not provide and evaluate information regarding the reasonable range of hazardous constituent concentration values that are likely to be applicable if the applicant is required to implement an [alternate concentration limit (ACL)] in accordance with 10 C.F.R. Part 40, App. A, Criterion 5B(5)(c).

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FSEIS Order app. A, at 1.

1. Witnesses and Evidence Presented

4 .58 SEI, the staff, and Joint Intervenors presented eight witnesses at the evidentiary hearing to testify on EC 2 and the adequacy of the FSEIS analysis of environmental impacts should SEI be unable to restore groundwater to primary or secondary limits under 10 C.F.R. Part 40, Appendix A, Criterion 5B(5)(a)-(b), and thus would be required to implement an ACL under Criterion 5B(5)(c). In addition to providing oral testimony, each witness also presented prefiled written direct and/or rebuttal testimony with supporting exhibits.[41]

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[41] See Tr. at 516–648; Knode Initial Testimony at 9–11; Schiffer Initial Testimony at 22–29; Schiffer Rebuttal Testimony at 17-19; Demuth/Lawrence Initial Testimony at 13–18; Demuth/Lawrence Rebuttal Testimony at 6; Staff Initial Testimony at 27–42; Staff Rebuttal Testimony at 16–24; Ex. JTI003-R, at 5-48 (Pre-Filed Testimony of Dr. Lance Larson on Contentions 2 and 3) [hereinafter Larson Initial Testimony]; Ex. JTI052-R, at 2–13 (Pre-Filed Rebuttal Testimony of Dr. Lance Larson on Contentions 2 and 3) [hereinafter Larson Rebuttal Testimony].

a. SEI

4 .59 At the evidentiary hearing, SEI presented four witnesses concerning EC 2: (1) SEI CEO Ralph Knode; (2) Ben Schiffer, WWC Engineering senior geologist and project manager; (3) Hal Demuth, a senior engineer/hydrologist and principal of Petrotek Engineering Corp.; and (4) Errol Lawrence, a Petrotek Engineering Corp. senior hydrologist. See Tr. at 516–29, 612–48.

4 .60 The qualifications of these SEI witnesses were discussed previously by the Board in connection with its ruling on EC 1. See supra section IV.A.1.a.

b. NRC Staff

4 .61 Three witnesses testified at the evidentiary hearing regarding the staff's position on EC 2: (1) Johari Moore, the NRC Ross Project lead environmental review project manager; (2) John Saxton, an NRC Ross Project safety review project manager and hydrogeologist; and (3) Dr. Kathryn Johnson, an AEC/JEC geochemist. See Tr. at 535–62, 612–48.

4 .62 The qualifications of the staff's witnesses were discussed previously by the Board above in connection with its ruling on EC 1. See supra section IV.A.1.b.

c. Joint Intervenors

4 .63 One witness, Dr. Lance Larson, an NRDC science fellow since January 2014, provided testimony at the hearing regarding Joint Intervenors' position with respect to EC 2. See Tr. at 587–648.

4 .64 Dr. Larson received a Bachelor of Engineering degree in environmental engineering from California Polytechnic State University, a Master of Science degree in civil and environmental engineering from the South Dakota School of Mines and Technology, and a dual doctorate in environmental engineering and biogeochemistry from Pennsylvania State University. See Larson Initial Testimony at 2; Ex. JTI004, at 1 (Lance Nichols Larson CV). In

support of Joint Intervenors' claims concerning EC 2, Dr. Larson prepared "storymaps," or visual representations of NRC ISR post-mining groundwater restoration data paired with post-licensing, pre-operational data, all geo-spatially mapped. See Larson Initial Testimony at 22–48. Storymaps, as well as the underlying NRC data, regarding the Smith Ranch ISR uranium mining site units A and B and the Willow Creek Christensen Ranch satellite facility ISR uranium mining site units 2-6 were prepared and admitted into evidence. See Tr. at 741–42; Ex. JTI005A-R2 (ISR Storymap Source Spreadsheet Data) [hereinafter Source Data]; Ex. JTI005B-R2 (ISR Storymaps Application) [hereinafter Storymaps].

d. Finding Regarding Witness Qualifications

4 .65 Based on the foregoing, and the respective background and experience of the proffered individuals, the Board finds that each of these SEI, staff and Joint Intervenor witnesses is qualified to testify relative to the adequacy of the FSEIS analysis of environmental impacts should an ACL be necessary for groundwater restoration.

2. Legal Background for Contention 2

a. NRC Regulations on ISR Groundwater Restoration

4 .66 The requirements for groundwater restoration standards for ISR mining operations are set forth in 10 C.F.R. Part 40, Appendix A, Criterion 5B(5):

> At the point of compliance, the concentration of a hazardous constituent must not exceed—
> (a) The Commission approved background concentration of that constituent in the ground water;
> (b) The respective value given in the table in paragraph 5C if the constituent is listed in the table and if the background level of the constituent is below the value listed; or
> (c) An alternate concentration limit established by the Commission.

Thus, three standards are accepted by the Commission as the bases for approval of an ISR operator's groundwater restoration. The first option, which is frequently referred to as "primary groundwater restoration standards," returns the constituent to background levels. See 10 C.F.R. Pt. 40, App. A, Criterion 5B(5)(a); see also NUREG-1569, at B-1 to -2. Additionally, there is restoration to what is known as "secondary groundwater restoration standards." Initially, this would be restoration of constituent levels to the drinking water limits enumerated in Appendix A, Table 5C. See 10 C.F.R. Pt. 40, App. A, Criterion 5B(5)(b); see also NUREG-1569, at B-2; Staff Initial Testimony at 10–11 (Johnson, Moore, Saxton). Thereafter, and a particular focus of EC 2, would be restoration to an ACL, which is permitted only when restoration to a primary or the secondary Table 5C standard is not "practically achievable." 10 C.F.R. Pt. 40, App. A, Criterion 5B(5)(c), (6); see also NUREG-1569, at B-2.[42]

4 .67 To have an ACL approved, a licensee must demonstrate that the hazardous constituent value is "as low as reasonably achievable, after considering practicable corrective actions, and that the constituent will not pose a substantial present or potential hazard to human health or the environment as long as the alternate concentration limit is not exceeded."[43] 10 C.F.R. Pt. 40, App. A, Criterion 5B(6). Moreover, nineteen different factors must be

[42] The Board notes that in referring to "secondary" standards, what Joint Intervenors are referencing is the secondary Table 5C standards. See Petition to Intervene and Request for Hearing by [Joint Intervenors] (Oct. 27, 2011) at 16–17; Larson Initial Testimony at 21.

The Board notes also that a dispute exists among the parties over whether this sequential requirement also extends into the primary and the secondary Table 5C standards. Specifically, the disagreement is whether a licensee must first attempt restoration to primary groundwater restoration standards before restoring groundwater constituents to secondary Table 5C standards or, instead, whether restoration may be achieved directly through satisfaction of the secondary standards. SEI and the staff assert that there is no obligation to first attempt restoration to primary standards. See Staff Reply Findings at 14; SEI Reply Findings at 8. Joint Intervenors disagree. See Joint Intervenors Findings at 40–41. The Board declines to express an opinion on the matter, which is outside of the scope of the issues presented by EC 2.

[43] The agency has issued guidance on how the staff is to assess compliance with the "as low as reasonably achievable" (ALARA) standard. See Ex. NRC021, at 4-34 to -36 (NMSS, NRC, [SRP] for the Review of a Reclamation Plan for Mill Tailings Sites Under Title II of the Uranium Mill Tailings Radiation Control Act of 1978, NUREG-1620 (rev. 1 June 2003)).

considered in making the "present and potential hazard" finding requisite to Commission approval of an ACL. See id. Criteria 5B(6)(a)(i)-(ix), (b)(i)-(x).

4 .68 Should an ISR licensee seek to meet its groundwater restoration obligations through an ACL, the licensee must request a license amendment. See Staff Initial Testimony at 30 (Johnson, Moore, Saxton); see also Tr. at 393 (Saxton); Demuth/Lawrence Initial Testimony at 18; Demuth/Lawrence Rebuttal Testimony at 6. In the context of agency consideration of that amendment request, the ACL, with its specific constituent limits, undergoes a NEPA review. See Demuth/Lawrence Initial Testimony at 18; Demuth/Lawrence Rebuttal Testimony at 6.

b. Relevant Requirements for FSEIS

4 .69 In EC 2, Joint Intervenors alleged that the FSEIS violates the agency's NEPA regulations in 10 C.F.R. §§ 51.90–50.94.[44] Section 51.90 imposes the legal requirements applicable to a draft EIS, as specified in section 51.70(b) and 51.71, onto a final EIS. Of particular relevance is section 51.71(d), which states that "[t]he analysis for all draft [EISs (and final EISs by virtue of § 51.90)] will, to the fullest extent practicable, quantify the various factors considered. To the extent that there are important qualitative considerations or factors that cannot be quantified, those considerations or factors will be discussed in qualitative terms." 10 C.F.R. § 51.71(d). Thus, where environmental impacts are practically quantifiable, section 51.71(d) imposes a duty on the agency to discuss them in those terms in the FSEIS.

4 .70 Furthermore, section 51.71(d) states that while license requirements and other environmental quality standards are to be considered in assessing environmental impacts, they

[44] 10 C.F.R. § 51.91 discusses the additional content required in a final EIS compared to a draft EIS. 10 C.F.R § 51.92 outlines when a supplement to a final EIS is required and what it must contain. 10 C.F.R. § 51.93 imposes distribution requirements for a final EIS (and a supplement to a final EIS) and section 51.94 mandates that a final EIS (or supplement to a final EIS) be considered in the agency's decisionmaking.

do not negate the staff's responsibility to consider all environmental effects. See id. ("Consideration will be given to compliance with environmental quality standards and requirements that have been imposed by Federal, State, regional, and local agencies . . . . The environmental impact of the proposed action will be considered in the analysis with respect to matters covered by environmental quality standards and requirements irrespective of whether a certification or license from the appropriate authority has been obtained.") (footnote omitted); see also id. at n.3 ("Compliance with the environmental quality standards and requirements of the Federal Water Pollution Control Act (imposed by EPA or designated permitting states) is not a substitute for, and does not negate the requirement for NRC to weigh all environmental effects of the proposed action, including the degradation, if any, of water quality, and to consider alternatives to the proposed action that are available for reducing adverse effects.").

3. FSEIS Discussion Relative to EC 2

4 .71 FSEIS section 4.5.1.3 (Ross Project Aquifer Restoration) discusses the Ross Project groundwater restoration matters that are relevant to EC 2. In this discussion of restoration, the FSEIS analyzed the environmental impacts of groundwater restoration to shallow aquifers, the OZ and surrounding aquifers, and deep aquifers.[45] See FSEIS 9A, at 4-44 to -48. The FSEIS in this regard also noted that "[w]ater quality is measured at the point of compliance that coincides with the established boundary of the exempted aquifer" and that SEI estimated that restoration of each wellfield at the Ross Project would take eight months. Id. at 2-34, 2-35.

4 .72 On the particular subject of ISR restoration impacts, to serve as reference points, the FSEIS included a one-page discussion of the three post-1980s-approved aquifer

[45] The Ross Project's aquifer-restoration methodology is described in FSEIS section 2.1.1.3. SEI proposes a combination and sequence of (1) groundwater transfer; (2) groundwater sweep; (3) reverse osmosis treatment with permeate injection; (4) groundwater recirculation; and (5) stabilization monitoring. See FSEIS 9A, at 2-35 to -37.

restorations — Crow Butte wellfield 1, Smith Ranch-Highland wellfield A, and Irigaray mine units 1-9 — and their respective impacts on water quality within the exempted aquifer. And with regard to each of these three sites, this historical review outlined the proportion of constituents restored to either post-licensing, pre-operational concentrations, or to the existing Wyoming domestic (Class I), agricultural (Class II), or livestock (Class III) use standards, and/or EPA's drinking water MCLs. Moreover, in the case of the Crow Butte and Irigaray sites, the staff included a discussion of the magnitude by which certain constituents increased from post-licensing, pre-operational concentrations to post-restoration concentrations.[46] See id. at 4-46; see also Staff Initial Testimony at 34 (Johnson, Moore, Saxton).

4 .73 The FSEIS review of Crow Butte wellfield indicated that twenty-three of thirty-four water quality parameters were returned to post-licensing, pre-operational concentrations and two were returned to the Wyoming domestic use standards/EPA drinking water MCLs, and one was returned to the Wyoming agricultural use standards. See Ex. NRC010, at 3–4 (FSME, NRC, NUREG-1910, Supp. 5 (Apr. 23, 2014) (tbl. Errata)) [hereinafter Errata 1]. Concentrations of alkalinity, bicarbonate, calcium, potassium, magnesium, and molybdenum exceeded post-licensing, pre-operational concentrations by six to sixty-five percent. No values were given concerning uranium concentrations. See id.

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[46] Previously, the NRC would approve groundwater aquifer restoration for a hazardous constituent that was returned to its pre-operational State-established class of use (i.e., drinking water use, livestock use, or agricultural use in Wyoming). See Tr. at 555 (Saxton); see also NUREG-1569, at 6-9. In 2009, the staff issued a regulatory issue summary stating that the "NUREG-1569 discussion of groundwater restoration to 'pre-operational class of use' as being a secondary standard is not accurate, and is not an appropriate standard to use in evaluating license applications." Ex. NRC038, at 3 (FSME, NRC, NRC Regulatory Issue Summary 2009-05, Uranium Recovery Policy Regarding: (1) The Process for Scheduling Licensing Reviews of Applications for New Uranium Recovery Facilities and (2) The Restoration of Groundwater at Licensed Uranium [ISR] Facilities (Apr. 29, 2009)). As such, although this state class of use standard was applicable to the three sites included in the FSEIS historical analysis, it is no longer utilized. In contrast, EPA drinking water MCL's continue to be an accepted groundwater restoration standard. See 10 C.F.R. Pt. 40, App. A, Criteria 5(B)(5)(b), 5C.

4 .74 According to the FSEIS, restoration of the Smith Ranch-Highland facility's wellfield A returned thirty-one of thirty-five water-quality parameters to post-licensing, pre-operational concentrations or Wyoming's domestic use standards. There was no mention of the percent by which those constituents not returned to pre-operational levels exceeded post-licensing, pre-operational levels of uranium. See FSEIS 9A, at 4-46.

4 .75 Finally, Irigaray mine units 1-9 were discussed in the FSEIS, for which twenty-seven of thirty-five parameters were returned to post-licensing, pre-operational concentrations or Wyoming's domestic use standards. Calcium, magnesium, sodium, bicarbonate, and alkalinity, as well as the measure for conductivity, for which there were no Wyoming class of use standards or EPA MCLs, exceeded post-licensing, pre-operational concentrations by 48 to 680 percent. The FSEIS also indicated that the NRC determined that the concentrations in excess of post-licensing, preoperational levels would not exceed EPA MCLs outside the aquifer-exemption boundary. No mention was made of the specific concentrations of uranium at the site before mining began and after aquifer restoration was approved. See id.

4 .76 Information regarding uranium concentrations for these three sites did, however, come to light in the staff's prefiled testimony. Staff witnesses stated that at these sites "the Commission approved restoration of uranium to values ranging from 4 to 71 times [(X)] post-licensing, pre-operational background values." Staff Initial Testimony at 33 (Johnson, Moore, Saxton). More specifically, the staff witnesses indicated that "the average concentration of uranium in the wellfield(s) for which the Commission issued restoration approval were as follows: (1) Crow Butte Well field 1: 1.73 mg/L, or 18[X] background levels; (2) Smith Ranch-Highland A-Well field: 3.53 mg/L, or 71[X] background levels; and (3) Irigaray Mine Units 1-9: 1.83 mg/L, or 4[X] background levels." Id. (internal citations omitted). The staff

witnesses indicated further that "based upon the available historical record of uranium concentrations at the close of active restoration, if an ACL is requested by Strata for the Ross Project, it is likely to range between 1.7 mg/L and 3.5 mg/L, or 4[X] to 71[X] the post-licensing, pre-operation background values for uranium . . . ." Id. This information the staff considered to be the FSEIS ACL "bounding analysis." See id. at 34.

4 .77 Ultimately the FSEIS concluded that impacts to groundwater in the OZ aquifer and surrounding aquifers for the Ross ISR project would be SMALL. See id. at 4-40 to -41, 4-48. The staff based its determination in this regard on LC 10.6 of SEI's (then-draft) source and byproduct materials license, which requires SEI to restore the OZ aquifer in accordance with 10 C.F.R. Part 40, App. A, Criterion 5B(5), and the legal requirements implicit in an ACL, namely that it must be protective of public health and safety to be approved. See id. at B-16 to -17; see also id. at 4-40 to -41; Staff Initial Testimony at 31, 35 (Johnson, Moore, Saxton); SEI License at 7–8.

4. Issues Raised in EC 2

4 .78 With EC 2, Joint Intervenors challenged two central aspects of the Ross Project FSEIS: (1) the sufficiency of the impacts analysis associated with groundwater restoration; and (2) the staff's conclusion that the impacts on the OZ and surrounding aquifers associated with groundwater restoration would be SMALL. Concerning the sufficiency of the analysis, Joint Intervenors argued that the FSEIS is legally inadequate as it fails to provide and evaluate adequately the historical information regarding the reasonable range of hazardous constituent concentration values that provide the basis for the FSEIS "bounding analysis" showing what might happen if, in restoring Ross site groundwater, SEI is required to use an ACL pursuant to 10 C.F.R. Part 40, Appendix A, Criterion 5B(5)(c), which Joint Intervenors asserted in EC 2 is a "virtual certainty." See Larson Initial Testimony at 8. Additionally, Joint Intervenors contended

that the quantitative data for historical ISR groundwater aquifer restoration efforts suggests that, in the event an ACL is employed, the impacts to the OZ aquifer and surrounding aquifers would be LARGE. See Larson Initial Testimony at 8–16; see also Larson Rebuttal Testimony at 2, 9–10. We consider each of these arguments and their technical bases below.

a. Adequacy of the FSEIS Impacts Analysis and Review of Historical ISR Sites

4 .79 Joint Intervenors initially disputed the adequacy of the FSEIS review of historical ISR sites, i.e., the FSEIS bounding analysis. They alleged that the review is neither comprehensive nor representative of the groundwater impacts that follow the operational conclusion of ISR projects and, as such, holds little value for assessing a future ACL at the Ross Project. Each of Joint Intervenors' specific concerns, as well as the staff and SEI responses, are reviewed below.

4 .80 At the outset, Joint Intervenors asserted that the FSEIS analysis is flawed because it lacks a "risk or dose" calculation to support the conclusion that the elevated concentrations of radium-226 and uranium that have been approved at historic sites, and can be anticipated for a uranium ACL at the Ross Project, pose no threat to human health and the environment. See Joint Intervenors Findings at 49; see also Larson Initial Testimony at 11. The staff argued that Joint Intervenors "have provided no evidence to show, however, how a risk or dose calculation to support the Commission's previous licensing decisions for the three sites discussed in the FSEIS is a necessary component of the bounding analysis called for by the Board in admitting this contention." Staff Reply Findings at 18 (emphasis omitted). Further, the staff asserted that Joint Intervenors have not put forward any legal authority to suggest that NEPA requires the agency to validate a prior licensing determination in its environmental review of a different ISR site. See id. at 19. SEI similarly maintained that Joint Intervenors' argument is without merit because, as part of the ACL-associated license amendment application review

process, the staff will conduct a present or potential hazard analysis and, by definition, no ACL may be approved unless the concentration will not pose a substantial present or potential hazard to human health or the environment. See SEI Reply Findings at 42. Additionally, according to SEI, the small potential risk to human health and safety is clear because (1) uranium recovery will take place only within an aquifer permanently exempted from protection as a drinking water supply, per EPA and WDEQ determinations that the OZ aquifer is not now, and will not in the future, become a drinking water source; and (2) as Joint Intervenors acknowledged, there are not current or anticipated drinking water wells in the licensing area. See id. at 42–43 (citing Tr. at 606 (Larson)).

4 .81 While the Board agrees with Joint Intervenors that, based on the historical record, ACLs are a foreseeable consequence of ISR mining, and thus should be considered in the EIS, we do not agree that NEPA mandates a risk or dose calculation be performed concerning historical or potential ACLs. As we have noted previously, NEPA requires neither the use of the best scientific technology nor what would demand virtually infinite study and resources. See supra Board Finding 3.3. If the substance of the staff's FSEIS bounding analysis withstands scrutiny, which we consider in more detail below, consistent with this touchstone we see no basis for labeling the staff's overall approach in preparing that analysis to be legally flawed under NEPA, particularly given the prospect of another NEPA analysis before an ACL is actually implemented relative to what is otherwise a non-drinking water source.[47] See

[47] Although Joint Intervenors have suggested that EPA has not considered whether the water in the exempted aquifer is of sufficient quality to be used for future drinking water purposes, see Joint Intervenors Findings at 27, as a legal matter, in granting the aquifer exemption EPA made such a determination. Under 40 C.F.R. § 146.4(b)(1), in exempting the aquifer, EPA had to find that the aquifer "cannot now and will not in the future serve as a source of drinking water" because, among other potential factors, it "is mineral, hydrocarbon or geothermal energy producing, or can be demonstrated by a permit applicant as part of a permit application for a Class II or III operation to contain minerals or hydrocarbons that considering their quantity and location are expected to be commercially producible." In deciding to exempt (continued...)

Alaska v. Andrus, 580 F.2d 465, 473–74 (D.C. Cir. 1978) ("One of the costs that must be weighed by decisionmakers is the cost of uncertainty — i.e., the costs of proceeding without more and better information. Where that cost has been considered, and where the responsible decisionmaker has decided that it is outweighed by the benefits of proceeding with the project without further delay, the courts may not substitute their judgment for that of the decisionmaker and insist that the project be delayed while more information is sought.")

4 .82 Joint Intervenors also argued that important details from the discussion of groundwater aquifer restoration at Crow Butte wellfield I, Smith Ranch-Highland wellfield A, and Irigaray mine units 1-9 are omitted such that the bounding analysis provides an inaccurate account of the scrutiny employed in appproving an ACL and the success of groundwater restoration after ISR mining operations cease. See Joint Intervenors Findings at 50–55. We consider the circumstances relative to each of these sites below.

4 .83 With respect to Crow Butte, Joint Intervenors asserted that the agency-approved ACL for uranium, 18X above post-licensing, pre-operational concentrations, lacks a scientific or empirical basis for assessing restoration performance.[48] See Joint Intervenors Findings

[47](...continued)
the Ross Project aquifer, EPA stated that the aquifer "is mineral producing and can be demonstrated to contain minerals that, considering their quantity and location, are expected to be commercially producible (40 CFR §146.4(b)(1).)." EPA Exemption Letter at 2. Thus, as granted by EPA, the aquifer exemption includes a determination that the aquifer cannot serve as a future source of drinking water.

[48] Albeit not the subject of any of Joint Intervenors' proposed findings, Joint Intervenors witness Dr. Larson pointed out an error the staff made in the FSEIS regarding Crow Butte's restoration by reporting that post-restoration uranium concentrations increased by 18 percent when, in fact, they increased by 18.8X above the baseline concentration. See Larson Initial Testimony at 11–12. While the staff fixed this error with an errata, see Errata 1, at 4, given that the staff continued to conclude that impacts to groundwater would be SMALL despite the increase in magnitude (an increase of 18X versus 18 percent), see id. at 2, Dr. Larson argued that this is further proof of the staff's cursory review of the environmental impacts at the Ross Project. See Larson Initial Testimony at 12. While no doubt this is the type of error the staff will strive not to repeat, the Board nonetheless finds the matter to be without substance, particularly
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at 50–51; see also Larson Rebuttal Testimony at 5. Joint Intervenors witness Dr. Larson pointed to the staff's initial denial of aquifer restoration approval for Crow Butte, Larson Rebuttal Testimony at 4 (citing Ex. JTI053, at 99 (CBR, Mine Unit 1 Restoration Report (Jan. 10, 2000)) [hereinafter Crow Butte Report]), and then noted the staff's subsequent approval following additional samplings despite those samples' roughly equivalent uranium concentration levels, see id. at 4–5 (citing Crow Butte Report at 125–26). Dr. Larson maintained that approval of concentration levels at 1.73 mg/L, or 18X background levels, was arbitrary, chosen out of expedience, and demonstrated that the agency's determination this was sufficient to protect human health and the environment was a condition-dependent, subjective statement that lacked a scientific or empirical basis. See id. at 5. Thus, instead of serving as a guidepost for what a future authorized ACL might be at the Ross site, Joint Intervenors contended that Crow Butte indicates the "Staff is likely to approve an ACL reflecting whatever contamination remains after SEI has worked on restoration efforts for a period that Staff deems sufficient . . . even if those levels are much higher than at Crow Butte or other sites." Joint Intervenors Findings at 51.

4 .84 The staff disputed any allegation of arbitrary decisionmaking associated with its Crow Butte ACL review. Staff witness Dr. Johnson testified that the staff did not initially approve restoration at Crow Butte unit 1 because it was uncertain whether concentration levels were stable and thus protective of human health and the environment. See Tr. at 615–16. After further monitoring determined that concentrations were indeed stable, the staff approved the restoration. See id. at 616. Dr. Johnson further declared that the staff's ACL decisionmaking is scientific in that the staff completes transport modeling to predict whether a constituent would travel beyond the boundary of the exempted aquifer before approving an aquifer restoration.

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[48](...continued)
given that the concentration level is well within the upper limits of the bounding analysis for uranium. See infra Board Finding 4.96.

See id. at 617. Finally, she declared that the approved concentration level of uranium at Crow Butte unit 1 was within the secondary standard in use at the time as imposed on the production zone under Crow Butte's Nebraska state underground injection control permit, and thus the staff assumed the concentration would also be protective outside the production area. See Tr. at 617–18.

4 .85 SEI agreed with the staff that it is incorrect to suggest that staff's approved Crow Butte ACLs lack a scientific or empirical basis given the systematic approach for Crow Butte groundwater restoration outlined in the FSEIS. See SEI Reply Findings at 36–37 (quoting Staff Initial Testimony at 37 (Johnson, Moore, Saxton)). Further, SEI witness Lawrence pointed out relative to the Ross Project that the nineteen required factors the staff must review in making a substantial present or future hazard finding and the requirement that an ACL be ALARA were proof of the staff's rigorous analysis of proposed ACLs. See Demuth/Lawrence Initial Testimony at 16–18. Also of note, according to Mr. Lawrence, is the fact that any ACL application will trigger a NEPA evaluation under 10 C.F.R. Part 51. See id. at 18.

4 .86 While it is not at all apparent that this licensing proceeding is the forum for relitigating the efficacy of prior staff ACL determinations, nonetheless, based on the preponderance of the evidence, the Board concludes that the aquifer restoration approval at Crow Butte was not arbitrary. No testimony or other evidence before us substantiates Joint Intervenors' assertion that the staff failed to undertake a serious review of the Crow Butte wellfield 1 restoration request or effectively counters the staff's testimony that it did not approve the application initially because it could not be certain that the concentration levels were stable, and then later granted the request based on further monitoring and a subsequent determination that those levels had stabilized. We thus find no basis for discounting the Crow Butte data as a legitimate part of the staff's bounding analysis.

4 .87 Joint Intervenors next argued that the FSEIS is inadequate given its discussion of Smith Ranch-Highland wellfield A, which they asserted lacks the requisite detail to satisfy NEPA. See Joint Intervenors Findings at 51. Specifically, while the FSEIS states that thirty-one of thirty-five water-quality parameters at the Smith Ranch-Highland site were returned to baseline, Dr. Larson challenged the adequacy of this discussion because it did not disclose information on constituent concentrations not returned to baseline, most importantly concentrations of uranium and heavy metals. See Larson Initial Testimony at 14.

4 .88 Staff witnesses maintained that the information provided in the FSEIS for this and the other two facilities – the proportion of constituents restored to post-licensing, pre-operational concentrations, to the existing Wyoming domestic use standards, or to EPA's drinking water MCLs – was sufficient. See Staff Initial Testimony at 32 (Johnson, Moore, Saxton). Moreover, in the staff's prefiled testimony, the approved ACL for uranium was provided: 3.53 mg/L, or 71X above post-licensing, pre-operational background levels. See id. at 33 (Johnson, Moore, Saxton).

4 .89 Given that ISR mining is intended to liberate uranium from a mineral deposit so that the uranium can then be extracted from groundwater, we would agree that including information about the post-restoration concentration levels of uranium is an important aspect of any ACL impacts analysis. Yet, despite Joint Intervenors' assertions to the contrary, see Joint Intervenors Findings at 10 ("The defense of the FSEIS must be confined to materials before the agency at the time the FSEIS was issued."), the Board does not find that the absence in the FSEIS of the information on uranium concentrations renders the NEPA process legally deficient. Rather, the post-restoration uranium concentration levels reported in the staff's prefiled

testimony supplements the FSEIS so as to cure any defect in that regard. See supra Board Finding 3.4.[49]

4 .90 Regarding Smith Ranch-Highland wellfield A, Joint Intervenors argued that the environmental impacts have been grossly underestimated by (1) disputing the reported 71X increase in uranium (to 3.53 mg/L), which is the purported high end of the bounding analysis for the Ross Project, see supra Board Finding 4.76; and (2) asserting that the FSEIS fails to include the impacts associated with a 30X increase in arsenic, a 70X increase in selenium, and a 71X increase in uranium.[50] See Joint Intervenors Findings at 51; see also Larson Initial Testimony at 14; Larson Rebuttal Testimony at 5. In this regard, Joint Intervenors witness Dr. Larson pointed to the storymaps, see supra section IV.B.1.c, to further highlight samples he asserts revealed much higher concentration values.[51] Additionally, Joint Intervenors argued that

[49] Although Joint Intervenors suggest that the fact of license issuance calls into question this well-established precept, see Joint Intervenors Findings at 9–10, we see no basis for drawing such a distinction given that the agency's NEPA record of decision remains open, and is subject to adjudicatory supplementation relative to matters associated with any pending admitted NEPA contention, at least until the hearing record is closed and the final agency adjudicatory decision is issued. Certainly, unlike the cases Joint Intervenors rely on, see Joint Intervenors Findings at 9–10 (citing cases), the Board's ruling is merely an initial decision so that no final agency action has taken place thus far. Moreover, Joint Intervenors overlook another critical distinction mentioned in the cases they cite as support: the difference between a fact-finding administrative body, such as this Board, with the authority to develop an evidentiary record, see 10 C.F.R. § 2.332(d) (hearing on environmental issues must await issuance of final EIS), and reviewing adjudicatory and judicial bodies, generally with a more limited record-creating authority. See Fla. Power & Light Co. v. Lorion, 470 U.S. 729, 743–44 (1985) (distinquishing a district court with "factfinding powers" from a reviewing court whose task is "to apply the appropriate [Administrative Procecure Act] standard of review, 5 U.S.C. § 706, to the agency decision based on the record the agency presents to the reviewing court.")

[50] Joint Intervenors presented this information in terms of percent increases, i.e, 3000 percent increase in arsenic, a 7000 percent increase in selenium, and a 7060 percent increase in uranium, see Larson Initial Testimony at 14, but for consistency we refer to these in terms of the factor by which these concentrations increased, i.e., by 30X, 70X, and 71X, respectively.

[51] For example, well MP-4's sampling ranged between 5.5-11.5 mg/L for uranium, a 183X-383X increase, or well MP-5 with post-restoration concentrations ranging between 5.9-11.00 mg/L, an increase of between 148X-275X from baseline. See Larson

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presenting the range of uranium concentrations determined for individual samples, as opposed to the average of all samples from a wellfield, is necessary to provide a meaningful bounding analysis in that the FSEIS should account for the much higher contamination levels found in individual wells, which is not discussed when the data is presented as an average. See Joint Intervenors Findings at 51 (citing Larson Rebuttal Testimony at 5).

4 .91 The staff responded to this concern by challenging Dr. Larson's analysis of post-restoration uranium concentrations at Smith Ranch-Highland. First, the staff's witnesses noted that Dr. Larson's storymaps include information on Smith Ranch-Highland mine unit B that has not received restoration approval and thus is irrelevant in forecasting a future ACL. See Staff Rebuttal Testimony at 22 (Johnson, Moore, Saxton). Moreover, in another context, staff witnesses explained that while Dr. Larson's approach relies on a range of sampling results collected during the groundwater sweep and during the stability period, this is inappropriate because of the changing and improving nature of the quality of groundwater undergoing restoration, so that Dr. Larson's sampling results do "not reflect the concentrations in the groundwater at the time restoration was approved." Staff Rebuttal Testimony at 24 (Johnson, Moore, Saxton). Staff witnesses claimed that the staff's method, i.e., using data from the final group of water samples for comparison against baseline, is more accurate. See id.

4 .92 Based on the preponderance of the evidence, the Board concludes that the staff's analysis of the post-restoration uranium concentrations at Smith Ranch-Highland wellfield A is adequate for the purposes of NEPA. Because the data from Smith Ranch-Highland unit B is essentially irrelevant in assessing the Ross ACL, given that unit does not have an approved ACL, uranium concentrations based on Dr. Larson's sampling results associated with unit B are not indicative of what a future ACL at the Ross Project site might be.

[51](...continued)
Rebuttal Testimony at 6.

Additionally, the Board does not take issue with the staff's presentation of uranium concentrations in the form of an average, nor do we find fault with the staff calculating that average based solely upon the final concentration levels for uranium when aquifer restoration was approved, both of which appear to be consistent with standard practices.

4 .93 Regarding the purported deficiency in the FSEIS bounding analysis discussion of Irigaray mine units 1-9, Joint Intervenors' concern is that the average baseline concentration of uranium (0.52 mg/L) is skewed because of pre-mining R&D activities at mine unit 1, i.e., the injection of lixiviant that was not restored prior to the collection of baseline samples. See Joint Intervenors Findings at 52–53; see also Larson Initial Testimony at 14–16; Larson Rebuttal Testimony at 11. Furthermore, Joint Intervenors maintained that the staff's averaging of the Irigaray mine units 1-9 baseline concentrations as a single "composite" average inaccurately raised the baseline level because of one higher value outlier. See Joint Intervenors Findings at 53-55; see also Larson Initial Testimony at 15–17 (reporting baseline uranium concentrations in mg/L for mine units 1-9, respectively, of 3.042, 0.130, 0.023, 0.046, 0.020, 0.112, 0.119, 0.041, 0.066). As a result, Joint Intervenors witness Dr. Larson asserted, the overall average uranium concentration at the site appears to have increased from only 0.52 to 1.83 mg/L, a 3.52X increase, i.e., the 4X increase staff used as the lower figure in its bounding analysis. See Larson Initial Testimony at 17. Dr. Larson maintained, however, that this manipulates the data (as was alleged the Nubeth data) so as to "mask the reality of the groundwater impacts of the mining operations," Larson Initial Testimony at 15, and that if wellfields 2-8 were calculated on an individual basis, uranium concentration increased between 16X and 125X above baseline levels, exceeding both the upper and lower bounding limits proffered by the staff (i.e., 4X to 71X), see Larson Rebuttal Testimony at 12.

4 .94 With respect to mine unit 1 (of the nine Irigaray units at issue), the staff's witnesses agreed with Joint Intervenors that its baseline was likely impacted by prior operations.[52] See Staff Initial Testimony at 24 (Johnson, Moore, Saxton); see also Tr. at 641 (Saxton). Nonetheless, staff witnesses attempted to refocus the debate over the significance of this factor, arguing that "[t]he Intervenors do not explain how the FSEIS's documentation of the Commission's restoration approval decision for Irigaray, whether or not the Commission's prior decision was based upon a flawed approach, amounts to a failure to comply with NEPA." Staff Initial Testimony at 41 (Johnson, Moore, Saxton); see also Tr. at 634–36 (Johnson) (stating that Joint Intervenors' argument concerning averaging is an attempt to redo aquifer restoration and thus irrelevant). Staff witnesses further asserted that to recalculate the initial average baseline concentrations for the mine units would be neither practicable nor useful, requiring the staff to re-do the agency's previous technical evaluation using a different baseline averaging assumption, an effort that, even assuming the necessary raw data was available, would involve an outlay of resources disproportionate to the value of the exercise, which is to record what actually occurred when alternate restoration values were approved at Irigaray. See Staff Initial Testimony at 41 (Johnson, Moore, Saxton); see also Tr. at 639–40 (Johnson). Further, noting WDEQ's approval of this methodology in calculating baselines and increases in concentrations,

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[52] In responding to Joint Intervenors' allegations concerning EC 1, the staff's witnesses stated

> the post-licensing, pre-operational baseline for several wells was established for the Irigaray wellfield in 1976-1977 after the pilot project had been conducted in 1975 with the area of [wellfield 1]. This timing, without any subsequent restoration report in the record, suggests that the baseline for Wellfield 1 was likely impacted by the prior pilot project operations.

Staff Initial Testimony at 23–24 (Johnson, Moore, Saxton) (citations omitted). The staff's witnesses did not agree, however, that the impact to the baseline concentration at Irigaray mine unit 1 supports Joint Intervenors' assertion that the Ross Project's baseline is also biased from previous operations. See id. at 24 (Johnson, Moore, Saxton); see also Tr. at 641 (Saxton).

the staff also observed that Joint Intervenors, while appearing to be asserting that either the staff members performing the Ross Project review or those involved with the Irigaray units employed biased data, nonetheless have failed to support their allegations with any evidence suggesting that staff had the requisite intent to manipulate the data. See Staff Reply Findings at 21–22.

4 .95 In reviewing the methodology and calculations drawn from the FSEIS consideration of the Irigaray site, the Board agrees in some respects with Joint Intervenors' concerns. Dr. Larson is correct that including anomalous mine unit 1 in the average background uranium values for the entire Irigaray project unduly lowered the staff's lower limit estimate for post-restoration uranium concentration relative to pre-mining background in the production zone aquifer. Staff witnesses' admission that the Irigaray site's baseline was impacted by earlier unrestored mining activities, see supra Board Finding 4.94, in conjunction with the gross disparity in mine unit 1's baseline concentration as compared to the other eight units, leads the Board to conclude that excluding mine unit 1 from this calculation better serves the purpose of the bounding analysis in assessing what an ACL might look like at the Ross site.

4 .96 Accordingly, using the table Dr. Larson provided in his initial testimony, see Larson Initial Testimony at 15, the average baseline uranium concentration for the eight wellfields (excluding wellfield number 1) is .0696 mg/L. Thus, using only the final sample, the average post-restoration uranium concentration for the other eight wellfields is 1.93 mg/L. See Source Data at 273–345.[53] And employing these figures, the ratio of average post-restoration

[53] This exhibit contains publicly available NRC data regarding ISR site baseline and restoration stability groundwater quality samples. The initial prefiled exhibit, JTI005, was deemed by the Board to be inadmissible for its inclusion of, and reliance on, Internet URL citations. See Board Finding 2.12. Subsequently, Joint Intervenors revised and refiled the prefiled exhibit as a multi-part exhibit, i.e., JTI005A-R, which set forth the source data, and JTI005B-R, which provided the storymaps. See id. Both the source data and storymaps exhibits were admitted into evidence after being amended an additional time before admission, (continued...)

uranium to background uranium at Irigaray would be twenty-eight. This, in turn, indicates that the more likely range for the ratio of post-restoration to pre-mining uranium concentrations in the production zone would be between 18X (i.e., the next lowest value, which is from the Crow Butte evaluation) and 71X (the highest value, which is from Smith Ranch-Highland evaluation), rather than the 4X to 71X background the staff indicated. While the Board, in making these findings, supplements the FSEIS bounding discussion and the associated uranium bounding analysis, this finding nonetheless does not materially affect the FSEIS impacts analysis as the upper range for likely uranium concentrations remains unchanged.

4 .97 On the other hand, the Board does not agree with Joint Intervenors' assertion that because each mine unit at Irigaray should be evaluated separately, the upper limit of the bounding analysis should be increased from 71X to 125X.[54] Rather, as the Board indicated earlier with respect to Smith Ranch-Highland wellfield A, NEPA does not require that the range of increase from background to post-restoration uranium concentrations be established using the highest value for any individual well unit.[55]

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[53](...continued)
as reflected by their R2 designations, to remove a cover page that provided URL citations that the Board considered inappropriate to the degree the information accessible via those URLs might be considered evidentiary material. See Tr. at 574, 741–42; see also supra note 5.

[54] The Board also observes that it does not agree with Dr. Larson's calculations that the individual mine units suggest that the upper range of the bounding analysis should be expanded to a 125X increase in uranium concentrations. To arrive at the figure of 125X, Dr. Larson averaged the uranium concentrations in water sampled for four successive stability measurements whereas, as the staff asserted and the Board agrees, see supra Board Finding 4.92, the final sample should only be used as it is the most representative of post-restoration water quality. These differing methodological approaches significantly impact the increase at mine unit 3, the unit that under Dr. Larson's calculations yields the greatest (i.e., a purported 125X) ratio for post-restoration water quality relative to background. When averaging only the last samples collected, the increase in uranium concentrations is 68.5X, just below the upper limit of the bounding analysis provided by staff witnesses in their testimony (i.e., 71X). See Source Data at 279–80.

[55] The Board notes that this may appear to be in conflict with its ruling regarding Irigaray
(continued...)

4 .98 Lastly, Joint Intervenors contend that the staff's bounding analysis, and thus the FSEIS, is deficient because it purportedly fails to include quantitative data from other ISR sites, specifically Christensen Ranch mine units 2-6, Smith Ranch-Highland unit B, and Nubeth. See Joint Intervenors Findings at 55–67. With respect to Christensen Ranch, Joint Intervenors witness Dr. Larson presented evidence, in the form of pie charts, a histogram, and storymaps, illustrating what he asserted was severe contamination of the groundwater despite having employed the standard NRC groundwater restoration plan, which is also proposed for the Ross Project. See Larson Initial Testimony at 18–19, 39–41; see also Storymaps at 2–20. Dr. Larson also testified that the last stability round sampling event for the Christensen Ranch wellfields revealed an average groundwater uranium concentration of 3.83 mg/L, up from the average baseline of 0.044 mg/L, or an increase of roughly 87X. See Larson Initial Testimony at 19. Similar quantitative analysis was presented in the form of storymaps for Smith Ranch-Highland unit B. See id. at 43; see also Storymaps at 24–25, 30-31. Regarding the Nubeth ISR R&D project in the 1970s in a portion of the area where the Ross Project is now located, Joint Intervenors witness Dr. Larson acknowledged the FSEIS addressed Nubeth water quality data in tables 3.7 (Project A) and 5.4 (Project B), but maintained that both tables have issues and, in any event, Nubeth data should be included in the bounding analysis as illustrating how unlikely it is that the Ross Project can be restored to either primary or secondary groundwater standards. See Larson Initial Testimony at 9–10 (citing FSEIS 9A, at 3-41 (tbl. 3.7), 5-28 (tbl. 5.4)). Specifically, Dr. Larson asserted that FSEIS table 5.4 results for project B omitted four samples taken post-restoration that, when averaged with the values in the table, showed

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mine unit 1. Mine unit 1 is being excluded from the averaging due to its unique circumstances, under which even staff witnesses noted that the baseline data was biased. See supra Board Finding 4.94. Because there is no reason to suspect that the other wellfield data was similarly biased, we find nothing inappropriate in calculating the magnitude of increase between background uranium levels and post-restoration levels among all the other well units.

increases in uranium concentrations from baseline by 109 to 2640 percent, much greater than the values the staff provided. See id. Dr. Larson also declared that the consideration of Nubeth project A in table 3.7 is inadequate because it provided pre-test data that is not useful in evaluating what transpired with groundwater restoration after leaching occurred. See id. at 10.

4 .99 The staff disagrees with Joint Intervenors' claims regarding the need to add this data to the FSEIS bounding analysis discussion. Staff witnesses declared that the bounding analysis relies on the best sources of information available in that the three analyzed sites are the only commercial wellfields since the 1980s that have received agency approval for aquifer restoration. See Staff Initial Testimony at 34 (Johnson, Moore, Saxton). Furthermore, staff witnesses maintained that water quality samples from Smith Ranch-Highland unit B and Christensen Ranch mine units 2-6 shed no light on potential future ACLs because the agency has not approved aquifer restoration for those sites.[56] See id.; see also Staff Rebuttal Testimony at 20 (Johnson, Moore, Saxton). As for Nubeth, staff witnesses declared that it was not an analogous site as it was a small R&D operation. Furthermore, they stated that historical records on Nubeth do not provide sufficient information to compare restoration to what would be conducted at the Ross site. See Staff Rebuttal Testimony at 23 (Johnson, Moore, Saxton). Finally, staff witnesses disputed Joint Intervenors' allegation that the data in FSEIS table 5.4 was incomplete, noting that the difference in approach, as contested elsewhere, is Dr. Larson's suggested averaging of all of the measurements taken from samples collected during the groundwater sweep and during the stability period, as opposed to using the final concentration

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[56] Regarding the Christensen Ranch satellite facility, the licensee has sought approval for restoration, but the agency has requested additional information and has identified corrective actions necessary to obtain agency approval. See Staff Initial Testimony at 34 (Johnson, Moore, Saxton); Staff Rebuttal Testimony at 20–21 (Johnson, Moore, Saxton). Staff witnesses asserted that this is evidence "that the NRC carefully reviews restoration reports submitted by licensees and does not approve restoration reports until the Staff can make the determination that concentrations of hazardous constituents in the groundwater will be protective of public health and the environment." Staff Rebuttal Testimony at 21 (Johnson, Moore, Saxton).

for comparison against baseline, as was done by the staff. See id. at 24 (Johnson, Moore, Saxton).

4 .100 The Board does not take issue with the staff's decision to limit the bounding analysis to include only those sites whose aquifer restoration has been approved (unlike the Christensen Ranch and Smith Ranch-Highland unit B facilities), see supra Board Finding 4.92, or that are analogous to the Ross Project, which the Nubeth R&D project is not. In addition, the Board does not find the FSEIS discussion of Nubeth or the data in FSEIS tables 3.7 or 5.4 to be inadequate.[57]

4 .101 In sum, the Board finds the FSEIS bounding analysis, as modified by the Board's opinion, including the staff's determination to exclude from that analysis the Christensen Ranch, Smith Ranch-Highland unit B, and Nubeth facilities, to be satisfactory under the dictates of NEPA.[58]

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[57] In this regard, we note that even if we accept the 109 to 2640 percent (1.09X to 26.4X) uranium value increases proposed by Dr. Larson for the Nubeth project, see Larson Initial Testimony at 9, which he indicated the percent change for which were calculated as "(POST-RESTORATION/BASELINE) * 100," id. at 10, these values are well below the maximum 71X increase presented in the FSEIS bounding analysis.

[58] Having found the staff's FSEIS bounding analysis, as supplemented by this decision, to be adequate to fulfill the agency's NEPA responsibilities, the Board notes that the staff apparently considers this analysis to be a "one and done" effort, i.e., the bounding analysis apparently was included in the Ross FSEIS only to address EC 2 as admitted by the Board and will not be replicated for any other ISR facility. See Tr. at 613–14 (Moore). SEI likewise continues to assert that the bounding analysis is unnecessary. See SEI Initial Position Statement at 42–48.

We cannot compel the staff to replicate the bounding analysis it performed in this proceeding as part of its environmental review for any other ISL facility. See Duke Energy Corp. (Catawaba Nuclear Station, Units 1 and 2), CLI-04-6, 59 NRC 62, 74 (2004). Nonetheless, this seems a short-sighted approach that raises unnecessary questions about agency compliance with the dictates of NEPA to provide "a public explanation of the impacts of being unable to restore the mined aquifer to primary or secondary baseline and, instead, having to use an ACL." LBP-12-3, 75 NRC at 197. As the record before us illustrates, no ISR facility has ever requested that all OZ aquifer groundwater hazardous constituents be restored to 10 C.F.R. Part 40, Appendix A, Criterion 5B(5)(a) CAB concentrations or Criterion 5B(5)(b) MCLs, as

(continued...)

b. Adequacy of FSEIS Impacts Determination

4 .102 In the context of EC 2, Joint Intervenors also take issue with the FSEIS conclusion that the impacts associated with groundwater restoration at the Ross Project will be SMALL.[59] See Joint Intervenors Findings at 43–48. The Board first reviews their arguments addressing the temporal nature of the impacts and then considers their concerns regarding the impact's severity.

4 .103 Central to the dispute between Joint Intervenors and the staff and SEI over the duration of the impacts to groundwater is natural attenuation. In this regard, Joint Intervenors witness Dr. Larson referenced data from Smith Ranch-Highland mine unit A and the so-called Borch study, which is a recent study regarding the efficacy of remediation at that Smith Ranch-Highland unit A, to suggest that post-restoration uranium concentrations are either rising within the OZ aquifer or, to the degree they are stable, remain elevated. See Larson Rebuttal Testimony at 8–9 (citing Ex. NRC029, attach. at 52 (tbl. 3-6) (Letter from Ken Garoutte, Cameco

[58](...continued)
those are currently defined. See Tr. at 553 (Saxton). As a result, at this juncture, the agency's experience indicates that an ACL is a foreseeable consequence of ISR mining, the environmental impacts of which seemingly should be addressed at the earliest realistic opportunity using relevant historical information. And we can understand a staff reluctance to add another analytical element to what already is an extensive environmental review effort for initial applications to establish and operate an ISR facility, particularly given the difficulties inherent to trying to incorporate data that was collected some time ago when at least one important regulatory benchmark was somewhat different. See supra note 46. Nonetheless, the bounding analysis information provided by the staff, and particularly that regarding the baseline and post-restoration values of uranium and the range in which those values might increase (i.e., 18X to 71X), arguably provided the agency and the public with a useful insight into the circumstances that may attend an important aspect of the Ross Project's post-operational existence.

[59] In this regard, although Joint Intervenors reference an FSEIS finding that the impacts of the Ross ISR facility on groundwater quality will be "SMALL and temporary," Joint Intervenors Findings at 45 (citing FSEIS 9A, at 4-36), this FSEIS statement is made in the context of discussing impacts regarding Ross Project operations rather than restoration, which is the subject of EC 2. For restoration impacts relative to the OZ aquifer and the surrounding confining aquifers, the FSEIS indicates the impacts would be SMALL. See FSEIS 9A, at 4-48.

Resources, to Lowell Spackman, WDEQ (July 31, 2012) (Power Resources Inc., Highland Uranium Project, WDEQ Permit #603, Annual Report (Jul. 31, 2012))) [hereinafter Highland Project Annual Report]); see also Tr. 628–29 (Larson) (citing Ex. NRC037 (Thomas Borch et al., Determination of contaminant levels and remediation efficacy in groundwater at a former [ISR] uranium mine, 14 J. Envtl. Monitoring 1814 (May 2012)) [hereinafter Borch Study]). Dr. Larson noted that the authors of the Borch study emphasize that declining uranium concentrations at one of the OZ monitoring wells in the Smith Ranch-Highland wellfield A are not necessarily due to natural attenuation, but could be attributed as well to more uranium leaving with groundwater than the influx of uranium. See Larson Rebuttal Testimony at 8. In contrast, the staff pointed to the same study, but focused on two perimeter monitoring wells for Smith Ranch-Highland wellfield A that showed no change in uranium as evidence that "natural attenuation appears to be effective." Tr. at 496–97, 625–28 (Johnson).

4 .104 The evidence provided by Dr. Larson certainly raises questions about the extent to which, in the decade following post-mining remediation, natural geochemical processes are effective in causing uranium concentrations in groundwater within an OZ aquifer to decrease. Nor is the Board persuaded by staff witness assertions that the low concentrations of uranium at the perimeter monitoring wells reported in the Borch study are evidence of successful natural attenuation. Given the natural groundwater flow rate in the study area was estimated at 5.6 feet per year, see Borch Study at 1816, it is unlikely that water in the OZ would have traveled the approximately 300 feet to the perimeter monitoring wells during the thirteen-year sampling period, see id. at 1817. Yet, the Board also finds support for natural attenuation in the Borch study results concerning an intermediate monitoring well, LTM-4, which is located approximately fifty feet downgradient from the wellfield. See id. Water samples from that location showed an increase in chlorine concentrations, but no statistically significant increase in uranium, which the

report suggests "provides some evidence that water from the mine unit has indeed reached LTM 4, but other less soluable minerals are being naturally attenuated." Id. at 1821. Thus, while the role of natural attenuation relative to the OZ itself may be unclear,[60] the Board concludes that the limited data available supports the staff's conclusion that natural processes inhibit the migration of uranium and other contaminants out of the OZ aquifer following restoration and so support the staff's SMALL impacts finding, see FSEIS 9A, at 4-48.[61]

4 .105 Finally, Joint Intervenors disputed the FSEIS conclusion that the impacts to groundwater of the Ross Project fit the definition of SMALL as set forth in the FSEIS, i.e., that "[t]he environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource considered." FSEIS 9A, at xx. Joint Intervenors asserted that the record does not support this determination. They maintained that,

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[60] In this regard, it may require decades of monitoring to resolve with any certainty the question of natural attenuation's effectiveness given the large distance between the production zone and the non-exempted aquifer, the boundary of which is the "point of compliance" at which water quality is measured, see FSEIS 9A, at 2-34, and the reasonably anticipated slow rate of groundwater migration.

[61] Relative to the staff's conclusions about the SMALL impact of ISR restoration on the OZ aquifer and the surrounding aquifers, see FSEIS 9A, at 4-48, we also note that whether a lack of natural attenuation would have an effect on that conclusion is not apparent, given that aquifer's exempted status and the requirement that it be subjected to Criterion 5B(5) restoration. See infra Board Finding 4.107.

Also relating to temporal impacts, Joint Intervenors argued that, given the past history of ISR groundwater restorations, in referencing the SEI estimate of eight months, see FSEIS 9A, at 2-35, the FSEIS seriously underestimates the time necessary to restore groundwater following the cessation of wellfield operation. See Larson Initial Testimony at 21. The staff asserted that this is outside the scope of EC 2 as admitted and limited by the Board. See Staff Initial Position Statement at 33–34. SEI, on the other hand, questioned the validity of Joint Intervenors' concern by pointing to advances in groundwater restoration technology that have reduced restoration time, see SEI Reply Findings at 38, and to LC 10.6, which explicitly mandates that restoration be completed within eight months, see SEI Rebuttal Position Statement at 27–28. While Joint Intervenor's skepticism of the anticipated timeframe is not untoward, given the length of time groundwater restoration activities have taken at other ISR mining sites, the Board nonetheless agrees with the staff that this concern is outside the scope of EC 2 as admitted.

in addition to the fact that no ISR site aquifer has ever been restored to baseline values, the quantitative data from Nubeth, Smith Ranch-Highland units A and B, and Christensen Ranch all support a determination that the impacts are "large and long term." Joint Intervenors Findings at 69; see Larson Initial Testimony at 36; Larson Rebuttal Testimony at 2–3, 10; see also FSEIS 9A, at xxi ("LARGE" defined as the "[e]nvironmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource considered").

4 .106 The staff responded that Joint Intervenors fail to acknowledge that the SMALL impacts determination follows from the GEIS. In this regard, staff witness Moore asserted that there are no site-specific issues associated with the Ross Project and concluded there was no basis to depart from the GEIS conclusion that, even if an ACL is used as the post-restoration groundwater standard, impacts to groundwater would be SMALL. See Tr. at 548; see also Staff Reply Findings at 17 & n.50. Staff witnesses also declared that the data Joint Intervenors rely on to suggest that the impacts would be "large and long term" is irrelevant, as those values involved sites without groundwater restoration approval or that are not analogous to the Ross Project or included post-restoration data that was unavailable at the time the Commission approved restoration. See Staff Rebuttal Testimony at 20–24 (Johnson, Moore, Saxton); see also Staff Initial Testimony at 38 (Johnson, Moore, Saxton). Finally, the staff asserted that Joint Intervenors have failed to explain how, in accord with the FSEIS definition of LARGE, the impacts from an ACL will be "clearly noticeable" and "sufficient to destabilize important attributes" of the groundwater, given the OZ aquifer is exempted as a United States drinking water (USDW) source. See Tr. at 548–49 (Moore); Staff Reply Findings at 25.

4 .107 The Board concludes that the FSEIS determination that restoration-associated impacts to groundwater in the OZ aquifer and surrounding confining aquifers would be SMALL is supported by the preponderance of the evidence in the record. The Board agrees with the

staff that there has been no showing that the impacts from employing an ACL will be "clearly noticeable" and "sufficient to destabilize important attributes of groundwater." This is particularly the case given that the OZ aquifer is permanently exempted as a drinking water source, see supra note 47, and there have been no reported instances of an excursion from an ISR facility negatively impacting drinking water, see Ex. SEI004A, at 2 (Memorandum from Charles L. Miller, FSME, to the Commission, Staff Assessment of Groundwater Impacts from Previously Licensed In-Situ Uranium Recovery Facilities (July 10, 2009)) (noting that there have been no excursions from ISR sites with "environmental impacts" and that the staff is aware of no instances in which a water supply well has been degraded, discontinued, or relocated due to ISR activities). Furthermore, while the Board does not consider Joint Intervenors' concern to be addressed solely by reliance on the LC 10.6 requirement that SEI restore the OZ aquifer in accordance with 10 C.F.R. Part 40, Appendix A, Criterion 5B(5), and the inherent legal requirements of an ACL, see supra Board Finding 4.77 , it does find that these factors nonetheless support the FSEIS SMALL impacts conclusion. The same is true for the State of Wyoming's standard mandating that there be no change in the class of use of the exempted aquifer. See Tr. at 543 (Saxton). Additionally, there is nothing in the record to suggest that SEI (or the staff) will not act in good faith to ensure that SEI's regulatory responsibilities, including its license conditions, are honored, and the Board cannot assume non-compliance. See, e.g., GPU Nuclear, Inc. (Oyster Creek Nuclear Generating Station), CLI-00-06, 51 NRC 193, 207 (2000) (citing cases); see also infra note 66. Finally, in reaching this conclusion, the Board is mindful that should an ACL be sought, a license amendment would be required, triggering another NEPA review, and a hearing opportunity, which will involve the analysis of more specific water quality data.[62] See supra Board Finding 4.68.

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[62] In making this ruling, the Board is also mindful of Joint Intervenors' concern about the

(continued...)

5. Board Conclusions Regarding EC 2

4 .108 Based on the findings set forth above, a preponderance of the evidence demonstrates that the FSEIS, as supplemented by the uranium bounding analysis discussed in this decision, adequately identifies the potential environmental impacts of an ACL should an ACL be necessary for the Ross Project site. Furthermore, the preponderance of the evidence before the Board supports the FSEIS determination that the restoration-associated impacts on groundwater quality within the Ross Project site OZ aquifer and surrounding aquifers will be SMALL.

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[62](...continued)
staff's statement that, "'the Staff's conclusion in the FSEIS regarding potential impacts to groundwater from the Ross project assumes that a Commission-approved ACL <u>of any amount</u> would have only a SMALL impact on groundwater at the site.'" Joint Intervenors Findings at 45 (quoting Staff Initial Position Statement at 32–33 and referencing Tr. at 559–61 (Johnson)). According to Joint Intervenors, this reflects "a lack of analysis and a meaningful standard to gauge the environmental impacts of ISL recovery in the exempted aquifer within the [OZ]" and means that "impacts of an ACL within the mined and exempted aquifer could never be considered 'large.'" Joint Intervenors Findings at 45, 46.

The staff did seek to clarify somewhat its position in this regard, indicating that if an ACL is issued, it is based on a regulatory finding that there is not a substantial present or potential hazard to the public health or the environment and, therefore, in the absence of any Ross site specific issues, consistent with the GEIS impacts finding regarding the potential future need for an ACL, any environmental impacts would not rise to the level of LARGE. <u>See</u> Staff Reply Findings at 16–17. Nonetheless, the crux of the staff's position on the impacts of an ACL, i.e., issuance of an ACL must be based on a finding that there is no substantial hazard to the public health or environment and, therefore, any environmental impacts must be SMALL, does, at least on its face, suggest a "resolution by definition" approach.

Ultimately, however, the validation of this staff approach lies in the fact that the ACL process requires another, separate agency judgment about what is an appropriate concentration level for the various hazardous constituents that will remain post-operation in the production aquifer and that this agency assessment is subject to an adjudicatory challenge. An SEI request for an ACL can be contested, as to both its safety and environmental components, when that proposal is made, affording an opportunity for Joint Intervenors (or others) to question before the agency (and seek judicial review regarding any agency decision on) whether the limits proposed by SEI are protective of the public health and the environment (and so result in SMALL impacts).

C. Contention EC 3

4 .109 As outlined by the Board in its order recognizing the migration of EC 3 as a FSEIS-related contention, this issue statement provides:

> [EC] 3: The FSEIS fails to include adequate hydrological information to demonstrate SEI's ability to contain groundwater fluid migration.
>
> CONTENTION: The FSEIS fails to assess [adequately] the likelihood and impacts of fluid migration to the adjacent groundwater, as required by 10 C.F.R. §§ 51.90-94 and NEPA, and as discussed in NUREG-1569 § 2.7, in that:
>
> 1. The FSEIS fails to analyze sufficiently the potential for and impacts associated with fluid migration associated with unplugged exploratory boreholes, including the adequacy of applicant's plans to mitigate possible borehole-related migration impacts by monitoring wellfields surrounding the boreholes and/or plugging the boreholes.
>
> 2. There was insufficient information for the NRC staff to make an informed fluid migration impact assessment given that the applicant's six monitor-well clusters and the 24-hour pump tests at four of these clusters provided insufficient hydrological information to demonstrate satisfactory groundwater control during planned high-yield industrial well operations.

FSEIS Order app. A, at 1.

1. Witnesses and Evidence Presented

4 .110 SEI, the staff, and Joint Intervenors presented a dozen witnesses in connection with EC 3 during the September-October 2014 evidentiary hearing in support of their respective positions on whether the FSEIS discussion and analysis of hydrological information was sufficient to demonstrate SEI's ability to contain groundwater fluid migration. Each of these witnesses also presented written direct and/or rebuttal testimony, with supporting exhibits.[63]

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[63] See Tr. at 671–784; Knode Initial Testimony at 11–13; Knode Rebuttal Testimony at 6–7; Schiffer Initial Testimony at 29–34; Schiffer Rebuttal Testimony at 19–22; Demuth/Lawrence Initial Testimony at 18–21; Demuth/Lawrence Rebuttal Testimony at 6–7;
(continued...)

a. SEI

4 .111 At the evidentiary hearing, SEI presented six witnesses regarding EC 3: (1) SEI CEO Ralph Knode; (2) Ben Schiffer, WWC Engineering senior geologist and project manager; (3) Hal Demuth, a senior engineer/hydrologist and principal of Petrotek Engineering Corp.; (4) Errol Lawrence, a senior hydrologist at Petrotek Engineering Corp.; (5) Michael Griffin, SEI's Vice President of Permitting, Regulatory, and Environmental Compliance; and (6) Ray Moores, a civil engineer/project manager with WWC Engineering. See Tr. at 671–703, 756–84.

4 .112 Following training as a submarine electrical operator in the United States Navy's nuclear power program, Michael Griffin completed more than three years towards a Bachelor of Science degree at the Universities of Utah and South Carolina. Prior to joining SEI, he was a principal with Griffin Consulting, Inc., and worked in various positions in field operations, facility licensing and permitting, regulatory affairs, environmental protection, health physics and industrial safety programs, and radioactive and hazardous waste management with Uranium One, Inc., CBR, Resource Technologies Group, Inc., and Chem-Nuclear Systems, Inc. At the Ross Project, he oversees licensing and permitting activities and the development of environmental, health and safety programs. See Griffin Initial Testimony at 3–4; Ex. SEI040, at 1–4 (Michael Griffin CV).

4 .113 Ray Moores holds Master and Bachelor of Science degrees in civil engineering from the University of Wyoming. A registered professional engineer in Wyoming and Colorado, his main role at the Ross Project has been to prepare the numerical groundwater model,

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[63](...continued)
Ex. SEI039, at 4–6 (Initial Written Testimony of Mike Griffin) [hereinafter Griffin Initial Testimony]; Ex. SEI049, at 3–4 (Rebuttal Testimony of Mike Griffin) [hereinafter Griffin Rebuttal Testimony]; Moores Initial Testimony at 5–11; Ex. SEI048, at 3–6 (Rebuttal Testimony of Ray Moores) [hereinafter Moores Rebuttal Testimony]; Staff Initial Testimony at 42–78; Staff Rebuttal Testimony at 24–39; Abitz Initial Testimony at 40–55; Abitz Rebuttal Testimony at 16–17; Larson Initial Testimony at 49–68; Larson Rebuttal Testimony at 14–24.

including developing the conceptual groundwater model and developing, calibrating, and running operational simulations using the numerical groundwater model. Additionally, he provided technical support for the aquifer tests, assisted with preparation of the license application, and assisted with geotechnical drilling and analysis within the proposed CPP. See Moores Initial Testimony at 3; Ex. SEI043, at 1 (Ray Moores CV).

4 .114 The qualifications of the other four SEI witnesses were discussed previously by the Board above in connection with its ruling on EC 1. See supra section IV.A.1.a.

b. NRC Staff

4 .115 At the hearing, four witnesses provided testimony regarding the staff's position concerning EC 3: (1) the NRC Ross Project lead environmental review project manager Johari Moore; (2) John Saxton, an NRC Ross Project safety review project manager and hydrogeologist; (3) AEC/JEC geochemist Dr. Kathryn Johnson; and (4) Dr. Anthony Burgess, an AEC principal hydrogeologist. See Tr. at 707–40, 756–84.

4 .116 Dr. Anthony Burgess, who is a licensed professional engineer in Washington state, received his Doctor and Bachelor of Science degrees in geology from the University of Durham, United Kingdom. He is currently president of Anthony Burgess Consulting, Inc. Dr. Burgess prepared the sections of the DSEIS and FSEIS that address groundwater issues. See Staff Initial Testimony at 2; Ex. NRC005, at 1, 2 (Burgess SPQ).

4 .117 The qualifications of the other three staff witnesses were discussed previously by the Board above in connection with its ruling on EC 1. See supra section IV.A.1.b.

c. Joint Intervenors

4 .118 During the hearing, two witnesses provided evidence relative to Joint Intervenors' positions on this contention: (1) Dr. Richard Abitz, the principal geochemist and owner of Geochemical Consulting Services, LLC; and (2) NRDC science fellow Dr. Lance Larson. See

Tr. at 748–84. The qualifications of each of these witnesses were previously discussed by the Board above in connection with its rulings on EC 1 and EC 2, respectively. See supra sections IV.A.1.c. and IV.B.1.c.

d. Finding Regarding Witness Qualifications

4 .119 Based on the foregoing, and the respective background and experience of the proffered individuals, the Board finds that each of these SEI, staff, and JTI witnesses is qualified to testify relative to the subject of the adequacy of the FSEIS's hydrological information regarding the containment of groundwater fluid migration.

2. FSEIS Discussion Relative to Contention EC 3

4 .120 Fluid migration is the subject of FSEIS sections 3.5.3.2 and 4.5.1.2. Section 3.5.3.2 provides a description of the local geologic stratigraphy and its relationship to the groundwater hydrology of the area of the Ross Project, as well as outlining the SEI pre-licensing monitoring programs to determine whether there is hydrologic communication, and the associated possibility of excursions, between the OZ layer and the other potentially impacted layers/aquifers across the Ross Project area. The pre-licensing monitoring programs included aquifer pumping tests performed on six well clusters (which SEI referred to as the regional baseline monitor wells). During six twenty-four hour tests and one seventy-three hour test, SEI pumped water from the OZ aquifer while monitoring the SA and SM aquifers (above the OZ) and the DM aquifer (below the OZ) to see whether the pumping had any affect on these aquifers indicative of hydrologic communication. See FSEIS 9A, at 3-37; Ex. SEI014G add. 2.7-F, at 5–6 (4 SEI, Ross ISR Project USNRC License Application, Crook County, Wyoming, [TR] (Apr. 2012)) [hereinafter Aquifer Test Report]. The FSEIS indicated that while no effects from the SEI OZ pumping were measured in any of the wells in the overlying SA or SM horizon, two of the six underlying DM wells declined slightly during the SEI pumping. The staff considered this to be

communication between the OZ and DM aquifers due to drill holes that were installed during previous resource-exploration efforts, but had not yet been located and properly abandoned (i.e., sealed) by SEI. According to the FSEIS, despite the communication, the integrity of the confining layer between the OZ and DM aquifers was established by the fact that the other four DM aquifer wells were not affected by the OZ pumping, including one well (Well 12-18), for which all the nearby exploration drill holes had been located and properly abandoned. See FSEIS 9A, at 3-37; see also id. at 4-42 .

4 .121 Further in this regard, the FSEIS indicates that condition 10.12 of the SEI license provides that to ensure the OZ aquifer remains hydraulically isolated, SEI must first "attempt" to locate and properly abandon all historical drill holes located within each wellfield's perimeter monitoring well ring prior to conducting the hydrologic wellfield data package testing mandated to begin ISR operations. See id. at 4-42; see also SEI License at 9 (LC 10.12 stating SEI "[p]rior to conducting tests for a wellfield data package, will attempt to locate and abandon all historic drill holes located within the perimeter well ring for the Wellfield"). This license condition is intended to address the presence of some 1682 drill holes known to exist within the Ross site and a half-mile buffer zone outside the Ross permit area as a consequence of a 1970s pilot project undertaken by Nubeth to locate potential uranium ore bodies. See FSEIS 9A, at 3-13, 4-42; Tr. at 679 (Knode). Further, of those 1682 drill holes, 1483 are located within the Ross Project permit area, of which 1354 have been located (as of October 1, 2014) and 108 have been plugged (as of August 1, 2014), while approximately 1382 of the 1483 are located within the somewhat smaller area of the to-be-installed perimeter well-monitoring ring, with 1265 of those having been found by SEI. See Tr. at 679–80 (Knode).

4 .122 FSEIS section 4.5.1.2 describes the environmental impacts to surface and ground water of Ross Project operations and potential mitigation measures. Referencing GEIS

section 4.2.4.2.2.2, see GEIS, at 4.2-22 to -25, the FSEIS indicates in connection with groundwater that horizontal excursions of degraded groundwater outside of the OZ could have a MODERATE to LARGE impact if a large volume of contaminated water leaves the OZ and moves downgradient into a consumption area. The FSEIS indicates further that while most excursions are horizontal and are recovered within months of detection, vertical excursions tend to be more difficult to recover and have remained in excursion status for as long as eight years. The FSEIS also acknowledges that one of the causes of vertical excursions are improperly abandoned drill holes from earlier exploration activities and that condition 10.12 to the SEI license is intended to mitigate potential impacts from the existing drill holes on the Ross site. Additionally, the FSEIS notes that LC 11.3 requires that SEI install monitoring wells around each wellfield to monitor the OZ, SM, and DM aquifers, while LC 11.5 mandates that SEI must cease injecting lixiviant into the uranium production area surrounded by a perimeter monitoring ring if a vertical excursion is detected during operation. Thereafter, SEI can resume injection operations only when SEI demonstrates to the staff's satisfaction that the vertical excursion cannot be attributed to leakage through any abandoned drill hole. Finally, assuming adequate monitoring well excursion detection and SEI groundwater pumping to recover excursions, the FSEIS concludes that the potential impacts of Ross Project operations to groundwater quality in the confined SM and DM aquifers above and below the OZ will be SMALL. See FSEIS 9A, at 4-37, 4-38, 4-42, 4-43; see also SEI License at 9, 12–14.

3. Joint Intervenors' Issues Regarding Groundwater Fluid Migration

4 .123 Relative to their fluid migration contention EC 3, Joint Intervenors have identified what they assert are three flaws in the staff's FSEIS analysis that must be corrected: (1) the FSEIS discounts the risk of fluid migration from unplugged and improperly abandoned boreholes; (2) the FSEIS did not properly assess the risk of fluid migration because the relied-

upon pump tests were inadequate to demonstrate aquifer containment; and (3) the FSEIS impacts analysis concludes inaccurately that lixiviant excursions will be adequately detected. See Joint Intervenors Findings at 72, 78, 79. We consider each of these concerns in turn.

a. Borehole Issue

4 .124 Declaring that the staff has previously designated as appropriate for ISR mining only aquifers that it considered "confined," i.e., bounded by an overlying and underlying geologic unit of relatively low permeability, Dr. Larson provided several examples of unexplained vertical excursions at what he asserted were otherwise staff-designated "confined" sites and stated that undetected, unsealed boreholes appear to be directly related to vertical excursions. See Larson Direct Testimony at 52–54. Joint Intervenors likewise pointed to a 1986 staff-sponsored study of excursions in Wyoming and Texas ISR mines that (1) indicates vertical excursions are "directly related to the intensity of" prior drilling activity that results in improperly plugged and abandoned exploration holes or poorly completed field wells; and (2) describes "standard practice" in addressing a vertical excursion as seeking to locate abandoned open boreholes (along with pressure testing completed wells in a search for defective or broken casings), but observes that the effectiveness of such a procedure depends on the ability to locate all the abandoned holes, which in the case of older holes is often difficult because of the lack of records, the scattering and covering of well cuttings by erosion and vegetation, and the collapse of exposed surface casings, if permanent casings were ever installed. Joint Intervenors Findings at 75 (citing Ex. NRC020, at 30 (W. P. Staub, et al., Oak Ridge National Laboratory, An Analysis of Excursions at Selected In Situ Uranium Mines in Wyoming and Texas, NUREG/CR-3967, ORNL/TM-9956 (July 1986))); see also Abitz Direct Testimony at 46.

4 .125 Against this background, Joint Intervenors criticized the staff's finding that the long-term impacts of excursions will be SMALL. Joint Intervenors asserted that the FSEIS did

not assess adequately the risk of fluid migration from improperly plugged and abandoned boreholes because it assumed that the remaining 1500+ Nubeth boreholes will be located and then properly filled. Given the acknowledged difficulty of locating and filling such old holes, in conjunction with SEI's plan not to try to fill boreholes beyond the perimeter monitoring ring for each wellfield, which may be established at any point within 400 feet of the production wells in a field, Joint Intervenors declare that contamination beyond those wellfield areas is even more likely to be unconfined as it may reach unplugged boreholes SEI does not intend to fill. See Joint Intervenors Findings at 77. Further, Joint Intervenors contend that LC 10.12, as a measure intended to mitigate the impact of any drill hole-related excursion, is inadequate because that condition requires SEI only to "attempt" to locate and fill the boreholes, an attempt that an SEI witness acknowledged might not be successful before ISR operations begin, see Tr. at 766 (Griffin), and that a staff witness stated may only be the subject of an enforcement action if the staff determines that SEI activities associated with not fulfilling the license condition were "willful," Tr. at 764 (Saxton). Moreover, Joint Intervenors asserted, LC 10.12's ineffectiveness as a mitigation measure, in conjunction with the acknowledged difficulty in locating old boreholes like those on the Ross site, established that the FSEIS is deficient because it failed to present a timetable and requirements for borehole location, plugging, and abandonment prior to any wellfield development. See Abitz Initial Testimony at 48.

4 .126 While recognizing Joint Intervenors' arguments regarding the LC 10.12 requirement that SEI "attempt" to locate and abandon all the approximately 1500 drill holes within the Ross permit area, the staff asserted that this concern rests on a mistaken assumption, i.e., that the location and proper filling of these boreholes is critical to the FSEIS conclusion that the environmental impacts associated with fluid migration will be SMALL. Instead, the staff declared, its FEIS impacts conclusion of SMALL "is based not on the finding

and filling of boreholes, as [Joint] Intervenors claim, but on the detection and recovery of potential excursions." Staff Reply Findings at 28; see id. at 29 (stating staff's ultimate conclusion long-term impacts to OZ aquifer outside the exempted area would be SMALL is based on staff's analysis of SEI's ability to recover potential excursions, not assumption all boreholes would be located and filled). The staff thus concluded that, as documented in FSEIS section 3.5.3.2, sufficient safeguards are in place to protect against excursions should SEI be unable to locate and abandon all the Nubeth drill holes within the perimeter well ring. See Staff Findings at 46.

4 .127 The presence of some 1500 pre-existing boreholes within the Ross permit area undoubtedly presents a daunting challenge both in assessing and mitigating the potential environmental impacts of the drill holes. As just noted, the staff places its main reliance in this regard on SEI's excursion detection and recovery efforts. Yet, in considering the evidence before us, we conclude the staff has overly discounted the importance of the license condition requirement that SEI act to locate and properly abandon all historic drill holes within the wellfield perimeter well ring as a factor in finding that long-term fluid migration impacts will be SMALL. The excursion monitoring requirements of LC 11.5, which govern excursion detection and recovery and upon which the staff places so much emphasis as the basis for its FSEIS impact determination, is labeled in the SEI license as one of the "Standard Conditions," see SEI License at 11, and likewise seems to be standard for other ISR licenses, see NRC, Materials License No. SUA-1600, Docket No. 40-09075, at 9, 10–11 (Apr. 8, 2014) (LC 11.5 for Powertech (USA) Inc. Dewey-Burdock Project among "Standard Conditions") (ADAMS Accession No. ML14043A392); NRC, Materials License No. SUA-1597, Docket No. 040-9067, at 10, 12 (amend. No. 3 Aug. 28, 2014) (same for LC 11.5 for Uranez Energy Corp. Nichols

Ranch Project) (ADAMS Accession No. ML14212A457).[64] Nonetheless, there is a "nonstandard" provision in this standard condition, which is a specific reference to the problem of existing boreholes on the Ross site that LC 11.5 in the SEI license addresses as follows:

> If a vertical excursion is detected during operations, then injection of lixiviant into the production area surrounding the monitoring well will cease until the licensee demonstrates to the satisfaction of NRC that the vertical excursion is not attributed to leakage through any abandoned drill hole.

SEI License at 14. While this requirement outlines the appropriate action that must be taken in the event a vertical excusion is identified, as a measure intended to ensure that the facility can operate safety on a continuing basis, it also emphasizes the importance of "Facility Specific" LC 10.12 that requires SEI "[p]rior to conducting tests for a wellfield package . . . [t]o attempt to locate and abandon all historic drill holes located within the perimeter well for the Wellfield." Id. at 9. Indeed, given the number of historic drill holes on the Ross site, see supra Board Finding 4.121, it is not apparent that, in the absence of the additional "locate-and-abandon" condition, to what degree the standard excursion detection and recovery condition would have been adequate to support the staff's FSEIS finding of SMALL long-term impacts outside the OZ exempted area. As a consequence, Joint Intervenors' concern about the extent to which LC 10.12, as it directs SEI to "attempt" to detect and abandon properly the myriad drill holes on the Ross site, will be implemented in such a way as to support adequately the staff's SMALL impact finding is not without significance.

4 .128 Looking then to the substance of that license condition and the activities it engenders, we note initially that pertinent to the issue whether SEI can be counted on to implement LC 10.12 appropriately is the established precept that, in the absence of some showing of substantial prior misdeeds, an applicant/licensee will be presumed to follow the

[64] The Licensing Board takes official notice of these NRC-issued licenses in accord with 10 C.F.R. § 2.337(f).

agency's regulatory requirements, including the directives in its license. See Private Fuel Storage, LLC (Independent Spent Fuel Storage Installation), CLI-01-9, 53 NRC 232, 235 (2001) (stating that "the NRC does not presume that a licensee will violate agency regulations wherever the opportunity arises") (citing GPU Nuclear, Inc. (Oyster Creek Nuclear Generating Station), CLI-00-6, 51 NRC 193, 207 (2000) (declaring the intervenor "also fails to offer documentary support for its argument that [the licensee] is likely to violate our safety regulations. Absent such support, this agency has declined to assume that licensees will contravene our regulations.")). Regardless of this assumption, however, SEI has a clear incentive here to put its best efforts into completing timely and fully the drill hole locate-and-abandon mission imposed by LC 10.12 to avoid the consequences of wellfield operations shutdown under LC 11.5 if SEI fails to identify and fill one or more boreholes.[65] As a consequence, we would anticipate that SEI's "attempt" under LC 10.12 will almost certainly involve (1) finding a very substantial portion, if not all, of the remaining 117 unlocated drill holes within the area bounded by a wellfield's perimeter monitoring well ring; and (2) properly abandoning all the identified drill holes within that perimeter. Moreover, additional measures are in place, including (1) the well abandonment records that SEI must complete and maintain for each borehole as it is located and plugged in compliance with LC 10.12, see Tr. at 736–39 (Saxton), 761 (Schiffer); see also TR 14C, at 3-20 to -21; and (2) the post-license, pre-production pump tests required by LC 10.13 that will help provide SEI and the staff with the requisite assurance regarding the adequacy (and success) of SEI's effort to comply with

[65] Although Joint Intervenors challenged the adequacy of LC 10.12 because there is no specified timetable for carrying out the locate-and-abandon task it imposes, see Joint Intervenors Findings at 77, 87, the schedule for completing this endeavor nonetheless seems clear, i.e., it must be done before SEI conducts the tests for a wellfield data package that SEI must finish prior to beginning facility operation, see supra Board Finding 4.121.

LC 10.12,[66] by indicating whether, for any reason, including undiscovered or inadequately plugged boreholes, the OZ aquifer is hydrologically connected to aquifers above or below, see Tr. at 689–91 (Demuth).[67] We thus conclude that, in most respects, LC 10.12 provides

[66] In undertaking its role to assess whether an applicant/licensee adequately carries out a licensing directive, we likewise are to assume that the staff will be fair and judge the matter of an applicant/licensee's compliance on the merits. See Pub. Serv. Co. of N.H. (Seabrook Station, Units 1 & 2), LBP-89-4, 29 NRC 62, 73 (1989) (citing United States v. Chem. Found., Inc. 272 U.S. 1, 14-15 (1926)), aff'd on other grounds, ALAB-918, 29 NRC 473 (1989), remanded on other grounds sub nom. Mass. v. NRC, 924 F.2d 311 (D.C. Cir.), appeal dismissed as moot, ALAB-946, 33 NRC 245 (1991). Yet, as is the case with SEI, the staff has an additional incentive here, i.e., in the face of extensive prior drilling intrusions into the Ross site, to fully support its predicative finding of SMALL long-term impacts from fluid migration, the staff necessarily must ensure that SEI's LC-required "attempt" to locate and abandon all drill holes within the monitoring well ring embodies a level of effort that maximizes the potential for eliminating excursions, particularly vertical excursions that would reach into the SM or DM aquifers.

Relative to the staff's role, we also observe that we do not believe this condition and the staff (and SEI) activities it contemplates violates the precept that post-hearing resolution of licensing issues must not be employed to obviate the basic findings prerequisite to a license. See Hydro Res., CLI-06-1, 63 NRC at 4. Particularly in the NEPA context, the path SEI and the staff must follow relative to LC 10.12 is sufficiently clear such that continuing to hold this hearing open while it is completed would be an unnecessary extension of the adjudicatory process. See id. at 5–6.

[67] The lack of potential hydrological impact from the numerous historic boreholes on the Ross site are, according to SEI, supported by the fact that its completed borehole abandonment efforts have demonstrated that the drill holes are, to some extent, self-sealing over time and that the pierzometric head in the SM aquifer is nearly 100 feet higher than the OZ aquifer, such that a significant amount of head will be induced into the OZ aquifer if there is an uplugged borehole, thereby limiting the potential for a vertical excursion into the SM aquifer. See SEI Reply Findings at 45 (citing Tr. at 708, 713 (Burgess), 757–58 (Schiffer)). Relative to the second point, the FSEIS does indicate that vertical gradients downwards from the SM to the OZ aquifers could have head differences of as little as 50 feet (or as much as 150 feet), see FSEIS 9A, at 3-35, and the testimony of staff witness Saxton recognized that the injection and removal of fluids within the production zone creates local perturbations in the hydraulic head in the OZ aquifer such that if an undiscovered and unplugged borehole were close to an injection well, the artificially-created head could potentially be great enough to reverse the vertical flow in the old borehole and allow lixiviant to contaminate the SM aquifer, see Tr. at 717–19 (Saxton). Nonetheless, in the unlikely event that a local anomaly generated by an injection would be great enough to overcome the 100-foot average difference needed to reverse the flow between the two aquifers or would occur under the specific circumstance in which the head difference was as small as 50 feet, we would agree with staff witness Saxton that the monitoring program required under LC 11.5, see Tr. at 719 (Saxton), as well as the requirement for lixiviant injection (continued...)

substantial support for the FSEIS conclusion that, despite the nearly 1500 historic boreholes on the Ross Project site, the environmental impacts associated with fluid migration during facility operation will be SMALL.[68]

4 .129 There is, however, one limited respect in which the evidentiary record before us indicates that LC 10.12 is not sufficient. Under its current terms, this condition applies only to drill holes within the "perimeter well ring for the Wellfield," notwithstanding the fact that there are in the neighborhood of 101 boreholes located in the area between the monitoring well ring and the Ross Project boundary, eighty-nine of which have been located. See Tr. at 679–80 (Knode). SEI declares that the potential for fluid migration via boreholes outside the monitoring well ring is minimized by natural hydrologic conditions, along with (1) LC 11.5, which requires immediate horizontal excursion corrective actions; (2) LC 10.7, which requires SEI to maintain a net inward hydraulic gradient in each wellfield between initial lixiviant injection and the start of post-groundwater restoration stabilization monitoring; and (3) the significantly smaller density of boreholes outside the mineralized areas of the Ross site. See SEI Reply Findings at 45–46 (citing SEI License at 8, 13–15). We recognize that, for all these reasons, this beyond-the-wellfield monitoring ring area generally is an area with a lower risk for excursions as compared to the area within the wellfield monitoring ring. More specifically, we are aware that the evidentiary record suggests that most of the Nubeth boreholes bottomed in the OZ aquifer and therefore are not potential conduits for fluids moving from the OZ to the DM horizon. See Tr. at 713 (Burgess). Nonetheless, given that SEI and the staff also attributed the aquifer

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[67](...continued)
shutdown if a vertical excursion is detected, provides adequate mitigation measures for this circumstance.

[68] And further reinforcing this conclusion, as the staff and SEI note, is the ongoing monitoring of water levels in the aquifers overlying and underlying the OZ pursuant to LC 11.5 that will provide a continuing check that the aquifers within the wellfield are hydrologically isolated. See Tr. at 700–01 (Lawrence), 719–20 (Saxton).

pumping tests response in the DM aquifer to unplugged boreholes, see FSEIS 9A, at 3-37, some of the Nubeth drill holes apparently did penetrate into the DM aquifer, thus creating the possibility for the downward movement of fluids from the OZ into the DM aquifer.

4 .130 To be sure, excursions outside the perimeter monitoring ring would require significant lateral movement within the OZ aquifer, which during mining and restoration is likely to be detected by the monitoring wells. On the other hand, based on the limited information before us, with the uncertainty about the lack of any rapid decline from the ACL-based concentrations of uranium and other contaminants within the production zones of the OZ aquifer, see supra Board Finding 4.104 & note 60, a decade after restoration any excursions affecting the DM as a consequence of unplugged boreholes beyond the perimeter monitoring well ring may well be difficult to detect and remediate, creating the possibility of long-term impacts from such unfilled boreholes that could be more than SMALL.

4 .131 Accordingly, so that any unfilled boreholes are located and abandoned that go into the DM aquifer or below and are within the area that is (1) downgradient of a wellfield; and (2) between the perimeter monitoring well ring and the closer of (a) the Ross site boundary, or (b) the boundary of the exempted OZ aquifer and the monitoring well ring, thereby ensuring that the staff's assessment that the impacts of such boreholes will be SMALL is fully supported, we revise LC 10.12 to read as follows:[69]

> 10.12 Prior to conducting tests for a wellfield data package, the licensee will attempt to locate and abandon all historic drill holes within:

[69] The Board recognizes that the protective measure we are imposing is not one that addresses a high-probability event. Nonetheless, because there are likely to be only about 100 boreholes potentially involved, see Tr. at 368–69 (Schiffer), this does not seem an inordinate requirement, particularly given it is intended to ensure the integrity of the exempted aquifer area as a buffer. Moreover, with only about 100 drill holes potentially at issue, of which apparently only 12 still need to be located, it could well be that SEI may find it more cost effective simply to locate and fill all the beyond-the-perimeter monitoring ring area drill holes, consistent with its approach to addressing the boreholes within the perimeter monitoring well ring, regardless of their depth.

A) The perimeter well ring for the Wellfield; and

B) To the extent the historic drill holes extend into the first underlying aquifer, the area that is downgradient of the Wellfield and is between the perimeter well ring for the Wellfield and the closer of either

i. The Ross Project license area boundaries shown in figure 1.4-2 of the approved license application; or
ii. The outer boundary of the exempted aquifer as defined by the Class III UIC permit issued by the Wyoming Department of Environmental Quality.

The licensee will document such efforts to identify and properly abandon all drill holes in the wellfield data package.

b. Pre-License Pump Test Issue

4 .132 In challenging the FSEIS analysis of Ross site hydrology, Joint Intervenors also questioned the adequacy of the battery of pre-licensing pump tests performed by SEI to show the hydrologic integrity of the OZ aquifer with respect to the SM and DM aquifers on the Ross site and used by the staff to analyze and reach its FSEIS conclusions about the potential impacts of the facility on local groundwater resources. See Joint Intervenors Findings at 78–79. In this regard, in his initial written testimony Joint Intervenors witness Dr. Abitz asserted that "neither the number of wells tested for hydrological parameters nor the short duration of the pump tests run to date establish adequate hydrological information to demonstrate control of groundwater." Abitz Initial Testimony at 49. Dr. Abitz also declared that "groundwater communication between the SM and OZ horizons is evident in the 24-hour pump test data from well 12-18OZ and the water-quality results for sodium and sulfate." Id. Further, regarding pump test duration, in response to a staff witness observation in his initial written testimony that the well 12-18OZ pump test referred to by Dr. Abitz was a seventy-two-hour test, not a twenty-four-hour test, see Staff Initial Testimony at 67 (Burgess), during the evidentiary hearing Dr. Abitz declared that, given the multi-year extraction process, pumping for seventy-two hours

or even one week would not be sufficient to demonstrate a lack of connectivity between aquifers, see Tr. at 769.

4 .133 As described in the initial written testimony of SEI witness Moores, during each aquifer pump test, the well installed within the OZ aquifer was pumped at a constant rate. Pressure transducers programmed to measure and record the water level in each well at one-minute increments were installed within the pumped OZ well and any OZ observation wells, the SM overlying water-bearing interval well, and the DM underlying water-bearing interval well. After completion of the pumping portion of the test, transducer-recorded water level readings continued at one-minute increments until pumped well water levels recovered to within at least ninety percent of the pre-pumping water level. Once sufficient time had passed for the water levels in the pumped wells to recover, the water-level data from the transducers was downloaded and graphs of drawdown and recovery versus time were developed. See Moores Initial Testimony at 5.

4 .134 These drawdown and recovery versus time graphs are, Mr. Moores testified, the key to understanding aquifer characteristics. Aquifer parameters such as transmissivity and storativity, see infra note 70, can be calculated by fitting the graphs measured during the aquifer test to graphs developed from an idealized model. For the Ross Project aquifer tests, both the drawdown and recovery curves, evaluated using applicable methods, were presented in the final aquifer test report that was part of the technical report submitted in support of SEI's license application. See Moores Initial Testimony at 5 (citing Aquifer Test Report at 1-254). Also, according to Mr. Moores, it was possible to measure the integrity of the confining layers above and below the OZ aquifer in the vicinity of the pumped well by evaluating responses, or lack thereof, recorded in the SM and DM wells. Further, referencing the aquifer test report, Mr. Moores declared that because the data collected during the aquifer tests was adequate to

develop trendlines and curves that allowed the aquifer tests to be successfully analyzed using appropriate empirical methods, the aquifer tests were of sufficient duration to meet their intended purposes. See id. at 5–6.

4 .135 Mr. Moores also indicated that the aquifer test transducers were very sensitive to even slight changes in pressure, as illustrated by the transducer in the 14-18 monitor well cluster in the DM well, which registered a change in head of 0.2 feet that was relatively minimal given the large drawdown in the OZ aquifer. According to Mr. Moores, based on his experience overseeing aquifer tests for coal mines and at other ISR operations, because the transducers are so sensitive, typically indicating aquifer communication very early in aquifer tests, it is possible to see trends that might indicate a leaking aquifer even over short pumping durations. Acknowledging that these trends become more pronounced the longer the aquifer test continues, Mr. Moores nonetheless maintained that any trend can usually be spotted within a few hours after the test begins. See id. at 6.

4 .136 Relative to the number of testing wells, Mr. Moores stated that as part of the license application SEI developed a groundwater model with the twin goals of determining hydrologic parameters (transmissivity, hydraulic conductivity, and storativity)[70] within the OZ and discovering whether there was leakage between the OZ aquifer and the overlying and underlying SM and DM water-bearing units. Combined with input from the WDEQ, this caused SEI to propose pumping tests at each monitor well cluster to obtain more hydrologic data to input into its numerical groundwater model. Prior to conducting the tests, the number and locations of the proposed pumping tests were presented in SEI's baseline sampling and analysis plan and approved by WDEQ. See Moores Rebuttal Testimony at 3 (citing Ex.

[70] Transmissivity is the flow rate of water through a vertical section of an aquifer, while hydraulic conductivity represents a measure of the capacity of a porous medium to transmit water and storativity is used to characterize the capacity of an aquifer to release groundwater from storage in response to a decline in water levels. See FSEIS 9A, at 3-34.

SEI020A, at app. E, at 1 (SEI, Preliminary Baseline Sampling Plan for the Ross ISR Uranium Recovery Project, Crook County, Wyoming (rev. May 13, 2010))). Additionally, Mr. Moores testified that besides the seven pumping tests outlined above, results from two historical pumping tests conducted in 1977 and 1978, which had results similar to the results from the more recent tests, were summarized in the license application and used in the groundwater model to increase the spatial coverage of the measured data. See id. at 3–4; Moores Initial Testimony at 7. Finally, Mr. Moores stated that the seven pumping tests were not designed or intended to demonstrate confinement throughout the entire Ross licensed area and that additional wellfield-scale pumping tests will be conducted prior to ISR operations to demonstrate adequate confinement to conduct ISR operations safely within each wellfield. See Moores Rebuttal Testimony at 4.

4 .137 For their part, staff witnesses asserted that Joint Intervenors' concern about the adequacy of the SEI pump test data to demonstrate aquifer confinement is negated by the fact that "[t]he type of pumping test used, i.e., modified single well pumping tests, are specifically listed in acceptance criterion (3) in Section 2.7.3 of NUREG-1569," the staff's ISR licensing SRP, and that "the pumping tests data were used as guidance for the numerical model of the Ross Project area that was calibrated to observed piezometric heads." Staff Initial Testimony at 63 (Burgess, Saxton) (citing NUREG-1569, at 2-23 to -24 (stating "[a]ny of a number of commonly used aquifer pumping tests may be used including single-well drawdown and recovery tests, drawdown versus time in a single observation well, and drawdown versus distance pumping tests using multiple observation wells")). This, the staff asserted, shows that the SEI pumping tests were tailored to provide accurate Ross site hydrology information. See Staff Reply Findings at 30. Along the same lines, SEI provided a USGS paper on basic groundwater hydrology stating that an aquifer test "in most cases, includes pumping a well at a

constant rate for a period ranging from several hours to several days and measuring the change in water level in observation wells located at different distances from the pumped well." Ex. SEI030, at 34 (Ralph C. Heath, USGS, Basic Ground-Water Hydrology, Water-Supply Paper 2220 (rev. 2004)).

4 .138 After reviewing the evidentiary record associated with Dr. Abitz's concerns regarding the adequacy of SEI's pump test program, we find that the preponderance of the evidence, and in particular the information provided by Mr. Moores, see supra Board Findings 4.133-4.136, supports the conclusion that the SEI pump-testing protocols, including the number and location of the testing wells and the duration of the pumping tests fall, within the appropriate parameters for conducting such tests at this facility.

4 .139 Regarding the additional, earlier referenced issue of whether the SEI pump tests demonstrated that groundwater communication exists between the SM and OZ aquifers on the Ross Project site, see supra Board Finding 4.132, as evidence of such a connection, Joint Intervenors witness Dr. Abitz in his initial testimony provided a graph of sodium concentrations plotted against sulfate concentrations for samples of groundwater collected from the OZ and SM aquifers. According to Dr. Abitz, samples collected at one of the wells screened within the OZ aquifer (14-18OZ) contained the greatest concentrations of sodium and sulfate of any of the water samples, as contrasted with wells in the SM aquifer (14-18SM, 12-18SM, 42-19SM, and 34-18SM), which show low sodium/sulfate concentrations, and thus provided an example of unmixed groundwater from the OZ. In contrast, according to Dr. Abitz, are the analyses of the samples from one of the wells screened to collect water from the OZ aquifer (12-18OZ) that plots sodium/sulfate concentrations within the range of the above-reference samples from the

SM aquifer, which he cites as strong evidence of mixing between the SM and OZ horizons.[71] See Abitz Initial Testimony at 50–51.

4 .140 While staff witnesses Burgess and Johnson recognized that the similarity of water analyses from the OZ aquifer well (12-18OZ) to waters sampled from the SM aquifer wells could, in fact, show the presence of unplugged boreholes in the vicinity of these wells, they go on to assert that "[i]t is more likely that the spread of the OZ data represents natural heterogeneity in the water chemistry, emphasized by the pumping test activities that were taking place during the period of sampling." Staff Initial Testimony at 69.

4 .141 Dr. Abitz's claim that the sodium and sulfate rich water samples from well 14-18OZ are representative of all "unmixed" groundwater in the OZ aquifer is, in the Board's estimation, little more than speculation. That being said, we also recognize that the roughly linear trend and overlap in compositions shown on his graph for various water samples from the SM and OZ aquifers are consistent with mixing. We do not find this convincing evidence of actual horizon mixing via excursions, however, concluding that the better explanation lies in the staff witnesses' assertion that the composition of groundwater in the OZ aquifer may vary considerably depending on the nature of the minerals with which the groundwater is in contact.[72]

[71] In plotting his graphic representation, Dr. Abitz also asserted that samples from an industrial well (22x-19) were collected from a screened interval that included both the OZ and SM aquifers so that analyses of these samples likewise should provide good examples of what the compositions of mixed OZ and SM groundwaters should look like. See Abitz Initial Testimony at 50. This turns out not to be the case, however, because the portion of the SEI technical report referred to in his testimony states that this well was screened through the OZ and DM aquifers and did not sample groundwater from the SM aquifer. See Staff Initial Testimony at 68 (Burgess, Johnson) (citing TR 14A, at 2-169).

[72] In making this determination, we note that Dr. Abitz's own graph suggests this may be the case. While the four sample plots for most of the OZ and SM wells are clustered in relative proximity, the sample plots for well 12-18OZ, the well plots that Dr. Abitz suggests shows strong evidence of horizon mixing, are the most widely scattered, two being within the low

(continued...)

c. Excursion Detection Issue

4 .142 Finally, as part of their challenge to the staff's FSEIS hydrology impacts assessment, Joint Intervenors have questioned the efficacy of SEI's excursion monitoring program as a means of detecting excursions. See Joint Intervenors Findings at 79–84. One aspect of this concern is that uranium is not being utilized as a chemical indicator of excursions. See id. at 81–83. Dr. Abitz noted that the FSEIS declares the indicators to be used for detecting excursions at the Ross Project will be chloride, conductivity, and total alkalinity because "'[t]hese constituents move through the aquifer faster than other water-quality parameters, and therefore levels above these would indicate excursions before radionuclides and other elements move outside the production (i.e., uranium-recovery) zone.'"[73] Abitz Initial Testimony at 41 (quoting FSEIS 9A, at 4-41 (emphasis omitted)). Citing published experimental studies entered as Joint Intervenors' exhibits,[74] Dr. Abitz maintained that this statement "is inaccurate and

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[72](...continued)
sodium/sulfate range with the other SM well plots and two being closer to the other OZ well plots in the higher sodium/sulfate range. See Abitz Initial Testimony at 50.

[73] The FSEIS indicates in this regard that

> At most in situ uranium-recovery operations, for example, chloride is selected because it does not interact strongly with the minerals in the ore zone; it is easily measured; and chloride concentrations are significantly increased during ISR operations. Conductivity, which is correlated to total dissolved solids (TDS), is also considered a good excursion indicator because of the high concentrations of dissolved constituents in the lixiviant as compared to the surrounding aquifers. Total alkalinity (carbonate plus bicarbonate plus hydroxide) is used as an indicator in wellfields where sodium bicarbonate or carbon dioxide is used in the lixiviant.

FSEIS 9A, 2-31 (citations omitted).

[74] See Abitz Initial Testimony at 42 (citing Ex. JTI022, at 1 (Gary P. Curtis, et al., Simulation of reactive transport of uranium(VI) in groundwater with variable chemical conditions, 42 Water Res. Research W04404 (2006)); Ex. JTI023, at 41 (ExxonMobil, Highland Uranium
(continued...)

presents an oversimplification of the dominant geochemical mechanisms which dictate subsurface transport of soluble uranium (i.e., uranium in the plus-six oxidation state, or U(VI)).”[75] Id. Instead, he concluded that “the aqueous uranium-carbonate species formed from lixiviant injection during [ISR] operations will be highly mobile in the groundwater.”[76] Id. at 42. As a

[74](...continued)
Mill Site, Final Closure Proposal, Casper, Wyoming (Aug. 3, 2010) (slide presentation)); Ex. JTI024, at 4435 (Ping Zhou & Baohua Gu, Extraction of Oxidized and Reduced Forms of Uranium from Contaminated Soils: Effects of Carbonate Concentration and pH, 39 Env’t. Sci. Tech. 4435 (2005))).

[75] Dr. Abitz explained further that

> [w]ithout the presence of carbonate anions, U(VI) as the uranyl ion (UO_2^{+2}) is readily adsorbed to the surfaces of various iron oxides and clays. However, with the introduction of an oxidizing, carbonate-rich lixiviant to enhance U(VI) solubility and mobility in the aquifer, uranium adsorption to iron oxide surfaces decreases, as relatively non-reactive uranyl-carbonate complexes ($UO_2(CO_3)_2^{-2}$ and $UO_2(CO_3)_3^{-4}$) form in solution.

Abitz Initial Testimony at 41–42 (citations omitted).

[76] As the basis for this conclusion, and a criticism of the FSEIS analysis (or lack of analysis) of excursion indicators, Dr. Abitz declared:

> U(VI) subsurface modeling has reported that adsorption of uranium in the subsurface is highly complex and varies spatially and temporally. Outside of reporting water-quality parameters and the slight mention of uranium minerals and pyrite in the fluvial deposits, the FSEIS presents very little about the current subsurface geochemical zonation and, more importantly, is silent on the extent to which mining activities will destroy the reducing geochemical conditions in the exempted aquifer. For example, the FSEIS is silent on the total reductive capacity of the aquifer and fails to estimate the reductive capacity of the aquifer and compare it to the expected amount of oxygen that will be injected into the aquifer to destroy the reducing conditions. This is a fundamental oxygen-balance analysis that would indicate whether sufficient reducing capability remains in the exempted aquifer after restoration to remove U(VI) carbonate species from solution by reductive precipitation to insoluble U(IV). Without this analysis, there is no logical basis to omit uranium as an excursion indicator, as the levels of uranium in the lixiviant are generally three to four

(continued...)

consequence, by not including uranium as a chemical indicator of excursions at perimeter monitoring wells, the FSEIS "fundamentally undermines the conclusions about the environmental impacts of the project on groundwater quality." Id.

4 .143 Discussions regarding this matter by the parties' witnesses in both their written and oral testimony focused on the validity of SEI and staff assertions that excursion indicators such as chloride, alkalinity, sulfate, and electrical conductivity will be detected at monitoring wells before any increase in uranium concentrations, owing principally to natural processes that remove uranium from the groundwater as it moves outward from the ore zone. In response to Dr. Abitz's claim that the presence of lixiviant would enhance the solubility and mobility of U(VI), thereby invalidating staff assumptions that uranium concentrations lag behind more "conservative" indicators such as chloride, staff witness Johnson admitted that uranium is less susceptible to removal by adsorption when it is joined or complexed with carbonate, but argued that, owing to the change in chemical environment, these complexes can break down when groundwater moves out of the OZ. Dr. Johnson also maintained that because the published studies cited by Joint Intervenors are based on controlled experiments, the results may not be applicable to the more complex and variable environments encountered in natural aquifers. See Tr. at 722–24, 728–29.

4 .144 The staff's argument in this regard is that the behavior of uranium during transport in groundwater is not yet well understood, so that its "conservative" nature is not established. Consequently, uranium is not as reliable for detecting excursions as the various aforementioned components of production fluids, a point that has also been made by several

[76](...continued)

> orders of magnitude greater than true baseline; and increases in chloride, alkalinity and TDS in the aquifer will be less than one or two orders of magnitude.

Abitz Initial Testimony at 42–43 (citations omitted).

documents prepared for, or issued by, the staff.[77] That being said, staff witness Johnson also recognized that the efficacy of possible excursion indicators depends on the geochemical environment of the aquifer system at issue. For instance, she maintained that in the case of the Ross Project, chloride, which is usually considered a conservative indicator, likely will be less effective as an indicator of vertical excursions into the DM aquifer than sulfate because of that underlying groundwater system's high chloride background. In other scenarios, alkalinity or sulfate might be affected by the geochemistry of an aquifer system. Nonetheless, according to Dr. Johnson, those three indicators, along with electric conductivity, are considered more conservative excursion indicators than uranium. See Tr. at 729–31; see also Tr. at 695–97, 702 (Schiffer).

4 .145 On balance, the evidentiary record persuades us that, as compared to other possible indicators such as chloride, alkalinity, sulfate, and electrical conductivity, uranium is not as effective a tool for providing a timely alert regarding a lixiviant excursion from an ISR facility. Yet, this would not necessarily end the matter in the face of convincing evidence that, for any particular facility, the aquifer geochemistry would make uranium equal (or better) as a well monitoring testing indicator. Based on the preponderance of the evidence before the Board, however, we conclude that the case for using uranium as an excursion indicator for the Ross Project is not compelling, particularly given Joint Intervenors' failure to present any convincing site-specific evidence to counter the staff and SEI showings that chloride and the other

[77] See Ex. NRC050, at 5 (W.J. Deutsch, et al., Pac. Nw. Lab., Methods of Minimizing Ground-Water Contamination from In Situ Leach Uranium Mining, NUREG/CR-3709 (Mar. 1985)) (stating "[m]any potential indicators (such as uranium and pH) are not conservative," in that "their values will change rapidly as the lixiviant interacts with the sediment" and "dissolved species that interact with the sediment do not travel as rapidly as the water and, thus, would not be useful as an early indicator of an excursion."); NUREG-1569, at 5-41 (stating "[u]ranium is not considered a good excursion indicator because, although it is mobilized by in situ leaching, it may be retarded by reducing conditions in the aquifer.").

indicators proposed for use by SEI and accepted by the staff would be effective excursion indicators at Ross.[78]

4 .146 Also part of Joint Intervenors' challenge to the adequacy of the FSEIS discussion of excursion detection is their assertion that, given the numerous excursions that have occurred at ISR sites that show uranium does migrate beyond the monitoring well ring, the staff's FSEIS conclusion that excursions can be detected and remedied, and thus the long term impacts from excursions will be SMALL, is unsupported in the record. See Joint Intervenors Findings at 79–81, 84 (referencing excursions at the Smith Ranch-Highland and Kingsville Dome ISR sites and citing FSEIS 9A, at 4-43). Further, according to Dr. Abitz, while the staff recognizes these uranium excursions, its mitigation/corrective action of changing pumping rates to recapture a lixiviant plume fails to have "a credible scientific basis because the FSEIS fails to address the needed detailed analysis on the hydrological properties in the exempted aquifer, redox conditions in the aquifer, the availability of various complexing anions, microbial community structure, and structural heterogeneity of the fluvial deposits." Abitz Initial Testimony at 44–45.

4 .147 In our estimation, however, in making its determination that long-term potential impacts to the OZ aquifer outside the exempted portion would be SMALL, the staff's reliance on the SEI program to detect and recover excursions via groundwater pumping is not misplaced. Because a lateral excursion would only impact the water in a non-EPA exempted aquifer if it extended beyond the monitoring ring at the Ross Project, which must be at least 100 feet inside the boundary of the exempted aquifer, see Tr. at 368–69 (Schiffer), we consider Joint

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[78] Moreover, our ruling here does not necessarily foreclose the use of uranium as an excursion indicator at the Ross Project for, as was pointed out by SEI witnesses Schiffer and Griffin, Wyoming regulations require SEI to perform a full chemical analysis of monitoring well water samples, which would include uranium, if a detected excursion has not been recovered within thirty days. See Tr. at 319–20 (Schiffer), 782–83 (Griffin).

Intervenors' focus on vertical excursions, see Joint Intervenors Findings at 79–80, as the crux of their concern. In the case of the Smith Ranch-Highland site, the document Joint Intervenors cite as evidence of the nature and extent of the vertical excursions notes that, while upgradient samples were taken to establish baseline, "[e]stablishing a single baseline class of use for all shallow [aquifers] at [Smith Ranch-Highland] is problematic due to [the] presence of abundant and sporadic natural mineralization." Ex. JTI036, at 9 (Wright Envtl. Servs., Inc. & Telesto Solutions, Inc., 2012 Status Update Case Leak Investigation, C, E and F Wellfields, Smith Ranch-Highland Operations (Feb. 20, 2013)). Because the pre-mining and upgradient water quality was highly variable, this report's authors concluded it was difficult to determine how much of the contamination in these aquifers occurred because of casing leaks during ISR mining and how much can be attributed to natural mineralization and historic surface mining. See id. at 9–12. Indeed, to the degree vertical excursions at Smith-Ranch Highland site were caused by an engineering failure, i.e., a casing leak, rather than by a failure of the basic design of the ISR facility, it provides a questionable example in support of the claim that vertical excursions are inevitable. Moreover, relative to the background data for Garcia Hills wells on the Kingsville Dome ISR site submitted by Joint Intervenors, see JTI021, at unnumbered pp. 2, 3, 6 (Carl F. Crownover, Jordan Labs., Inc., Reports of Analysis (May 12, 1988 & July 13, 2007)), the fact that these wells are "just outside" of the monitoring well ring, Joint Intervenors Findings at 81, suggests that, per the circumstances at the Ross Project, they would still be in the EPA exempted aquifer.

4 .148 Joint Intervenors also reference Dr. Abitz's blanket statement that "[a] monitor well that goes on excursion status does not prevent groundwater contamination outside the exemption zone when corrective actions are implemented, as uranium contamination has moved past the monitor-well ring when an excursion is reported," see id. at 84 (citing Abitz

Rebuttal Testimony at 17). This statement, however, does not account for (1) the evidentiary record before us, as discussed in Board Findings 4.142-4.145 above, indicating that lixiviant indicators such as chloride arrive at the monitoring wells before uranium; (2) the fact that at the Ross Project any horizontal uranium excursion would have to move at least 100 feet past the monitor well ring to exit the exemption zone; and (3) the recovery response that is triggered when an excursion is discovered, which is designed to remediate the problem before contaminants move out of the exempted aquifer.

4 .149 Finally, regarding Joint Intervenors' reference to Dr. Abitz's statement claiming the FSEIS analysis inadequately characterizes the exempted aquifer because it fails to account for "redox conditions in the aquifer, the availability of various complexing anions, microbial community structure, and structural heterogeneity of the fluvial deposits," see id. (citing Abitz Initial Testimony at 45), in the face of the evidence presented by SEI and the staff regarding the particulars of Ross Project and SEI's program for excursion detection and recovery,[79] Joint Intervenors again have not provided an adequate evidentiary basis for the Board to endorse the type of extensive analysis they seek as part of the agency's NEPA review for this (and presumably every other) ISR facility. See supra Board Finding 4.22. In a normal aquifer, what they propose is likely to require years of work by a university research team, a task that would be even more difficult in a mineralized system like the OZ aquifer beneath the Ross site with its

[79] This includes evidence regarding (1) the potential for (a) vertical excursions given the bounding properties of the upper and lower confining units and the hydraulic head difference between the OZ and SM aquifers, see Staff Initial Testimony at 43 (citing FSEIS 9A, at 3-34, 3-37, 4-42) (Burgess, Saxon); see supra note 67, and (b) horizontal excursions given the less-permeable and non-mineralized zones within the OZ sandstones, see FSEIS 9A, at 4-41; (2) SEI's license condition responsibilities to deal with unplugged or improperly plugged boreholes, see SEI License at 9 (LC 10.12); see also supra Board Finding 4.128, excursion detection (LC 11.5), see SEI License at 13–14 (LC 11.5), and mechanical integrity testing for wells on a periodic and as-serviced basis, see id. at 7 (LC 10.5); see also FSEIS 9A, at 2-23; and (3) vertical and horizontal excursion recoveries, see GEIS at 2-46 to -48; Griffin Initial Testimony at 4–5; Griffin Rebuttal Testimony at 4; Knode Initial Testimony at 13; Moores Initial Testimony at 8 (computer modeling).

numerous and profound small scale lateral and vertical heterogeneities. In this context, it may be that Joint Intervenors are seeking to have all ISR operations deferred until scientific research has progressed to the point where a complex hydrogeologic system such as that associated with the Ross Project can be completely understood. The Board, however, does not see a basis for imposing an investigative protocol under NEPA that has the practical effect of leaving essentially open-ended the question of how much information is enough.

4. Board Conclusions Regarding EC 3

4 .150 Based on the findings set forth above, the Board concludes that, with the revision to LC 10.12 outlined in Board Finding 4.131 above, a preponderance of the evidence before the Board demonstrates that (1) with the addition of the Board-directed revision to LC 10.12, the FSEIS adequately analyzes the environmental impacts of fluid migration associated with unplugged exploratory boreholes; and (2) SEI's six monitor-well clusters and the twenty-four-hour pump tests at four of these clusters and its excursion detection and recovery protocols, including the use of excursion indicators other than uranium, have provided sufficient information to demonstrate that the staff's conclusions that groundwater control during Ross Project operations would result in SMALL impacts outside the exempted portion of the OZ in the event of an excursion.

V. SUMMARY FINDINGS AND CONCLUSIONS

5 .1 With respect to Joint Intervenors' EC 1, the Board rules that (1) to comply with NEPA and the agency's Part 51 implementing regulations, the applicant's 10 C.F.R. Part 40, Appendix A, Criterion 7 pre-licensing monitoring program for the purpose of site characterization was not required to be conducted so as to provide the information needed to set Appendix A, Criterion 5B groundwater protection standards, in accord with an

Appendix A, Criterion 7A pre-operational license condition-based monitoring program; and (2) Joint Intervenors' challenges to the adequacy of the FSEIS as it was based on the supposed technical deficiencies associated with SEI's monitoring well deployment program (including well numbers and location), SEI's aquifer sampling intervals, the staff's use of sampling results averaging, the purported data bias resulting from standard SEI drilling techniques, the purported data bias resulting from SEI's sequential development of additional wellfields, and the purported data bias associated with using well samples from the Nubeth R&D site cannot be sustained based on the preponderance of the evidence in the record before the Board. As such, a judgment on the merits regarding EC 1 is entered in favor of the staff and SEI.

5 .2 With respect to Joint Intervenors' EC 2, the Board finds that (1) the bounding analysis provided in section 4.5.1.3 of the FSEIS, as supplemented in the record before this Board, provides sufficient information about a reasonable range of the hazardous constituent concentration values associated with a potential 10 C.F.R. Part 2, Appendix A, Criterion 5B(5)(c) post-operational ACL for that Ross Project so as to provide an appropriate NEPA assessment of the environmental impacts that will occur if SEI cannot restore groundwater to primary or secondary limits in accord with Criterion 5B(5)(a)-(b); and (2) the quantitative data from historical ISR groundwater aquifer restoration efforts used to create the bounding analysis in FSEIS section 4.5.1.3 does not invalidate the FSEIS conclusion that the groundwater impacts of aquifer restoration using an ACL on the exempted OZ aquifer and the surrounding aquifers would be SMALL. We thus conclude that EC 2 is resolved on the merits in favor of the staff and SEI.

5 .3 With respect to Joint Intervenors' EC 3, the Board concludes that (1) with the Board-directed revision to LC 10.12, the FSEIS adequately assesses the risk of fluid migration from unplugged and abandoned boreholes; (2) the FSEIS did not improperly assess the risk of

fluid migration in light of its reliance on SEI pump tests to demonstrate aquifer containment; and (3) the FSEIS impacts analysis is accurate in concluding that various lixiviant indicators other than uranium will serve as accurate excursion indicators and that the SEI detection and recovery protocols will result in SMALL impacts outside the exempted portion of the OZ in the event of an excursion. As a consequence, a judgment on the merits regarding EC 3 is entered in favor of the staff and SEI.

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6 .1 Pursuant to 10 C.F.R. § 2.1210, it is this twenty-third day of January 2015, ORDERED, that:

A. Condition 10.12 to license SUA-1601 is revised as set forth in Board Finding 4.128 above, and Joint Intervenors issue statements EC 1, EC 2, and EC 3 are resolved on the merits in favor of the staff and SEI, and the proceeding before this Board is terminated.

B. In accordance with 10 C.F.R. § 2.1210, this initial decision will constitute a final decision of the Commission 120 days from the date of issuance (or the first agency business day following that date if it is a Saturday, Sunday, or federal holiday, see 10 C.F.R. § 2.306(a)), i.e., on Tuesday, May 26, 2015, unless a petition for review is filed in accordance with 10 C.F.R. § 2.1212, or the Commission directs otherwise. Any party wishing to file a petition for review on the grounds specified in 10 C.F.R. § 2.341(b)(4) must do so within twenty-five (25) days after service of this initial decision. The filing of a petition for review is mandatory for a party to have exhausted its administrative remedies before seeking judicial review. Within 25 days after service of a petition for review, parties to the proceeding may file an answer supporting or opposing Commission review. Any petition for review and any answer shall conform to the requirements of 10 C.F.R. § 2.341(b)(2)-(3).

THE ATOMIC SAFETY
AND LICENSING BOARD[80]

/RA/

G. Paul Bollwerk, III, Chairman
ADMINISTRATIVE JUDGE

/RA/

Craig M. White
ADMINISTRATIVE JUDGE

Rockville, Maryland

January 23, 2015

[80] Dr. Richard F. Cole, a full-time technical member of the Atomic Safety and Licensing Board Panel who served with distinction beginning in 1973, was a member of this Licensing Board from its inception and participated in the September 28 limited appearance session and the September 30-October 1, 2014 evidentiary hearing. Judge Cole passed away in December 2014 before this decision was finalized.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of	)	
	)	
Strata Energy, Inc.	)	Docket No. 40-9091-MLA
(Ross In Situ Recovery Uranium Project)	)	
	)	
(Materials License Application)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing **INITIAL DECISION LBP-15-3 (Ruling on Joint Intervenors' Environmental Contentions 1 – 3)** have been served upon the following persons by Electronic Information Exchange.

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[Original signed by Brian Newell]
Office of the Secretary of the Commission

Dated at Rockville, Maryland
this 23rd day of January, 2015