SEI026

August 25, 2014

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judges:

G. Paul Bollwerk, III, Chairman
Dr. Richard F. Cole
Dr. Craig M. White

In the Matter of:	)	
	)	
Strata Energy, Inc.	)	Docket No. 40-9091-MLA
	)	ASLBP No. 12-915-01-MLA-BD01
	)	
(Ross In Situ Recovery	)	
Uranium Project)	)	

INITIAL WRITTEN TESTIMONY OF HAL DEMUTH AND ERROL LAWRENCE

TABLE OF CONTENTS

1.0 WITNESS BACKGROUND INFORMATION

Q.1. Please state your name, position and employer, including duration of employment.
A.1.a Hal Demuth. I am a senior engineer/hydrologist and principal of Petrotek Engineering Corporation, where I have been employed since 2001. My *curriculum vitae* is included as Exhibit SEI027.

A.1.b Errol Lawrence. I am a senior hydrologist employed by Petrotek Engineering Corporation since 2004. My *curriculum vitae* is included as Exhibit SEI028.

Q.2. Please state your education, professional registration and memberships.
A.2.a (H. Demuth) I hold an M.S. in Hydrogeology from the University of Idaho and a B.S. in Petroleum Engineering from the University of Tulsa. I am a member of the Association of Ground-water Scientists and Engineers (NGWA), the Society of Petroleum Engineers (SPE) and the Society of Mining Engineers (SME).

A.2.b (E. Lawrence) I hold an M.S. in Geological Engineering from the Colorado School of Mines and a B.S. in Geology from Northern Arizona University. I am a registered professional geologist in Wyoming and Texas and a member of the National Ground Water Association, American Institute of Professional Geologists, and the National Water Well Association.

Q.3. What ISR projects have you worked on while with Petrotek and other entities?
A.3.a (H. Demuth) I have worked on 19 uranium ISR projects in the U.S. In addition to the Ross ISR Project, these have included 11 Wyoming projects (Irigaray Ranch, Christensen Ranch, Reno Creek, Ludeman, Allemand Ross, Lost Creek, Jab/Antelope, Moore Ranch, Smith Ranch/Highland, Reynolds Ranch and Hank-Nichols), 4 Nebraska projects (Crow Butte, North Trend, Three Crow and Marsland), 1 South Dakota project (Dewey-Burdock) and 2 Texas projects (Holiday El-Mesquite and La Palangana).

A.3.b (E. Lawrence) I have worked on more than a dozen uranium ISR projects in the U.S., Paraguay, Turkey and Kazakhstan. In addition to the Ross ISR Project, other U.S. projects I have worked on include nine Wyoming projects (Irigaray Ranch, Christensen Ranch, Willow Creek, Lost Creek, Moore Ranch, Allemand Ross, Reno Creek, Ludeman, and Smith Ranch/Highland), one South Dakota project (Dewey-Burdock) and two Texas projects (Holiday El-Mesquite and La Palangana).

Q.4. How many of these projects have involved groundwater characterization?
A.4. (H. Demuth and E. Lawrence) All of them to some degree.

Q.5. How have you been involved with groundwater characterization at uranium ISR facilities?

A.5. (H. Demuth and E. Lawrence) We have been involved in the preparation of permit and license applications, including evaluating the regional and site groundwater hydrology, evaluating site-wide baseline groundwater quality characteristics, developing conceptual hydrologic models, and preparing numerical groundwater models as well as designing, conducting, and analyzing aquifer pumping tests. We have worked directly with NRC staff, using their guidance to provide them the information necessary for their review and acceptance of permit and license applications. We have often responded directly to NRC requests for additional information (RAIs) during the permit/license review process. We have participated in numerous public meetings with NRC staff to discuss characterization plans, results from field testing, development of the hydrogeologic conceptual models, groundwater modeling approaches and modeling results. We also have been involved with post-license groundwater characterization, including designing and conducting wellfield pumping tests and evaluating the effectiveness of groundwater restoration.

Q.6. What has been your role in the Ross ISR Project?

A.6.a (H. Demuth) I oversaw preparation of the Class I UIC permit application for the Ross Project deep disposal wells as well as providing peer review of the hydrogeologic sections of the license application, including portions of Technical Report (TR) Sections 2.6 (Geology, Exhibit SEI014A at 131-179) and 2.7.3 (Groundwater, Exhibit SEI014A at 193-223). In addition, I oversaw detailed, pre-submittal review of key addenda to the TR including Addendum 2.7-F (Aquifer Testing, Exhibit SEI014G at 139-397).

A.6.b (E. Lawrence) I participated in a detailed review of TR addenda 2.7-H (Ground Water Model, Exhibit SEI014H at 27-201).

Q.7. Would you explain how groundwater characterization is done for a uranium ISR project?

A.7. (H. Demuth and E. Lawrence) As will be explained in greater detail in the written testimony below, groundwater characterization is a phased process. During preparation of a source and byproduct material license application for a uranium ISR facility, data are collected to characterize the project area and surrounding region, including its geology, groundwater hydrology and groundwater quality in the various aquifers. The purpose of this site characterization is to demonstrate that suitable hydrologic conditions are present to safely conduct uranium ISR. Following license issuance but prior to operating each ISR wellfield, additional characterization is done on the geology, groundwater hydrology and groundwater quality of that wellfield. This information is summarized in a wellfield package prepared for each wellfield.

Q.8. In your experience please describe generally what type of groundwater characterization information is contained in the license application as compared with the wellfield packages.

A.8. (H. Demuth and E. Lawrence) The NRC guidance document NUREG-1569, (Exhibit SEI007) describes the information needed for license applications in Section 2. This includes descriptions of regional and site geology, a description of the hydraulic properties of the production zone aquifer, sufficient information on aquitard units to demonstrate that ISR solutions can be confined to the production zone sufficiently to safely conduct ISR operations, and groundwater quality characterization of the production zone aquifer and overlying and underlying aquifers. The application typically includes the results of one or more aquifer tests used to determine the hydraulic characteristics of the production zone aquifer including hydraulic conductivity, transmissivity and storativity. These aquifer tests (also referred to as pumping tests) are also used to characterize the confining properties of low-permeability overlying and underlying units referred to as aquitards. A conceptual hydrologic model is prepared to characterize the regional and site hydrology. Although not specifically required by NUREG-1569, for some ISR operations, a numerical groundwater flow model is prepared.

In addition to providing site-wide groundwater characterization information in the application, the applicant is also required to describe the procedures that will be used to assess the geology, groundwater hydrology and adequacy of the monitoring well network of each wellfield prior to operations. These procedures are described in Section 5 of NUREG-1569 and include items like detailed delineation drilling, preparing wellfield-specific geologic maps depicting the thickness and continuity of confining units, installing monitor well networks to detect the potential horizontal or vertical movement of ISR solutions away from the production zone, and verifying the effectiveness of the monitor well networks through pumping tests that are conducted for each wellfield. NRC staff also review the procedures used to sample pre-operational baseline groundwater quality in each wellfield and calculate Commission-approved background (CAB) water quality that is used to set restoration goals and upper control limits (UCLs) that are used for excursion monitoring.

The wellfield-specific data are collected after license issuance and wellfield construction, but before operating each wellfield. NRC regulations in 10 CFR 40.32 prohibit installing the monitor well network for the wellfields that would be needed to collect the wellfield-specific data prior to license issuance (refer to ¶A.13 and ¶A.21 of this written testimony for more information). Based on my experience, this phased, performance-based licensing approach has been used at ISR facilities in Nebraska and Wyoming for decades.

Q.9. Would you please explain for background information what an aquifer is?

A.9. (H. Demuth and E. Lawrence) Please refer to Exhibit SEI029, which is a conceptual diagram of a two-aquifer system that has been modified from U.S. Geological Survey Water-Supply Paper 2220 (Exhibit SEI030). It notes that an aquifer "is a rock unit that will yield water in a usable quantity to a well or spring" (definition and original figure found in Exhibit SEI030 at 11). The shallower aquifer (colored in blue) is an unconfined aquifer, meaning that it does not

have an overlying geologic confining unit. This is also known as a “water table aquifer.” A well drilled in the shallower aquifer will be a “water table well,” meaning the water level in the well is the same as the water level in the aquifer.

The conceptual diagram depicts a confining clay unit under the shallow aquifer, below which is a deeper aquifer. This aquifer is geologically confined, meaning that there is an overlying, geologic confining unit, also referred to as an aquitard, that will restrict groundwater flow. A well drilled into a confined aquifer may be an artesian well, meaning that the water level (also known as potentiometric surface) is above the top of the aquifer. In some cases the potentiometric surface will be above ground surface, in which case the well will be known as a flowing artesian well, which will flow at the surface without pumping.

Within an aquifer, water flows by porous media flow in interstitial spaces between the sand grains that make up the aquifer. This is depicted in the enlargement on the right of the conceptual diagram.

Q.10. Is it required that ISR take place in an aquifer?

A.10. (H. Demuth and E. Lawrence) Yes. This is described in the National Mining Association’s Generic Environmental Report (GER) prepared in support of the GEIS (Exhibit SEI031 at 38, emphasis in original):

> “For a uranium ore body to be amenable to ISR uranium recovery using the typical recovery chemistry noted above, the ore zone must be saturated with relatively fresh water and the rock must have enough transmissivity for water to flow from injection to extraction wells. In other words, for ISR uranium recovery to work, the ore must be situated in an aquifer. *There are no ISR uranium recovery operations in ore bodies that are not in aquifers.”*

Q.11. Will you please briefly describe the ISR process?

A.11. (H. Demuth and E. Lawrence) Yes. The following description of the ISR process is summarized from the GER (Exhibit SEI031 at 37-40).

> ISR leaves the underground ore body in place and continuously re-circulates native groundwater, which has been fortified with oxygen and carbon dioxide, through the aquifer in which the ore body [is located]. Uranium deposits amenable to the ISR process occur in permeable sand or sandstones that are confined above and below by less permeable strata. These formations may either be tabular or C-shaped deposits within a permeable sedimentary layer formed as “roll-fronts.” These uranium-bearing formations were formed by the lateral movement of groundwater bearing minute amounts of oxidized uranium in solution through the aquifer with precipitation of the uranium occurring when oxygenated waters encounter a low oxygen reducing interface, causing precipitation of uranium minerals along that boundary. Most, if not all, of these *redistributed* ore deposits are present in sediments that have fluvial origins, which are common to ISR-amenable

deposits in the states of Nebraska, Texas, Wyoming, South Dakota, Colorado, and New Mexico.

[T]he geologic structure and conditions in an ISR-amenable uranium ore body provide adequate natural safeguards against potential environmental impacts. After the uranium recovery and groundwater restoration operations cease, reducing conditions return over time. The same reducing processes that originally minimized the mobility of uranium and created the ore zone, continue to minimize its mobility after operations are complete. As a result, the uranium and other minerals remain in close proximity to the ore zone.

[T]he operational process of developing an ISR project site provides further safeguards against potential environmental impacts. After an ore body that is amenable to ISR is identified, the licensee develops well field designs to progressively remove uranium from the identified ore body. Well field design is based on grids with alternating extraction and injection wells, monitor wells above and below the recovery zone, and a ring of monitor wells surrounding the entire recovery zone to detect any potential *excursions* of recovery solutions from the uranium recovery production zone.

During active operations, native groundwater from the recovery zone in the aquifer is pumped to the surface for fortification with oxygen and carbon dioxide. This fortified water … is then circulated in the recovery zone through a series of *injection* wells in varying patterns in the well fields. The volume of water withdrawn from *extraction wells* in these patterns exceeds the volume injected into the patterns creating a "cone of depression" that assures a net inflow of water into the recovery zone. This ensures no horizontal or vertical water movement from the small portion of the aquifer where ISR operations will occur, towards adjacent, non-exempt underground sources of drinking water (USDWs).

The extraction pumping causes the injected recovery solutions to move through the uranium ore body oxidizing and solubilizing the uranium present in the host sandstone. The water from the extraction wells is then run through ion exchange (IX) columns containing synthetic resins, which remove the uranium [,which is processed,] dewatered and dried to produce saleable yellowcake.

After uranium removal in the IX column, the water in the circuit is re-fortified and re- injected as part of a continuous process until the uranium in the ore zone is exhausted. After active ISR operations cease, the groundwater in the recovery zone is restored *consistent with baseline* or other water quality criteria that are approved by NRC prior to the commencement of active ISR operations.

Q.12. Do you have a visual aid to depict the typical ISR process?

A.12. (H. Demuth and E. Lawrence) Strata developed two generic figures, provided in Exhibit SEI032, that depict typical ISR uranium operations. These figures depict ISR operations within the wellfield as well as provide a schematic overview of an ISR facility.

2.0 CONTENTION 1 - ALLEGED FAILURE OF THE FSEIS TO ADEQUATELY CHARACTERIZE BASELINE (i.e. ORIGINAL OR PREMINING) GROUNDWATER QUALITY

Q.13. What is the nature of your testimony regarding this contention?

A.13. (H. Demuth and E. Lawrence) According to NRC regulations and guidance, a license applicant is not permitted until after license issuance to install a complete wellfield monitor well network that is used to establish Commission-approved background (CAB) groundwater quality within the production zone of each wellfield and upper control limits (UCLs) that are used for excursion monitoring in underlying, overlying and perimeter monitor wells. Applicable guidance documents and regulations that support this conclusion include 10 CFR § 40.32(e) and NUREG-1569. This is summarized in NUREG-1569 (Exhibit SEI007 at 28):

> "Beginning construction of process facilities, well fields, or other substantial actions that would adversely affect the environment of the site, before the staff has concluded that the appropriate action is to issue the proposed license, is grounds for denial of the application [10 CFR 40.32(e)]."

2.1 Acquisition of Baseline Groundwater Quality Data is a Phased Process

Q.14. Please respond to the allegations that NRC Staff will require additional data in order to establish a credible baseline for use in the regulatory process, and the applicant has failed to adequately define the specific aquifer restoration criteria/standards during the NEPA process (Moran 2011 ¶70, Sass 2011 ¶23, Abitz 2013 ¶28).

A.14. (H. Demuth and E. Lawrence) These allegations demonstrate a clear lack of understanding of the different phases of baseline groundwater quality data collection for an ISR facility. In order to permit an ISR facility, the applicant must demonstrate the adequacy of site characterization baseline groundwater quality in conformance with NUREG-1569 Section 2. Such data are collected on a site-wide basis. At the same time the applicant must demonstrate appropriate <u>procedures</u> for establishing pre-operational groundwater quality data and target restoration values (TRVs) for each wellfield in conformance with NUREG-1569 Section 5. It is not until after license issuance that the licensee is permitted to install the wellfield monitoring networks that allow the collection of pre-operational groundwater quality data for each wellfield that are necessary to establish CAB, UCLs and TRVs.

Q.15. Is there information in NRC regulatory guidance that addresses the different phases of baseline groundwater quality data collection?

A.15**.** (H. Demuth and E. Lawrence) Yes. NUREG-1569 clearly defines three phases of groundwater monitoring (Exhibit SEI007 at 133):

> "There are three distinct phases of ground-water and surface-water monitoring: pre-operational, operational, and restoration. Pre-operational monitoring is conducted as a part

of site characterization, and review procedures are in Section 2 of this standard review plan."

Q.16. Does the regulatory guidance describe the pre-operational groundwater quality data that are considered "operational" and "restoration" data?
A.16. (H. Demuth and E. Lawrence) Yes. This is described in Sec. 5.7.8.2 of NUREG-1569 (Exhibit SEI007 at 134):

> "Well field hydrologic and water chemistry data are collected before *in situ* leach operations to establish a basis for comparing operational monitoring data. Hydrologic data are used to (i) evaluate whether the well field can be operated safely, (ii) confirm monitor wells have been located correctly, and (iii) design aquifer restoration activities. Water chemistry data are used to establish a set of water quality indicators, and the concentrations of these indicators in monitoring wells are used to determine whether the well field is being operated safely. Water chemistry data are also used to set the water quality standard for restoring the production zones and adjacent aquifers after *in situ* leach extraction ceases."

Q.17. When are "operational" and "restoration" data collected?
A.17. (H. Demuth and E. Lawrence) Prior to operating each wellfield, the operator must establish baseline groundwater quality for that wellfield in order to define TRVs and UCLs. However, it is not the baseline groundwater quality for each wellfield that is required at the licensing stage but the <u>procedures</u> for establishing future pre-operational groundwater quality for each wellfield. This is clearly illustrated by NUREG-1569 acceptance criterion 5.7.8.3(1), the first paragraph of which states (Exhibit SEI007 at 136, emphasis added):

> "For **each new well field**, the **applicant's approach for establishing baseline water quality data** is sufficient to (i) define the primary restoration goal of returning each well field to its pre-operational water quality conditions and (ii) provide a standard for determining when an excursion has occurred. The reviewer should verify that acceptable procedures were used to collect water samples, such as American Society for Testing and Materials D4448 (American Society for Testing and Materials, 1992). The reviewer should also ensure that acceptable statistical methods are used to meet these three objectives, such as American Society for Testing and Materials D6312 (American Society for Testing and Materials, 1998)."

Several important conclusions can be drawn from this citation from NUREG-1569:

- NUREG-1569, which is the primary guidance document for preparing and reviewing license applications for uranium ISR facilities, includes pre-licensing, site characterization baseline groundwater sampling requirements in Section 2 that are different from the pre-operational groundwater sampling requirements in Section 5; this is self-evident based on the titles of Section 2 (Site Characterization) and Section 5 (Operations).

To comply with the provisions of NUREG-1569:

- A license applicant characterizes site-wide baseline groundwater quality in conformance with Section 2 of NUREG-1569.
- A license applicant establishes pre-operational groundwater quality for each wellfield pursuant to Section 5 (Operations), under which the applicant shows that the procedures for obtaining such information conform to NUREG-1569 acceptance criteria, specifically 5.7.8.3(1).
- All acceptance criteria in Section 5 are clearly in reference to operations as opposed to site characterization (Section 2).
- "[E]stablishing baseline water quality data" for "each new well field" is clearly part of operations (Section 5).

Q.18. Do ISR licenses typically require specific procedures for establishing pre-operational groundwater quality data for each wellfield?
A.18 (H. Demuth and E. Lawrence) Yes. The guidance in NUREG-1569 for collecting pre-operational groundwater quality data for each wellfield and establishing CAB, UCLs and TRVs based on these data typically are included in an ISR license as standard or facility-specific conditions that in turn reference or 'tie-down' to detailed sections of the approved license application. These procedures are described in the FSEIS for the Ross ISR Project (see, for example, Exhibit SEI009A at 109-110).

Q.19. Do you know whether Strata's license contains conditions that address these procedures?
A.19. (H. Demuth and E. Lawrence) Yes. License condition (LC) 10.13 lists the requirements for wellfield packages, including providing "baseline values to establish ground water protection standards and Upper Control Limits (UCLs) for the Wellfield in accordance with LC 11.3" (Exhibit SEI015 at 9). LC 11.3 lists the requirements for establishing background water quality in the ore zone, perimeter monitor wells and overlying and underlying aquifers (Exhibit SEI015 at 12-13). LC 11.4 contains the requirements for establishing UCLs for perimeter monitor wells and for monitor wells completed in the overlying and underlying aquifers (Exhibit SEI015 at 13).

Q.20. Are you aware of anything that would have prevented Strata from establishing Commission-approved background (CAB), upper control limits (UCLs) and target restoration values (TRVs) for each wellfield prior to license issuance?
A.20. (H. Demuth and E. Lawrence) Yes. As described in ¶A.13 of this initial testimony, 10 CFR 40.32(e) and guidance in NUREG-1569 indicates that installing all of the production zone wells, underlying monitor wells, overlying monitor wells and perimeter monitor wells needed to establish CAB, UCLs and TRVs for an entire ISR wellfield specifically is prohibited prior to license issuance.

NRC staff's position on pre-license construction of a wellfield monitoring network is also described in the July 24, 2009 letter from NRC staff to Lost Creek ISR, LLC (Exhibit SEI033 at 1), which states:

> "The NRC staff's interpretation of 10 CFR 40.32(e) is that installation of a limited number of wells for pumping tests and baseline data collection for the site is permitted under 10 CFR 40.32(e). However, installation of the monitoring well network for a specific wellfield goes well beyond that needed for background data collection, and bears on how a licensee will ensure that public health and safety and the environment will be protected during operation. Accordingly, the NRC staff concludes that such activities are not permitted under 10 CFR 40.32(e) and can only be performed after a license is issued."

Q.21. Has it been your experience that this phased approach to collecting baseline groundwater quality data is commonly used at ISR facilities?

A.21. (H. Demuth and E. Lawrence) Yes, Strata's phased approach to licensing and developing a uranium ISR facility is the same approach that has been used in the industry for decades and that has been recently approved by the NRC in source and byproduct material licenses issued for the Moore Ranch Project (SUA-1596, issued 2010), Nichols Ranch Project (SUA-1597, issued 2011), Lost Creek Project (SUA-1598, issued 2011) and Dewey-Burdock Project (SUA-1600, issued 2014).

Q.22. It has been alleged that in the course of simultaneously constructing, operating, and restoring numerous individual wellfields in sequence that post-licensing, pre-operational water quality may be degraded in adjacent wellfields (Abitz 2013 ¶17). In your experience, how do ISR operators typically protect against degradation of the aquifer outside of the operational wellfield?

A.22. (H. Demuth and E. Lawrence) Typically in an operating wellfield the operator extracts more water from the wellfield than is reinjected back into the aquifer (this is referred to as bleed). The bleed forms an inward hydraulic gradient within the wellfield which means that fresh water from outside of the wellfield is drawn into the wellfield. Most uranium recovery licensees (including Strata's Ross ISR Project) have a license condition requiring maintaining a net inward hydraulic gradient through production and restoration phases. This prevents water from leaving the active wellfield and potentially contaminating areas outside of the active wellfield. Operational monitoring, including excursion monitoring, is used to verify that ISR solutions do not migrate away from the wellfield. Section 4.1 of this testimony describes wellfield control in more detail.

Q.23. Please explain how the monitor well network will be used to verify that adjacent areas are not being impacted by wellfield operations.

A.23. (H. Demuth and E. Lawrence) NRC regulations and facility-specific license conditions require installation of a monitor well ring surrounding the active wellfield. Each monitor well

will be sampled at least twice monthly to ensure that no operational fluids have reached the monitor well. As described in more detail in ¶A.29 of this testimony, by actively monitoring for water chemistry changes at the monitor well rings Strata will demonstrate that adjacent areas are not being impacted by operations in the active wellfields. The perimeter monitor well network around each wellfield also is used to confirm hydraulic wellfield control. This is done by monitoring the water level in each perimeter well and comparing the levels to pre-operational levels to ensure that an inward hydraulic gradient is maintained. Water level monitoring typically provides an early warning of a potential imbalance before water chemistry changes would actually be detected through excursion sampling.

2.2 Drilling and Well Completion Methods Employed at the Ross Project Conform to Standard Industry Practices

Q.24. Based on your experience at other ISR sites, do the borehole drilling methods employed at the Ross ISR Project differ from methods used at other facilities?
A.24. (H. Demuth and E. Lawrence) Based on a review of drilling methods, borehole drilling at the Ross ISR Project has been conducted in accordance with standard industry practices.

Q.25. Are the monitor well drilling and construction methods used at the Ross ISR Project different from techniques employed at other ISR sites you have been involved with?
A.25. (H. Demuth and E. Lawrence) No. Based on previous experience, monitor well construction at the Ross ISR Project conforms to standard industry practices used at ISR operations in Wyoming, Nebraska, and Texas.

2.3 Baseline Water Quality Does Not Have to Exceed EPA MCLs in Order to Permit or Operate an ISR Project

Q.26. It has been alleged that the methods used in the application to determine whether the water quality in the baseline wells exceeds EPA MCLs are incorrect and in some cases there are not sufficient data to make this determination (Abitz and Larson 2014 ¶26, 27, 28, 30). Is it necessary for Strata to demonstrate that baseline groundwater quality exceeds EPA MCLs in order to permit the Project?
A.26. (H. Demuth and E. Lawrence) No. Whether or not the pre-operational baseline groundwater quality in the production zone and surrounding aquifers is above or below EPA MCLs does not affect how the Ross ISR Project will be (or has been) permitted; however, it is noted that various site specific parameters such as uranium, radium and heavy metals frequently will exceed the relevant MCLs. For example, baseline groundwater quality did not serve as a primary basis for EPA to exempt a portion of the ore zone aquifer for ISR operations. EPA's aquifer exemption approval of a portion of the production zone aquifer at Strata's Ross Project describes the basis for the aquifer exemption under 40 CFR § 146.4 (Exhibit SEI034 at 2):

- it does not currently serve as a source of drinking water (40 CFR §146.4(a)), and

- it 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)(l).).”

The FSEIS (Exhibit SEI009A) similarly describes the procedure for obtaining an aquifer exemption for Class III wells at 96:

> “…the portions of an aquifer designated for uranium recovery must be exempted as an underground source of drinking water (USDW) by the EPA and reclassified by the WDEQ/Water Quality Division (WQD) in accordance with the Safe Drinking Water Act (SDWA). Outside of the aquifer-exemption boundary, the aquifer is still protected as a source of drinking water because the governing regulations regarding underground injection found at 40 CFR Part 144.12 prohibit the movement of any contaminant into the underground source of drinking water which is located outside the aquifer-exemption boundary.”

Q.27. Is it necessary for Strata to demonstrate that baseline groundwater quality exceeds EPA MCLs in order to operate the Project?

A.27. (H. Demuth and E. Lawrence) No. Whether or not the pre-operational baseline groundwater quality in the production zone and surrounding aquifers is above or below EPA MCLs also does not affect how the Ross ISR Project will be operated. For example, LC 11.3 (Exhibit SEI015 at 12-13) requires Strata to establish, prior to operating each wellfield, Commission-approved background (CAB) water quality for the ore zone, underlying aquifers, overlying aquifers and the perimeter monitoring areas. In the procedures for determining CAB, which are provided LC 11.3, no mention is made of EPA MCLs; CAB will be determined based on the post-licensing, pre-operational groundwater quality in and surrounding each wellfield.

Similarly, excursion monitoring upper control limits (UCLs) will be established as a function of the post-licensing, pre-operational baseline groundwater quality for the underlying aquifers, overlying aquifers and perimeter monitoring areas. Calculation methods for UCLs, as documented in LC 11.4 (Exhibit SEI015 at 13), do not consider whether the baseline groundwater quality is above or below EPA MCLs.

3.0 CONTENTION 2 – ALLEGED FAILURE OF THE FSEIS TO ANALYZE THE ENVIRONMENTAL IMPACTS THAT WILL OCCUR IF THE APPLICANT CANNOT RESTORE GROUNDWATER TO PRIMARY OR SECONDARY LIMITS

3.1 Restoration Methods that Will Be Used at the Ross Site Are the Same Methods Used Successfully at Other ISR Facilities

Q.28. Please respond to the allegation that the ISL industry has historically had and continues to struggle with the inability to control aquifer contamination (Viviano 2011 ¶7, Moran 2011 ¶75, Abitz 2013 ¶27).

A.28. (H. Demuth and E. Lawrence) This allegation is unsupported by facts. This is a heavily regulated industry that has been successful at protecting groundwater resources for decades. In order to commence uranium ISR, a project must be fully permitted at multiple levels of government, which includes reclassification of the host aquifer by the state or EPA then exempting it from the Safe Drinking Water Act by the EPA. It is common for intervenors in these proceedings to point to excursions at operating ISR facilities as evidence that uranium ISR is unsafe or causes significant environmental impacts. However, excursions are merely the detection of nonhazardous indicator parameters (typically alkalinity, chloride and electrical conductivity) at a monitor well that provide early warning that corrective actions are needed to prevent groundwater contamination outside of the exempted aquifer. The important point here is that an excursion is not a violation of regulations or license conditions; rather it is an indication that mining fluids may be migrating away from the hydraulic control of the wellfield unless corrective action is undertaken. The ultimate point of compliance is the aquifer exemption boundary not the monitor well itself. As described in Exhibit SEI034 (at 1) the aquifer exemption boundary for the Ross ISR Project extends 100 feet beyond the monitor well ring. The excerpt below from the Moore Ranch FSEIS further illustrates how NRC defines an excursion (Exhibit SEI036 at 479, emphasis added):

> "**NRC does not define an excursion as contamination that moves into a USDW. An excursion is defined as an event where a monitoring well in overlying, underlying, or perimeter well ring detects an increase in specific water quality indicators, usually chloride, alkalinity and conductivity, which may signal that fluids are moving out from the wellfield**. These specific water quality parameters are used because they are present in high concentrations in the ISR production fluids and are "conservative" in the sense that they move at roughly the same rate as the groundwater flow and are not significantly attenuated by adsorption or reduced by other factors. **Therefore, they serve as early indicators of imbalance in the wellfield flow system to notify operators to take appropriate actions**. The perimeter monitoring wells are located in a buffer region surrounding the wellfield within the exempted portion of the aquifer. These wells are specifically located in this buffer zone to detect and correct an excursion before it reaches a USDW. The overlying and underlying monitoring wells are located in aquifers that are separated from the ore zone by aquitards, which NRC has determined have sufficient thickness and integrity to prevent an excursion. However, in all cases, any excursion that lasts longer than 60 days is required to undergo corrective action to meet the drinking water protection standards in 10 CFR Part 40, Appendix A, Criterion 5B 5. **To date, no excursions from an NRC-licensed ISR facility has contaminated a USDW**."

Also with respect to excursions at NRC-licensed ISR facilities, this is addressed in a July 10, 2009 memorandum from NRC Staff to the Commissioners, in which NRC Staff reviewed records from licensed ISR facilities and made the following conclusion (Exhibit SEI004A at 1-2, emphasis added):

> "With regard to the migration of production liquids toward the surrounding aquifer, each licensee must define and monitor a set of nonhazardous parameters to identify any unintended movement toward the surrounding aquifer. Exceedances of those parameters result in an event termed an excursion; excursion events are not necessarily environmental impacts but just indicators of the unintended movement of production fluids. The data show over 60 events had occurred at the 3 facilities. For most of those events, the licensees were able to control and reverse them through pumping and extraction at nearby wells. Most excursions were short-lived, although a few of them continued for several years. **None had resulted in environmental impacts**."

NUREG/CR-6733 similarly addresses the history of excursions at U.S. ISR facilities and the finding that no off-site impacts have resulted (Exhibit SEI037 at 83, emphasis added):

> "It is worth noting that, although the detection of horizontal and vertical excursions is frequent enough to be of concern, **there were no reports of extraction fluid excursions being detected in off-site water supplies in any of the documentation for U.S. uranium ISL sites reviewed for this report**. Therefore, for purposes of the following analyses of excursion risks, it is assumed that available technology and the resources set aside by surety arrangements would be sufficient for remediation of potential horizontal or vertical excursions before they could cause contamination of off-site water supplies. It is further assumed that current regulatory monitoring requirements are sufficient to preclude systematic or persistent human errors (e.g., failure to follow approved monitoring procedures) that might result in off-site excursions of uranium ISL fluids."

"Since the allegation is attacking the "ISL industry" as a whole, it is also relevant to point out the Texas Commission on Environmental Quality's determination that decades of ISR in Texas have not resulted in off-site groundwater contamination (Exhibit SEI038 at 48):

> "The Executive Director is not aware of a documented case in over 30 years of *in situ* mining of off-site groundwater contamination from *in situ* uranium mining in South Texas."

Q.29. It has been alleged that it will not be possible to restore the wellfields to baseline values (Abitz 2011 ¶29; Abitz 2013 ¶24, 27 Abitz and Larson 2014 ¶31). Is it necessary to restore all constituents in the aquifer to baseline values in order to demonstrate regulatory compliance for aquifer restoration?

A.29. (H. Demuth and E. Lawrence) No it is not. It has been our experience that for NRC-licensed ISR facilities, licensees are required to restore groundwater to appropriate groundwater quality standards under 10 CFR 40 Appendix A, Criterion 5B (5). This criterion states that for aquifer restoration to be achieved, the concentration of a hazardous constituent, measured at the point of compliance, must not exceed:

(a) The NRC Commission-approved background concentration of that constituent in ground water;
(b) The respective value given in the table in paragraph 5C (usually a drinking water standard) if the constituent is listed in the table and if the background level of the constituent is below the value listed; or
(c) An alternate concentration limit (ACL) established by the NRC.

Conceptually, background concentrations pose no incremental hazards to human health and the environment and the drinking water limits in paragraph 5C were developed by EPA specifically to be protective of human health, but these two options may not be practically achievable at a specific site. It has been our experience that ACLs may be proposed by licensees for NRC staff consideration, but only after attempting practicable corrective actions and providing a robust technical assessment of the fate and transport and exposure hazards of the constituent(s).

Q.30. Do you have any experience in the ACL application process?
A.30. (E. Lawrence) Yes. I was a Project Leader on the ACL application for the Umetco Minerals Corporation Gas Hills Uranium Mill in Wyoming, an UMTRCA Title II site that was being decommissioned and undergoing final groundwater restoration. The Gas Hills ACL application was reviewed and accepted by the NRC staff in 2001. I was also involved in the ACL application for the Umetco Minerals Corporation Uravan Uranium Mill Site in Colorado. The Uravan ACL application was reviewed and accepted by the Colorado Department of Public Health and the Environment in 2003. In 2011, I provided third party review and comment on the ExxonMobil Highland Reclamation Project License Amendment Request, which was an application to revise ACLs for a former uranium mill and mine site in Wyoming.

Q.31. In your experience, what is required for an ACL application?
A.31. (E. Lawrence). It has been my experience that an ACL application must contain sufficient site-specific information to demonstrate that an elevated concentration of a certain constituent will not pose a substantial present or future hazard to human health or the environment, as long as the proposed ACL is not exceeded at the Point of Compliance (POC), and that the ACL is as low as reasonably achievable (ALARA), considering practicable corrective actions. The application must assess the hazards of the constituent(s) in question and evaluate the consequences presented by potential exposure to the constituent(s).

An ACL application typically requires several key components including,

- detailed description of the site/facility including physiography, meteorology, operational history, geology, hydrology, geochemistry and nature and extent of contamination,
- a hazard assessment, including source term and contaminant characterization, transport assessment and exposure assessment,

- a corrective action assessment, including summary and evaluation of corrective action (restoration operations), an ALARA analysis of implemented corrective actions, and feasibility of alternate corrective actions, and
- proposed ACLs, and definition of the POC and Point of Exposure (POE).

The application must include enough detailed information to allow the NRC reviewer to independently verify that the proposed ACL will not pose a significant present or future hazard to human health or the environment and that the limit is ALARA, considering practicable corrective actions. The application must analyze the nineteen (19) factors listed in 10 CFR Part 40 Appendix A Criterion 5B(6), including:

(a) Potential adverse effects on ground-water quality, considering—
  (i) The physical and chemical characteristics of the waste in the licensed site including its potential for migration;
  (ii) The hydrogeological characteristics of the facility and surrounding land;
  (iii) The quantity of ground water and the direction of ground-water flow;
  (iv) The proximity and withdrawal rates of ground-water users;
  (v) The current and future uses of ground water in the area;
  (vi) The existing quality of ground water, including other sources of contamination and their cumulative impact on the ground-water quality;
  (vii) The potential for health risks caused by human exposure to waste constituents;
  (viii) The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents; and
  (ix) The persistence and permanence of the potential adverse effects.

(b) Potential adverse effects on hydraulically-connected surface water quality, considering—
  (i) The volume and physical and chemical characteristics of the waste in the licensed site;
  (ii) The hydrogeological characteristics of the facility and surrounding land;
  (iii) The quantity and quality of ground water, and the direction of ground-water flow;
  (iv) The patterns of rainfall in the region;
  (v) The proximity of the licensed site to surface waters;
  (vi) The current and future uses of surface waters in the area and any water quality standards established for those surface waters;
  (vii) The existing quality of surface water including other sources of contamination and the cumulative impact on surface water quality;
  (viii) The potential for health risks caused by human exposure to waste constituents;
  (ix) The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents; and
  (x) The persistence and permanence of the potential adverse effects.

Furthermore, in a letter to the National Mining Association, NRC has re-stated EPA's position that an ACL applicant can use compliance with prior class of use as an additional factor to demonstrate the basis for an ACL that is ALARA (Exhibit SEI044 at 2).

Q.32. In your opinion are ACLs protective of human health and the environment?
A.32. (E. Lawrence). Yes. There are numerous reasons why ACLs are protective. An ACL is a site-specific, constituent-specific, risk based, groundwater protection standard that the licensee must show will not pose a substantial present or future hazard to human health or the environment at the Point of Exposure (for an ISR facility the POE is outside of the exempted aquifer). Demonstration that the ACL is protective of human health and the environment is robust (as described in ¶A.32, it requires extensive assessment of the fate and transport of hazardous constituents in groundwater and hydraulically connected surface water).

Further, it is my understanding of the federal regulations that ACL applications are not permissible unless groundwater corrective action efforts have satisfied ALARA requirements/guidelines.

I also understand that as part of the review of an ACL application, the NRC is required to perform a complete 10 CFR Part 51 environmental analysis (in the form of an EA) and safety review for requested ACLs. It has been my experience that an approved ACL becomes a license condition for the licensee as it is a license amendment.

4.0 CONTENTION 3 - ALLEGED FAILURE TO INCLUDE ADEQUATE HYDROLOGICAL INFORMATION TO DEMONSTRATE SEI'S ABILITY TO CONTAIN GROUNDWATER FLUID MIGRATION

4.1 Sufficient Controls Will Be in Place to Prevent Lack of Confinement Due to Unplugged or Improperly Plugged Exploration Holes

Q.33. Please describe your experience regarding historical drill holes in ISR wellfields.
A.33. (H. Demuth and E. Lawrence) In our direct experience in working with over a dozen operating ISR wellfields in Wyoming, Nebraska and Texas, most or all of these facilities contain hundreds or thousands of historical exploration drill holes yet have been successful at maintaining control of ISR solutions and preventing impacts to groundwater outside of the exempted aquifers. The primary reasons for this are that most historical drill holes were plugged and abandoned using techniques sufficient to prevent vertical migration of wellfield solutions; natural processes seal open drill holes; and adequate procedures were put in place to locate unplugged or improperly plugged holes during wellfield delineation and testing and prevent potential impacts.

Q.34. Please comment on how horizontal migration of ISR solutions is typically controlled.
A.34. (H. Demuth and E. Lawrence) Horizontal fluid migration typically is limited by operational controls (especially maintaining hydraulic wellfield control through bleed and

wellfield balancing) and verified through monitoring. This is summarized in the FSEIS (Exhibit SEI009A):

- "As described in Section 2.1.1.2 of this SEIS, chloride, conductivity, and total alkalinity would be measured twice monthly in the monitoring wells to detect excursions. These 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." (at 315)
- "In addition to sampling the monitoring wells for water-quality parameters, the Applicant would measure water levels during the semi-monthly sampling to detect anomalous hydrostatic pressure increases which may signal an operational upset." (at 317)

Further, the FSEIS at 116, citing the ISR GEIS Sec. 2.11.4, states the following:

- "…the NRC licensees typically retrieve horizontal excursions back into the uranium-recovery zone by their repairing and reconditioning respective wells as well as adjusting the pumping rates in the wellfield where an excursion has occurred."

4.2 The Aquifer Test Durations Are Adequate for their Intended Purpose

Q.35. It has been alleged that Strata's seven separate aquifer tests ranging from 24 to nearly 73 hours described in TR Addendum 2.7-F (Exhibit SEI014G at 139-397) are not of sufficient duration to establish adequate hydrological information to demonstrate control of groundwater (Abitz and Larson 2014 ¶58, Abitz 2013 ¶32, Moran 2011 ¶29). Please comment on how these durations compare with your experience with other ISR operations.

A.35. (H. Demuth and E. Lawrence) These durations are consistent with those of more than 40 pumping tests that Petrotek Engineering Corporation has designed and conducted at uranium ISR facilities in Texas, Wyoming and Nebraska. As described in Strata's license application, the primary purpose of the aquifer tests described in TR Addendum 2.7-F were to calculate hydraulic parameters of the aquifer zone to further understand the system as well as provide measured parameters for modeling purposes. Based on review of the aquifer test procedures and results, it is our opinion that these aquifer tests provided sufficient information in conformance with guidance in NUREG-1569. The NRC will require additional aquifer tests at a wellfield scale to ensure hydrologic isolation of the production aquifer. This is documented in the FSEIS (Exhibit SEI009A) at 316:

> "To ensure the integrity of confining layers, Condition No. 10.13 of the Draft License would require the Applicant to submit a hydrologic-test data package to the NRC staff for review and verification prior to conducting operations in a wellfield (NRC, 2014b). The hydrologic-test data package must adequately define ground-water-flow paths, demonstrate the lateral continuity of the OZ aquifer, provide an evaluation of the heterogeneities within the ore zone, and confirm the hydraulic isolation of the OZ aquifer (NRC, 2014b)."

4.3 The Numerical Groundwater Model Provides a Reasonable Representation of Site Hydrologic Conditions

Q.36. Please describe your role related to the numerical groundwater model for the Ross ISR Project.
A.36. (E. Lawrence) I provided peer review of the numerical model that was submitted as part of the license application.

Q.37. Please describe your prior experience in developing groundwater models for uranium ISR facilities.
A.37. (E. Lawrence) I developed the groundwater models used in licensing of UR Energy's Lost Creek ISR project and the Uranium One's Moore Ranch ISR project, both in Wyoming. NRC staff reviewed and accepted both models and issued source material licenses for each site. I developed a model for Powertech's Dewey-Burdock Project in South Dakota, which has also been licensed. I have provided oversight for modeling developed for the AUC Reno Creek license application that is currently under review by NRC. I developed a model for the Cogema Irigaray site, also in Wyoming, that was used to support a demonstration of aquifer restoration at that facility. That model was accepted by the NRC staff and groundwater was deemed restored. I have developed numerous wellfield-scale models for the Uranium One Willow Creek Project (formerly the Christensen Ranch Project) in Wyoming, to support production and restoration at those sites. Outside of the United States, I have developed models to support feasibility studies and due diligence reviews for ISR projects in Turkey and Kazakhstan. I have also developed numerous groundwater models in support of groundwater characterization studies and groundwater remediation system designs (capture zone evaluation) often in direct support of the EPA and state regulatory agencies. I have also provided third party independent review to the EPA on numerous groundwater flow models for oil refineries, industrial facilities and mine sites.

Q.38. Were the software used, approach, and methods used to develop the Ross ISR Project numerical groundwater model typical of groundwater models you have been involved with?
A.38. (E. Lawrence) Yes. Strata used MODFLOW, which was developed by the USGS and has become the standard in the industry. The pre/post processing software (Groundwater Vistas) is commonly used as well. The modeling approach followed standard modeling protocol.

Q.39. Please comment generally on the use of groundwater models for uranium ISR projects.
A.39. (E. Lawrence) Groundwater flow models are used to assist the user as a decision-making tool, allowing the user to adjust the input parameters such as which wellfields(s) are in production and restoration at a given time and at what net flow rate and to evaluate the probable outcome. The use of a numerical groundwater model allows the user to incorporate the variability observed in measured hydrologic parameters when conducting predictive analyses. While there is no expectation of 100% accuracy, the model is the best tool available at the time it was developed to do predictive analysis of probable and reasonable outcomes.

The model inputs and calibration are based on site-specific data including hydraulic properties obtained from aquifer test results and core samples, potentiometric data, observed drawdown during pumping tests, etc. Certain parameters are sometimes adjusted as necessary to improve calibration, but they remain within the general range of values determined from pump tests conducted in the project area. Calibration to steady-state potentiometric surfaces based on monitor well data and verification of the model to transient pump testing results provide confidence in the model's ability to predict site-wide impacts.

Although not required under NRC regulations in Appendix A or as a necessary component of a license application in NUREG-1569, it has been my experience that NRC staff have come to expect a groundwater flow model to present a 'picture' of site hydrogeology and to provide at least a preliminary assessment of potential impacts to groundwater resulting from ISR operations. Because each site has specific geologic and hydrologic considerations that need to be evaluated, groundwater models provide the best tool to evaluate potential impacts and outcomes. With the tremendous increases in computer processing speed and the enhancement of computer modeling codes and graphical capabilities, fairly complex hydrologic systems can be simulated much more readily than was possible even 10 years ago. As a result, numerical modeling is commonly used in support of ISR permitting and licensing. In my personal experience NRC staff have indicated that if an applicant decides against developing a groundwater model to support a license application, the NRC staff will develop one independently to assist in evaluating the safety of a proposed ISR operation.

Q.40. Are you aware of any special conditions or circumstances at the Ross ISR Project that are not typically encountered at other sites?

A.40. (E. Lawrence) Yes. A measurable hydraulic stress was placed on the Lance/Fox Hills aquifer, which is the uranium ore bearing zone at the Ross ISR Project, beginning in the late 1970s/early 1980s. Groundwater from the Lance/Fox Hills aquifer was used to support water flooding of oilfields in the Minnelusa Formation. Many of the wells used to provide groundwater for the oilfield water flood project have been pumping for up to 30 years. This has resulted in a depression of the potentiometric surface (groundwater elevation) in the vicinity of the oilfield water supply wells. Potentiometric data and pumping rate records are available for much of the waterflood project. These data were used to calibrate/verify the groundwater flow model. Calibrating the model to what is essentially a 30-year aquifer test provides a greater degree of confidence in the model's ability to provide reasonable predictive simulations.

5.0 REFERENCES

Abitz, R., 2011, Declaration of Dr. Richard Abitz on Behalf of the Natural Resources Defense Council and Powder River Basin Resource Council, ADAMS Accession No. ML11300A191, October 23, 2011, Attachment to the Petition to Intervene and Request for Hearing by the Natural Resources Defense Council and Powder River Basin Resource Council, PDF pages 106 to 132.

Abitz, R., 2013, Second Declaration of Dr. Richard Abitz on Behalf of the Natural Resources Defense Council and Powder River Basin Resource Council, ADAMS Accession No. ML13126A402, May 6, 2013, Exhibit 2 to Natural Resources Defense Council's and Powder River Basin Resource Council's Joint Motion to Resubmit Contentions and Admit One New Contention in Response to Staff's Draft Supplemental Environmental Impact Statement.

Abitz, R. and L. Larson, 2014, Joint Third Declaration of Dr. Richard Abitz and First Declaration of Dr. Lance Larson on Behalf of the Natural Resources Defense Council and Powder River Basin Resource Council, ADAMS Accession No. ML14091A004, March 31, 2014, Exhibit 1 to Natural Resources Defense Council's and Powder River Basin Resource Council's Joint Motion to Migrate or Amend Contentions, and to Admit Contentions in Response to Staff's Final Supplemental Environmental Impact Statement.

Moran, R.E., 2011, Declaration of Robert E. Moran on Behalf of the Natural Resources Defense Council and Powder River Basin Resource Council, ADAMS Accession No. ML11300A191, October 24, 2011, Attachment to the Petition to Intervene and Request for Hearing by the Natural Resources Defense Council and Powder River Basin Resource Council, PDF pages 12 to 69.

Sass, R.L., 2011, Declaration of Dr. Ronald L. Sass on Behalf of the Natural Resources Defense Council and Powder River Basin Resource Council, ADAMS Accession No. ML11300A191, October 25, 2011, Attachment to the Petition to Intervene and Request for Hearing by the Natural Resources Defense Council and Powder River Basin Resource Council, PDF pages 70 to 105.

Viviano, P., 2011, Declaration of Pamela Viviano, ADAMS Accession No. ML11300A191, October 21, 2011, Attachment to the Petition to Intervene and Request for Hearing by the Natural Resources Defense Council and Powder River Basin Resource Council, PDF pages 7 to 11.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	
Strata Energy, Inc.	)	Docket No. 40-9091-MLA
	)	ASLBP No. 10-915-01-MLA-BD01
	)	
(Ross In Situ Recovery	)	
Uranium Project)	)	

AFFIDAVIT OF HAL DEMUTH

I declare under penalty of perjury that my statements in prefiled Exhibit SEI026 (Hal Demuth and Errol Lawrence Initial Written Testimony) and SEI027 (Hal Demuth CV) are true and correct to the best of my knowledge and belief.

Hal Demuth

Executed in Littleton, CO
This 21 of August, 2014

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
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Strata Energy,Inc.	)	Docket No. 40-9091-MLA
	)	ASLBP No. 10-915-01-MLA-BD01
	)	
(Ross In Situ Recovery	)	
Uranium Project)	)	

AFFIDAVIT OF ERROL LAWRENCE

I declare under penalty of perjury that my statements in prefiled Exhibit SEI026 (Hal Demuth and Errol Lawrence Initial Written Testimony) and SEI028 (Errol Lawrence CV) are true and correct to the best of my knowledge and belief.

Errol Lawrence

Executed in Littleton, CO
This 25th of August,2014