



Meridian Institute

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Research Priorities for In-Situ Uranium Recovery in Wyoming:

A Report to the University of Wyoming School of Energy Resources

Prepared by Meridian Institute for the School of Energy Resources
University of Wyoming
October, 2009

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Key Findings

Under the sponsorship of the University of Wyoming's School of Energy Resources, 92 representatives of the uranium industry, state and federal regulatory agencies, and the University gathered in Cheyenne on September 22-23, 2009, "to determine the challenges and opportunities where the University of Wyoming can make significant contributions through research to optimize the economic recovery of uranium." Participants identified the following critical issues and research priorities:

EXPLORATION AND PRODUCTION

- Exploratory drilling is expensive and environmentally disruptive. Less-invasive alternatives to exploratory drilling should be evaluated. Potential avenues include the use of isotopes to trace groundwater flow paths and location of deposits; development of surface geophysical and soil geochemical methods; use of oil well database for identifying deep disposal well zones and characteristics; and remote sensing / trace hole geophysics.

OPERATIONS

- Lixivants oxidize many elements that are not desired and significantly increase total dissolved solids (TDS). Development of a lixiviant designed to extract uranium without mobilizing other redox sensitive elements would greatly reduce water consumed and reduce the potential for degradation of groundwater.
- Establishing and frequent sampling of multiple monitoring wells can create negative effects on aquifers and landscape and add significantly to operational costs. Research needs include: development of in-situ devices for remote monitoring of groundwater; evaluation of monitoring well patterns, spacing, and sampling cycles that minimize effects on vegetation and aquifers; use of isotope geochemistry to monitor groundwater for excursions; and adaptation of techniques being developed for carbon sequestration.
- The cause for decreased well flow over time and preventing it are priority research topics.
- More effective methods for waste water management, treatment, and use are needed, including methods for decreasing the salt load without high water use; application of wastewater to beneficial uses, including irrigation and water for livestock; and more cost-effective solidification of residuals.

RESTORATION

- Restoration through ground water sweep and reverse osmosis can involve significant volumes of water. In addition, accepted procedures for groundwater restoration have an efficacy that seems to vary widely depending upon the aquifer being treated. The following research priorities would help to address these challenges: methods to remove elevated redox sensitive constituents with low water use; the potential effects of leaving higher than background levels of TDS in ore bodies (which would reduce the use of water) on underground sources of drinking water; developing effective methods for bioremediation; developing low-cost methods for long-term

monitoring; determining the effectiveness of restoration techniques over the long term; and modeling and monitoring of natural attenuation for aquifers with different characteristics.

REGULATION

- Several state and federal agencies regulate certain aspects of ISR. Overlapping jurisdictions result in inconsistent interpretations of compliance obligations and technical information between agencies. In addition, the unique Memorandum of Understanding between the U.S. Environmental Protection Agency and the Wyoming Department of Environmental Quality presents challenges to industry. Closer coordination and collaboration between state and federal partners is needed. Research needs include: precedents and future options to address overlapping jurisdictions and minimize dual regulation, streamline processes, and increase interagency cooperation and coordination in permitting.
- The implications of Wyoming submitting an application to become an “agreement state” with the Nuclear Regulatory Commission (NRC) should be evaluated in terms of limiting the scope to “source” and “by-product” material, staffing and budgetary requirements, and NRC guidelines.
- The Department of Environmental Quality anticipates applications for permits that would dramatically expand ISR in Wyoming. The implications of this for groundwater are not known. Injecting waste water into deep disposal wells is the preferred method of waste water management by industry as it is most economically efficient. However, obtaining permits is difficult. Alternatives all result in a residue of evaporated salts that must be transported to an approved 11e(2) disposal site.
- Long term monitoring of restored sites would be in the interest of both the public and the industry, which would gain knowledge of the effectiveness of its restoration methods. Research needs include: development of a regulatory approach that would remove industry liability while providing the community greater assurance about the long term protection of groundwater; effectiveness of historic restoration efforts; and the likelihood of post-restoration migration of recovery fluids to an adjacent non-exempt underground source of drinking water.
- Determining baseline condition of groundwater is challenging. Possible research includes: identifying origins of uranium to better characterize ore bodies and estimate baseline concentrations; and independent research and data compilation of pre-operational groundwater quality at existing and proposed ISR facilities.

ASSESSMENT AND COMMUNICATION OF THE SAFETY AND SUSTAINABILITY OF IN-SITU RECOVERY OF URANIUM

- The public seems to perceive ISR as presenting a greater health and environmental risk than many in the industry and regulatory community believe it actually presents. Objective analysis of the historic actual risk to the public of ISR, based on past performance of ISR facilities and their restoration would be helpful, as would research into effective means for communicating to the public about the relative risk of ISR.
- The long-term environmental sustainability of ISR on a state-wide basis using current technology has not been assessed. Developing a sustainable model for ISR in relation to other resource needs and uses would be useful.

1. Overview and Background

In 2009, the Legislature of the State of Wyoming awarded the School of Energy Resources (SER) at the University of Wyoming \$1.6 million for activities related to the development of uranium extraction in the State. “Under the direction of the University of Wyoming energy resources council and in consultation with the Wyoming mining industry,” SER was authorized to use the funds in part to develop a research program for uranium that “shall focus on optimizing the economic recovery of the resource through groundwater restoration, research on waste water management and the development of a seminar to educate the public and the industry about uranium and uranium extraction” (Chapter 159 – Wyoming Session Law 2009 Section 339[c]iii).

To establish a common understanding of the need to develop such a research agenda and to begin planning for a public seminar on uranium, SER organized a two-day workshop, “*Uranium Extraction Workshop: Identifying the Challenges and Opportunities for Research*,” which took place in Cheyenne on September 22 – 23, 2009. The workshop, organized by SER staff in consultation with representatives of the uranium mining industry, had the following objective:

To determine the challenges and opportunities where the University of Wyoming can make significant contributions through research to optimize the economic recovery of uranium.

In conjunction with industry leaders, SER recruited expert speakers and panelists representing the industry, state and federal regulatory agencies, relevant federal research initiatives, and relevant departments and schools of the University of Wyoming. SER engaged the Meridian Institute to provide professional facilitation of the meeting and draft a meeting report. An agenda of the meeting can be found in Appendix A.

92 people attended the workshop and undertook the following tasks together:

- identifying a wide range of issues facing the uranium extraction industry that research would assist in addressing;
- identifying research strategies to address these issues;
- cataloguing the relevant research resources and capacities of the University of Wyoming, United States Geological Survey, and Los Alamos and Sandia National Laboratories;
- prioritizing research topics; and,
- outlining the goals, program, and target audiences for the public forum on uranium extraction.

This report summarizes the outcomes of the workshop and the discussions about formulating a research agenda to accomplish the legislative directive given to the School of Energy Resources.

2. Key Issues and Corresponding Research Priorities

Following are the key issues and research priorities, as well as additional research gaps, identified by workshop participants in five categories:

1. Exploration and Production
2. Operations
3. Restoration
4. Regulation
5. Assessment and Communication of the Safety and Sustainability of In-Situ Recovery of Uranium

2.1 EXPLORATION AND PRODUCTION

2.1.1 Key Issues

- Exploratory drilling is expensive and environmentally disruptive, at least in the short term
- Potential for large unknowns in reserve calculations
- Efficient collection of baseline data
- Determining if multiple resources occurring in the same area (e.g., uranium ore and coal bed methane) can be developed effectively and safely for public health and the environment

2.1.2 Priority Research Topics

- Development of non-invasive alternatives to exploratory drilling
 - Use of isotopes to trace groundwater flow paths and location of deposits
 - Development of surface geophysical and soil geochemical methods for locating redox boundaries at depth, including helium and radon tracers
 - Use of oil well database for identifying deep disposal well zones and characteristics
 - Remote sensing / trace hole geophysics
 - Slim-hole drilling techniques

2.1.3 Other Research Gaps Identified

- Improved methods of characterizing and understanding ore deposits / hydrology to better design well field patterns
- Reserve calculations: post-mining investigation to evaluate accuracy of reserve calculations and determine best methods
- Baseline data collection
- Improved drill rig design to increase safety and efficiency
- Environmentally sound methods for developing and modeling ISR in unconfined deposits: (where there is no sealing shale above and/or below uranium deposits to prevent groundwater from migrating)
- Comparison of advantages of top soil stripping and storage vs. leaving soil in place

- Development of well casing material alternatives
- Methods for improving compatibility of ISR and preservation of sage grouse habitat
- Ore body mapping/delineation: determining best type of radiological logging device for measuring the depth of ore zones; cost effectiveness of using expensive neutron measurement devices.
- Use of geo-statistical methods to estimate uranium ore reserves.
- Use of statistical methods to predict the future life of ISR wells after production data has been obtained from them for the first few months of their operation

2.2 OPERATIONS

2.2.1 Key Issues

- Lixivants oxidize many elements that are not desired, and significantly increase total dissolved solids (TDS), leading to the generation of large amounts of wastewater, given current regulatory requirements. If TDS are not introduced into the groundwater, then it does not need to be removed; the only requirements would be to stabilize trace contaminants, which increases options for restoration, including bioremediation.
- Optimal concentrations of oxygen in lixiviant are not known
- Establishing and sampling monitoring wells every two weeks can create negative effects on aquifers and landscape
- Degradation of well flow over time (effect of chemical reactions of lixiviant or breakdown of clays in the formation)

2.2.2 Priority Research Topics

- Lixivants
 - Development of a lixiviant designed to extract uranium without mobilizing other redox sensitive elements. There is a great deal of interest in developing such a “silver bullet” solution to minimizing waste water and improving restoration. This might involve geochemical simulations as well as experimentation, and may require site specific development.
 - Determination of optimal amounts of oxygen to use in lixivants
 - Finding alternatives to oxygen
- Groundwater monitoring
 - Development of in-situ devices for remote monitoring of groundwater, including solar powered devices
 - Evaluation of monitoring well patterns, spacing, and sampling cycles that minimize effects on vegetation and aquifers
 - Use of isotope geochemistry to monitor groundwater for excursions
 - Adaptation of techniques being developed for monitoring of effects of sequestered carbon on P_h of groundwater
- Waste water management, treatment, and use
 - Methods for decreasing the salt load without high water use.

- Application of wastewater to beneficial uses, including for irrigation and livestock (once arsenic and selenium are removed with cupric oxide, a new method developed at the University of Wyoming by Dr. K.J. Reddy), heat pump systems, inline turbines for power generation
- More effective/cheaper solidification of residuals
- Life-cycle environmental analysis of wastewater management
- Determining cause of reduced flow over time, including drawing on research undertaken by oil and gas industry (reactive transport models)

2.2.3 Other Research Gaps Identified

- Clean up of spills: review of health and environmental impacts, effectiveness of bioremediation, early warning systems, appropriate clean up criteria
- Characterization of deep formations to demonstrate they are not suitable as underground sources of drinking water (USDW).
- Methods for reducing the volume of waste water, including the practicality and effectiveness of solar boilers to concentrate waste water
- Re-examination of potential use of acid lixivants given current cleanup technologies.
- Use of hydrological and geochemical methods to aid well field operators in the effort to avoid excursions of lixivate from mining zones
- Best methods for economically metering fluids that consist of two phases (oxygen/aqueous) with sufficient accuracy

2.3 RESTORATION

2.3.1 Key Issues

- Industry views the time required from cessation of operations through completion of restoration is excessive and is looking for means to accelerate the process.
- Restoration through ground water sweep and “pump and treat” methods such as reverse osmosis can involve significant volumes of water.
- Accepted procedures for groundwater restoration (ground sweeps, reverse osmosis, etc.) have an efficacy that seems to vary widely depending upon the aquifer being treated.
- Is bioremediation – the use of the naturally occurring bacteria in the formation to return water to baseline conditions – a viable alternative?
- Federal research institutions lack access to needed resources:
 - Opportunities to test applications of low-water-use restoration techniques under development
 - Access to retired ISL sites to test effectiveness of restoration

2.3.2 Priority Research Topics

The United States Geological Survey (USGS) and the Los Alamos and Sandia National Laboratories are undertaking a wide range of research related to groundwater restoration. The following research topics are those not currently being pursued, or pursued sufficiently, by these institutions.

- Reducing water use
 - Technologies to remove the hazardous constituents (uranium, selenium, radium-226, arsenic, and manganese) with low water use
 - Effects on adjacent, non-exempt USDW of leaving high levels of TDS in ore bodies
 - Development of protocols and methods for site specific efforts to minimize water use
 - Viability of using reverse osmosis permeate as a sweep solution
 - Comparative cost/benefit analysis of water used in restoration vs. water use for other purposes
 - Effectiveness of purely chemical restoration methods such as sulfide addition
- Bioremediation (ongoing development and experimentation by Cameco)
 - Development of effective methods
 - Determining most effective amendments to spur growth of naturally occurring bacteria
 - Developing effective delivery methods for amendments
 - Role of biofilms
 - Avoid the fouling or plugging of well bores with bacterial slimes or mats
- Monitoring
 - Low-cost methods for long-term monitoring
 - Effectiveness of restoration techniques over long term (some studies underway by USGS)
 - Relationship between level of constituents over time and their migration
 - *See section 2.2.2 above for additional well-monitoring research topics.*
- Natural attenuation
 - Modeling and monitoring of natural attenuation for aquifers with different characteristics

2.3.3 Other Research Gaps Identified

- Effective and efficient methods for revegetation
- Determining if identifying the geochemical and/or hydrological characteristics of mined aquifers can aid in choosing what restoration strategy is best

2.4 REGULATION

2.4.1 Key Issues

- ***Overlapping jurisdictions:*** Several state and federal agencies regulate aspects of ISR. There are many overlapping jurisdictions as well as inconsistent interpretation of compliance obligations and technical information between agencies. The federal regulatory landscape is changing. A consistent and predictable regulatory environment that assures adequate public health and safety is needed. This requires closer coordination and collaboration between state and federal partners.
- ***Federal-state regulatory agreements:*** The unique Memorandum of Understanding between the U.S. Environmental Protection Agency and the Wyoming Department of Environmental

Quality presents challenges to industry. Both the state and ISR operators may benefit by reduced compliance costs if Wyoming were to become an “agreement state” with the NRC. However, issues such as staffing and budgetary requirements, limiting the scope to “source” and “by-product” material, and acceptability of NRC guidelines should be evaluated before an application is submitted.

- ***Implications of dramatic expansion of ISR exploration and operations in Wyoming:*** The Department of Environmental Quality anticipates applications for permits that would dramatically expand ISR in Wyoming. The implications of this for groundwater are not known. Furthermore, with thousands of holes being drilled, DEQ is beginning to have concerns about plugging and abandonment of drill holes and the adequacy of the systems in place to protect ground water. With current operations, permit expectations often do not often match up with actual production. More information up front is needed for regulatory agencies. For DEQ, adaptive management is not a satisfactory path forward in permitting ISR facilities. There could be as many as eleven mines in the State. DEQ suggests that if the first few are not done correctly, DEQ will not have the public support required to issue additional permits.
- ***Waste water disposal:*** Injecting waste water into deep disposal wells is the preferred method of waste water management by industry as it is most economically efficient. It allows disposal onsite, eliminates the need for transportation, and puts contaminants in an aquifer that is not suitable for drinking water. However, obtaining permits is difficult. Currently used alternatives to deep disposal wells include:
 - Evaporation ponds, which are: subject to leaks in the lining (potentially impacting nearby surface drinking water supply) and require fences and monitoring to keep wildlife away.
 - Chemical precipitation, which, while effective at conventional mines, generates large amounts of solids.
 - Zero liquid discharge forced evaporation: a costly disposal method that requires high energy use.

All of these alternatives result in a residue of evaporated salts that must be transported to an approved 11e(2) disposal site.

- ***Unconfined conditions:*** Federal agencies commonly have found in recent applications for ISR unconfined conditions (lack of impermeable rock layers to prevent migration of lixiviant from ore body), particularly faulting going through the extraction zone. Unusual geological site conditions require additional attention and detailed analysis to determine if NRC / DEQ have the technical basis for issuing a license.
- ***Restoration:*** Long term monitoring of restored sites would be in the interest of both the public and the industry, which would gain knowledge of the effectiveness of its restoration methods. However, industry does not want to extend its liability beyond the current one year period after restoration is complete. It would be beneficial to develop a regulatory approach that would remove industry liability while providing the community greater assurance about the long term protection of groundwater.
- ***Determining baseline condition of groundwater:***

- Not enough is known about the characteristics of ore bodies to accurately model baseline conditions.
- Determining baseline conditions is complicated by development of multiple resources in single locations, such as coal bed methane. Some areas have been polluted from previous mining. In some cases, the public doesn't feel that it is being fully protected because the NRC doesn't require previous mining pollution to be cleaned up.

2.4.2 Priority Research Topics

- **Overlapping jurisdictions:**
 - Precedents and future options to address overlapping jurisdictions and minimize dual regulation, stream line processes, and increase interagency cooperation and coordination in permitting. Situations in which there is a lead agency / primacy should be researched, as should the viability of a single document that would satisfy the requirements of all regulatory agencies.
 - Implications of Wyoming achieving "agreement state status" for public, state, and industry interests, including costs to the State and the availability of qualified individuals to perform necessary tasks.
- **Implications of dramatic expansion of ISR exploration and operations in Wyoming:** Long term implications for groundwater of a dramatic expansion of drilling for ISR.
- **Waste water disposal:** Options for granting ISR Underground Injection Control (UIC) permits.
- **Baseline conditions:** Methods for background baseline analysis (to complement work currently underway at Los Alamos / Sandia National Labs and the US Geological Survey)
- **Restoration:**
 - Likelihood of post-restoration migration of recovery fluids to an adjacent non-exempt USDW.
 - Effectiveness of historic restoration efforts.
- **Risk assessment:** Review of approved permit applications for ISR and associated reports of exposure of public to radioactive material
- **Establishing baselines concentrations**
 - Identifying origins of uranium to better characterize ore bodies and estimate baseline concentrations.
 - Independent research and data compilation of pre-operational groundwater quality (e.g., uranium, radium, radon, and heavy metal concentrations) at existing and proposed ISR facilities.
- **Framework for long term risk management: site monitoring and industry liability**
 - Use of trusts as a vehicle to address post-restoration expenses (as currently under the Mill Tailings Act).

2.4.3 Other Research Gaps Identified

- Methods for measuring radon and other air pollutant emissions from fluid surfaces

- Determining which data are needed for adequate assessment of pre- and post-ISR mining groundwater quality
- Managing spills: early detection systems, immediate and long term remediation, measuring impacts, use of bioremediation
- Review of the health physics impact of ISR
- Treatment of ISR is a more holistic manner
- Strategies and methods for creating a regulatory environment that encourages restoration, research, and innovation / removal of barriers to progress; research of other states' regulatory approaches to encouraging innovation

2.5 ASSESSMENT AND COMMUNICATION OF THE SAFETY AND SUSTAINABILITY OF IN-SITU RECOVERY OF URANIUM

2.5.1 Key Issues

- The public seems to perceive ISR as presenting a greater risk to health and environmental quality than many in the industry and regulatory community.
- The long-term environmental sustainability of ISR on a state-wide basis using current technology has not been assessed.

2.5.2 Priority Research Topics

- Objective analysis (not conducted or paid for by industry or regulatory agencies) of the historic actual risk to the public of ISR, based on past performance of ISR facilities and their restoration.
- Effective means for communicating to the public about the relative risk of ISR, including in relation to other risks the public faces, and its management.
- Developing a sustainable model for ISR in relation to other resource needs and uses.

2.5.3 Other Research Gaps Identified

- The life cycle carbon footprint of ISR sourced electricity.

3. Setting and Executing a Research Agenda

During the course of the workshop and in follow-up communications, participants made some suggestions regarding how the university might set and execute a research agenda to advance ISR in Wyoming.

Suggested criteria for projects:

- Priority research needs identified by workshop participants.
- Well-matched to existing capacities of the University and prospective partners (e.g., federal research institutions, industry, and other universities).
- Foster collaboration among schools and departments at the University.
- Strong potential to benefit the public.
- Timely, relevant, and immediately applicable to the problems at hand.
- Focused on developing practical solutions rather than publications.

Guidance offered regarding the pursuit of projects:

- Industry pace is much faster than academia. The University should take on projects that it can complete in a timeframe useful to industry and regulators.
- Develop clear communications and expectations for partnerships with industry.
- Select a few projects and do them well rather than attempt to undertake a wide range of projects.
- Make use of student interns at federal, state, and industry facilities.
- Collaborators in other uranium producing states.

In addition, numerous presenters and participants urged SER to consider developing a research site for practical application and testing of alternative technologies. This would provide opportunities for collaboration with industry, federal research institutions, and regulators. The University might apply for an R&D license to test restoration methods on state or federal land. (USGS has set up similar facilities in collaboration with the oil and gas industry, and there has been some discussion of conducting in-field uranium mining research.)

Furthermore, SER was encouraged to consider how it might develop an ongoing mechanism for the ISR research community to communicate, consider the long-term research outlook, and pool resources (i.e., a University of Wyoming-sponsored consortium of universities and federal research facilities studying ISR).

SER has indicated that these suggestions will now form the basis for future discussions it will facilitate aimed at more definitive design of a research program, partnership development, and outreach activities. SER will develop a proposal and budget for conducting this work prior to the 2010 legislative budget session.

4. Planning a Public Forum on Uranium Extraction

Workshop participants discussed the Public Forum on Uranium Extraction being planned by the School of Energy Resources for Spring, 2010. The group identified goals, program suggestions, and target audiences for a public forum focused on uranium-related issues in Wyoming.

Goals:

- Identify public concerns and questions: suggestion to conduct poll/focus groups in advance of the forum to better understand nature of public concerns
- Address public concerns about uranium mining and nuclear power
- Provide basic education about uranium production and use and its benefits
- Enable groups concerned about uranium production to present their concerns

Program Suggestions:

- Overview of uranium use in the United States
- Benefits of uranium use vs. the actual and perceived risks
- Presentations by health and medical professionals independent of industry
- Groundwater (basic hydrology, use during and effects of mining, Safe Drinking Water Act regulations and oversight, comparative use and effects on water by agriculture and various industries)
- Economic impact of uranium mining in Wyoming
- Land use issues
- Transportation of uranium
- Carbon footprint of ISR

Target Audiences:

- Agricultural / rural community (industry interaction during exploration)
- Schools and educators across disciplines and at different levels
- Local government officials
- Legislators
- Native tribes (those living in WY and those with heritage in WY)
- Media
- Civic organizations
- Land owners

Workshop participants suggested that the following perspectives be represented on a Steering and Planning Committee: industry, regulators, legislators, medicine and public health, environmental organizations.

APPENDIX A: Workshop Program

Uranium Extraction Workshop – Identifying the Challenges and Opportunities for Research

University of Wyoming – School of Energy Resources

Co-Sponsored by the UW College of Law

September 22-23, 2009

Cheyenne, Wyoming

Little America

Room: Wyoming C-D

Workshop Objective: To determine the challenges and opportunities where the University of Wyoming can make significant contributions through research to optimize the economic recovery of uranium.

September 22, 2009

8:30 AM Welcome – Opening of the Workshop - Outline of Goals

Mary Byrnes, University of Wyoming, School of Energy Resources

Mark Jacobs, Meridian Institute (facilitator)

8:45 AM Overview of Operation of In-situ Recovery in Wyoming

Objectives:

- Introduce participants to the In-Situ Recovery method, including stages in the life-of-project for an ISR facility
- Develop common terminology and understanding of the topics
- Identify research underway related to ISR
- Define major areas where there are research gaps

Session Chair: Wayne Heili – UR Energy

Presenters: Tom Cannon, Cameco

Pete Stahl, University of Wyoming, Renewable Resources

Kevin Chamberlain – University of Wyoming, Geology & Geophysics

Respondents: John Kaszuba, University of Wyoming, Geology & Geophysics

Ken Sims – University of Wyoming, Geology & Geophysics

NOON: Lunch – Provided

1:00 PM Policy, Regulatory and Legal Reform

Objectives:

- Introduce the regulatory requirements for licensing, operating, and decommissioning an ISR facility
- Identify key issues that need to be addressed to improve the regulatory process and outcomes
- Identify research that would help address those issues
- Identify how regulators, industry, and the university might better collaborate to advance needed research

Session Chair: Tony Thompson – Thompson & Simmons PLLC

Presenters: *Regulatory Community*

John Corra – Wyoming Department of Environmental Quality

Stephen Cohen, U.S. Nuclear Regulatory Commission

Dan Jackson, U.S. Environmental Protection Agency – Region 8

Pete Sokolosky, U.S. Bureau of Land Management

Industry

John Cash, UR Energy USA

Robert VanVoorhees, Bryan Cave LLP

Academia

Dennis Stickley, University of Wyoming – College of Law

September 23, 2009

8:30 AM Groundwater Restoration

Objectives:

- Provide an overview of the industry technologies currently used for groundwater restoration and current challenges.
- Review groundwater restoration regulatory requirements and WY-DEQ's priorities for restoration.
- Review current research regarding groundwater restoration and identify research gaps.
- Review current research into new groundwater restoration technologies and identify research gaps.

Session Chair: Donna Wichers – Uranium One Americas

Presenters: Larry Reimann, Cameco

Don McKenzie, WY Department of Environmental Quality, Land Quality

Tanya Gallegos, U.S. Geological Survey

Susan Hall, U.S. Geological Survey

Patrick Longmire, Los Alamos National Lab
Malcolm Siegel, Sandia National Lab

12:00 PM Lunch - Provided

1:00 PM Wastewater Management

Objectives:

- Provide an overview of the current regulatory landscape.
- Describe the operations currently utilized by industry to address regulations and challenges faced.
- Identify technology gaps for areas in which wastewater management might be improved.
- Survey current research in wastewater management.
- Identify additional research needed to improve wastewater management.

Session Chair: Kevin Frederick – Wyoming DEQ, Water Quality

Presenters: Hal Demuth, Petrotek Engineering Corp
KJ Reddy, UW Renewable Resources
Larry Reimann, Cameco
Bridgette Hendricks, Golder Associates

4:00 PM Planning the Uranium Forum for Spring, 2010

Objectives:

- Identify forum goals and elements.
- Identify planning committee inclusive of industry, researchers, environmental community, regulatory community and other stakeholders.

4:30 PM Wrap up of Workshop – Next Steps

5:00 PM Adjourn

APPENDIX B: Presenters and Attendees

<u>Industry</u>		
	Tiffani Fehlmann Energy Laboratories, Inc	Marion Loomis Wyoming Mining Association
Gregory Adams Titan Uranium USA Inc.	Cory Foreman, Respec	Conrad Parrish Telesto Solutions
Craig Bartels Uranium Resources	Sheryl Garling Rand D Enterprises, Inc	Oscar Paulson Kennecott Uranium Company
Nick Bielstein Strathmore Resources US Ltd	Mike Griffin Uranium One Americas	Mark Pelizza Uranium Resources
Richard Bluaugh Powertech (USA) Inc	John Hamrick Cotter Corporation USA	Larry Reimann Cameco Resources
Steven Brown SENER Consultants Limited	Matt Hartmann SRK Consulting Inc	Benjamin Schiffer WWC Engineering
Kent Bruxvoort Telesto Solutions	Mike Hawks Leppert Associates, Inc	Ken Schlieper Petrotek Engineering Corp
Tom Cannon Cameco Resources	Wayne Heili UR Energy USA	Jim Shriver TREC, Inc
John Cash UR Energy USA	Bridgette Hendricks Golder Associates	Mik Thomas Uranerz Energy Corporation
Glenn Catchpole Uranerz Energy Corporation	Mark Hollenbeck Powertech (USA) Inc	Tony Thompson Thompson & Simmons PLLC
Jim Clay Cameco Resources	Conrad Houser Geovic Energy Corp	Erich Tiepel Golder Associates
Matt Cunningham Integrated Production Resources	Leland Huffman UR Energy USA	Mark Travis Strathmore Resources US Ltd
Hal Demuth Petrotek Engineering Corp	Wes James Petrotek Engineering Corp	Robert Van Voorhees Bryan Cave LLP
Brian Dewald Cameron's Measurement Systems	Rick Johnson Lyntek Inc	Ken Vaughn Cameco Resources
Steve Dobos Energy Laboratories, Inc	Charles Kelsey UR Energy USA	Kaci Walker R Squared Incorporated
Dan Dowers Neutron Energy	Dawn Kolkman Cameco Resources	Lynn Welker Wyoming Mining Association
	Shawn Leppert Leppert Associates, Inc	

Krista Wenzel
Cameco Resources

Miriam Whatley
Cameco Resources

Donna Wichers
Uranium One Americas

Ted Wilton
Neutron Energy

Regulatory Community

Stephen Cohen
Nuclear Regulatory Commission

John Corra
Wyoming Department of
Environmental Quality

Kevin Fredrick
Wyoming Department of
Environmental Quality

Robert Gregory
Wyoming State Geological
Survey

Ed Heffern
Bureau of Land Management
Wyoming State Office

Dan Jackson
Environmental Protection
Agency
Region 8 Ground Water Unit

George Langstaff
Wyoming Department of
Environmental Quality

Don McKenzie
Wyoming Department of
Environmental Quality

Brenda Neuman
Bureau of Land Management
Wyoming State Office

Pete Sokolosky
Bureau of Land Management
Wyoming State Office

University of Wyoming

Kevin Chamberlain
Department of Geology &
Geophysics

Tim Drever
Geology & Geophysics

Steve Easton
College of Law

Jim Herrold
Environmental Health & Safety

John Kaszuba
Department of Geology &
Geophysics

Rick Miller
Government, Community and
Legal Affairs

KJ Reddy
Department of Renewable
Resources

Ken Sims
Department of Geology &
Geophysics

Pete Stahl
Department of Renewable
Resources

Dennis Stickley
College of Law

Federal Research Facilities

Tanya Gallegos
U.S. Geological Survey

Susan Hall
U.S. Geological Survey

Patrick Longmire
Los Alamos National Lab

Malcolm Siegel
Sandia National Laboratories

Ardyth Simmons
Los Alamos National Lab

Other

Roger Bower
Wyoming Business Council

Lee Clapp
Texas A & M

Dennis Ellis
Ellis Public Affairs

Michael Faas
Faas Law Firm, LLC

JoAnn Fulton

Bob Hopkins
Citizens for Uranium Resource
Education

Heather Jacobson
Jacobson Law Office

Mari-Frances Kline
CRMC

Stephen Payne
Independent Consulting
Geologist

Jermey Pelzer
Casper Star Tribune

Nathaniel Saladin
Geochemist

APPENDIX C:

Research Resources:

University of Wyoming and Complementary Federal Resources

The University of Wyoming has a wide range of resources that may be mobilized in pursuit of a research agenda to advance in-situ recovery of uranium in Wyoming. As identified by workshop participants, these include:

- Stable Isotopic Facility, Department of Renewable Resources, College of Agriculture (including reactive transport modeling, stable isotopes, short lived counting)
- Department of Geology and Geophysics, College of Arts and Sciences
 - Micro Analytic Facility
 - Development of monitoring methods for sequestered CO₂
 - Computation Fluid Dynamics
- Geomicrobiology Lab (bioremediation), Department of Microbiology, College of Agriculture
- Mechanical Engineering (well casing, drill rig design, instrumentation), Department of Mechanical Engineering, College of Engineering and Applied Sciences
- Department of Chemistry, College of Arts and Sciences (in-situ analysis)
- Wildlife and Range Faculty (restoration and revegetation)
 - Department of Veterinary Science, College of Agriculture
 - Department of Zoology and Physiology, College of Arts and Sciences
- Wyoming Natural Diversity Database
- Reclamation and Restoration Center, College of Agriculture and School of Energy Resources
- Environmental Health and Safety Department

Researchers from USGS and Los Alamos and Sandia National Labs present at the workshop identified a range of federal research programs, resources, and capacities with which the University of Wyoming might partner / draw as it develops and pursues a research agenda:

USGS

- Investigations of groundwater stability in ISR well fields
- Alternative groundwater restoration techniques
- Core research center
- Anaerobic lab setup
- Spectroscopic expertise
- Uranium geology expertise
- Ability to collaborate with universities, agencies, and industry (inter-state)

Sandia National Lab (U.S. Department of Energy-Environmental Management, U.S. Department of Energy Waste Isolation Pilot Plant, U.S. Department of Energy Yucca Mountain Project, Arsenic Water Technology Partnership)

- Reactive transport models
- Risk assessment (*Waste Isolation Pilot Plant, Energy Yucca Mountain Project*)
- Nanotechnology Center
- Water treatment technology (arsenic, desalination, selective extraction)
- Radionuclide Transport Lab
- Natural Monitored Attenuation (NMA) evaluation (geohydrologic characterization)

Los Alamos National Lab

- Site characterization (geologic/geophysics, hydrology, geochemistry)
- Isotope forensics (stable and U-series)
- Reactive transport modeling
- Lab experiments – site restoration and monitored natural attenuation
- Confidence building – natural analogues
- Risk assessment (U.S. Department of Energy Waste Isolation Pilot Plant, U.S. Department of Energy Yucca Mountain Project)
- Design of monitoring networks (radiation, long term monitoring approaches)
- “Smart” tracers (unique organics)

APPENDIX D: Presentations

Slides from the following presentations made at the workshop are available at <http://www.uwyo.edu/ser/info.asp?p=15511>.

Overview of Operation of In-situ Recovery in Wyoming

- Identifying the Challenges and Opportunities for Research
 - Wayne Heili, Vice President, Mining & Engineering, Ur-Energy, USA
- Research Opportunities
 - Tom Cannon, Cameco
- Identifying the Challenges and Opportunities for Research
 - Pete Stahl, Professor of Soil Ecology, Department of Renewable Resources, College of Agriculture, University of Wyoming
- Potential Applications of Isotope Geochemistry to ISR
 - Kevin Chamberlain, Research Professor, Department of Geology and Geophysics, College of Arts and Sciences
 - Ken Sims, Associate Professor, Isotope Geology, Department of Geology and Geophysics, College and Arts and Sciences

Policy, Regulatory, and Legal Reform

- Approaches to Licensing Uranium Recovery Facilities
 - Tony Thompson, Thompson & Simmons PLLC
- Regulatory Framework under EPA Regulations
 - Dan Jackson, Leader, Class I, II, III Wells, U.S. EPA Region 8
- Bureau of Land Management Process
 - Pete Sokolosky, Geologist, U.S. Bureau of Land Management
- Underground Injection Control (UIC) Permitting for ISR Facilities
 - Robert Van Voorhees, Partner, Bryan Cave LLP
- Should Wyoming become a “Limited” Agreement State?
 - Dennis Stickley, Visiting Professor of Law, College of Law, University of Wyoming

Groundwater Restoration

- Overview of Groundwater Restoration Techniques
 - Donna Wichers, Senior Vice President, ISR Operations, Uranium One Americas
- Current Research: Uranium Extraction and the Environment
 - Tanya J. Gallegos, Mendenhall Fellow, U.S. Geological Survey
 - Susan Hall, Geologist, U.S. Geological Survey
- Monitored Natural Attenuation of Uranium Migration from Restored *in-situ* Mining Sites
 - Malcolm Siegel, ITRD Technical Coordinator, Sandia National Laboratories
 - Ardyth Simmons, Program Manager, Water Stewardship at Los Alamos National Laboratory
 - Jeffrey Heikoop, Isotope Geochemist, Los Alamos National Laboratory
 - Patrick Longmire, Hydrogeochemist, Los Alamos National Laboratory
- Geochemical Evaluation of Aquifer Restoration at an In-Situ Recovery Uranium Site
 - Patrick Longmire, Hydrogeochemist, Los Alamos National Laboratory

Wastewater Management

- Wastewater Management at Uranium ISR Facilities
 - Hal Demuth, Senior Engineer, Petrotek Engineering Corporation
 - Ken Cooper, Engineering Manager, Petrotek Engineering Corporation
- Wastewater Management “Selenium and Arsenic”
 - K.J. Reddy, Professor, Department of Renewable Resources, College of Agriculture, University of Wyoming
- Wastewater Treatment: Technology Gaps and Areas for Improvement
 - Bridgette Hendricks, Golder Associates

APPENDIX E: Public Notice

News Release

UW School of Energy Resources to Host Two-Day Uranium Workshop

Sept. 16, 2009 -- Industry, regulatory and academic experts and other interested stakeholders will discuss the potential future of uranium research and extraction in Wyoming at a University of Wyoming School of Energy Resources (SER)-sponsored workshop Sept. 22-23 in Cheyenne.

The goal of the two-day workshop, "Identifying the Challenges and Opportunities for Research," is to identify knowledge, technology and regulatory barriers that will be keys to the future of the uranium industry in Wyoming. Sessions begin at 8:30 a.m. each day at the Little America Hotel, 2800 W. Lincolnway. The workshop is free and open to the public.

During its 2009 general session, the Wyoming State Legislature appropriated \$1.6 million in Abandoned Mine Land (AML) funds to the SER to conduct uranium research, create a research program for uranium at UW, conduct workshops and other seminars to educate the public and to develop a database of information on uranium exploration, development and production.

The Sept. 22-23 workshop is the first event in the SER's quest to satisfy the state's directive. Findings will be used to assist the SER in developing a research plan that will be presented to the Joint Minerals, Business and Economic Development Interim Committee. A second event, a public forum, is being planned for spring 2010.

To register for the workshop or for more information, call Mary Byrnes at (307) 766-6851 or e-mail mbyrnes@uwyo.edu. Registration is necessary only to provide an accurate headcount for meals.