EXHIBIT C

DEQ/DMME URANIUM STUDY:

INITIAL REPORT

Uranium Study:
Initial Report

Commonwealth of Virginia
Department of Environmental Quality
Department of Mines, Minerals and Energy

Date: October, 2012

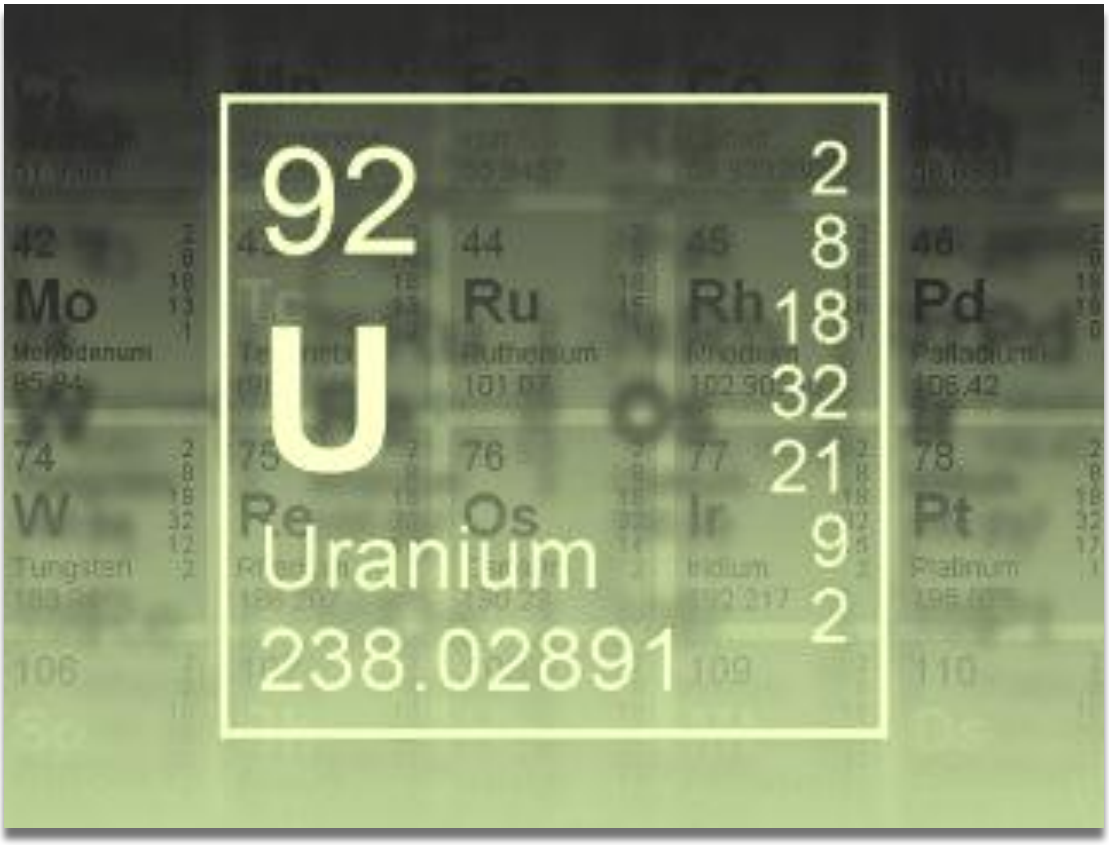

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TABLE OF CONTENTS

FIGURES

TABLES

APPENDICES

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ABBREVIATIONS

ALARA	As Low As Reasonably Achievable
AQCD	Air Quality Control Division
BLM	Bureau of Land Management
CAQCD	Colorado Air Quality Control Division
CDOT	Colorado Department of Transportation
CDHPE	Colorado Department of Public Health and Environment
CEAA	Canadian Environmental Assessment Agency
CWQCD	Colorado Water Quality Control Division
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CNSC	Canadian Nuclear Safety Commission
CDRMS	Division of Reclamation, Mining and Safety
DEQ	Department of Environmental Quality
DMME	Virginia Department of Mines, Minerals and Energy
EA	Environmental Assessment
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EMS	Environmental Management System
EPA	Environmental Protection Agency
FLPMA	Federal Land Policy and Management Act
FONSI	Finding Of No Significant Impact
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
ISO	Organization for Standardization
ISR	In Situ Recovery
KPS	Key Performance Indicators
MOU	Memorandum of Understanding
MSHA	Mine Safety and Health Administration
NAS	National Academy of Sciences
NEA	Nuclear Energy Agency
NEI	Nuclear Energy Institute
NEPA	National Environmental Policy Act
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act of 1966, As Amended
NORM	Naturally Occurring Radioactive Materials
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
OECD	Organization for Economic Co-operation and Development
OHS	Occupational Health and Safety

ABBREVIATIONS (CONTINUED)

OSHA	Occupational Safety and Health Administration
PDCA	Plan, Do, Check and Act
QA/QC	Quality Control and Quality Assurance
RCRA	Resource Conservation and Recovery Act
RFP	Request for Proposal
TENORM	Technologically Enhanced Radioactive Materials
UDOGM	Utah Division of Oil, Gas and Mining
UPSAT	Uranium Production Site Appraisal Team
UWG	Uranium Working Group
WDEQ	Wyoming Department of Environmental Quality
VDH	Virginia Department of Health
WNA	World Nuclear Association
WQCD	Water Quality Control Division
WySHPO	Wyoming State Historic Preservation Office

EXECUTIVE SUMMARY

ES 1.0 INTRODUCTION

This initial report is developed in response to the requirements of Work Task A, identified in the Virginia Department of Environmental Quality (DEQ) contract No. EP881027 and awarded on May 21, 2012. The information within this report is intended to assist the Uranium Working Group in developing a scientific policy analysis related to potential future uranium mining in the Commonwealth of Virginia.

On January 19, 2012, the Governor of the Commonwealth of Virginia (Virginia) directed members of his cabinet to form a Uranium Working Group (UWG) with staff from the Virginia Department of Mines, Minerals and Energy (DMME), the DEQ, and the Virginia Department of Health (VDH). This UWG was established to provide a scientific policy analysis to help the General Assembly assess whether the moratorium on uranium mining in Virginia should be lifted, and if so, how best to do so.

Recent studies on uranium mining in Virginia have identified important issues related to the protection of public and occupational health and safety, as well as associated environmental and socioeconomic impacts. Consequently, the UWG has sought to develop a conceptual regulatory framework that would address these issues and any other issues identified by the UWG, the public, or other stakeholders. This conceptual regulatory framework will form part of the Departments' policy analysis and will be one of the many pieces of information the General Assembly will consider while deciding whether or not to lift Virginia's moratorium on uranium mining.

In order to help respond to this directive, the UWG issued two requests for proposal (RFP) to solicit expert advice and analysis of uranium mining issues in Virginia relevant to the statutory jurisdictions of DEQ, DMME and VDH (the Departments). Due to the different areas of focus and responsibilities of the agencies within the UWG, two procurements were developed; one to address the areas of responsibility related to the DEQ and DMME, and one to address areas of responsibility related to VDH.

On March 2, 2012, the DEQ issued the first of these procurements, RFP # 12-06-PJ (Uranium Study). Sealed bids were submitted by April 3, 2012 and contract EP881027 was awarded to Wright Environmental Services on May 21, 2012.

The team assembled by Wright Environmental Services consists of a diverse group of highly experienced and qualified individuals from a variety of backgrounds. The team includes regulators from the United States, Canada, and the Nuclear Regulatory Commission (NRC) who were directly responsible for regulation of uranium mining and/or milling in their respective state

and federal organizations. In addition, the team includes a radio-ecologist and internationally recognized radiation health physicists whose combined experience totals more than 200 years. Further, the engineering expertise within the team includes individuals who have assisted NRC in developing their early regulations and individuals who have recent experience and expertise with design of mines and mine waste management systems across the country.

The Contract identifies two major work Tasks (A and B). Work Task A involves the development of an initial report addressing the following items:

- A review of studies related to uranium mining and milling in Virginia;
- A comparison of other existing regulatory programs for uranium mining; and
- A review of related emerging standards from international organizations.

Work Task B involves ongoing technical advice and assistance to the UWG. The efforts of Work Task B will result in a series of interim reports analyzing a range of issues identified in the RFP, as well as other issues identified by the UWG. These reports will provide additional detail concerning identified issues, including those related to potential uranium milling in Virginia. The reports will also elaborate on the points for consideration (PFC) outlined in this initial report.

The Work Task A and B work products will provide information for the UWG to assist in development of the requested policy analysis. These work products will also illustrate the range of programs currently being implemented by other state and federal agencies. This comparison will aid Virginia in any potential future action to develop a new statute and set of regulations to allow uranium mining.

This executive summary states the purpose and objectives of this Initial Report, the approach and scope of the literature review (Section 2.0), the comparison of regulatory programs (Section 3.0), and the review of emerging international standards (Section 4.0). The executive summary then presents major points for consideration developed from these reviews and comparisons (Section 5.0). More detailed treatment of each subject and the points for consideration are provided in this Report and its Appendices.

ES 1.1 Purpose and Objectives

The purpose of the Initial Report is to respond to the Work Task A requirement in Contract EP881027. Based on a review of existing studies, existing regulatory programs, and emerging international standards, this report presents initial analyses and recommendations concerning issues and provisions that a potential future regulatory framework for uranium mining and milling in Virginia might encompass.

ES 2.0 Literature Review

This review utilizes a focused literature review along with our combined professional experience to make recommendations concerning findings of these studies that are relevant to Virginia's existing regulatory framework that would apply to uranium mining and milling.

The literature review focuses on a group of selected studies and literature that 1) relate to uranium mining issues that are relevant in Virginia and 2) lay the groundwork for what issues and provisions a potential future regulatory framework in Virginia might encompass. This report focuses specifically on studies and literature that have raised concerns regarding effective control of uranium mining and protection of the environment and human health. While there is an extensive body of literature regarding the impact of uranium mining, comprehensive review of this material is beyond the scope of this Initial Report. Issues relating exclusively to uranium milling will be identified and addressed in future reports.

The literature review includes the following studies:

1. Chmura Study - The Socioeconomic Impact of Uranium Mining and Milling in the Chatham Labor Shed, Virginia (Chmura, 2011);

2. RTI Study - Proposed Uranium Mine and Mill, Coles Hill Virginia: An Assessment of Possible Socioeconomic Impacts (RTI, 2011);

3. Roanoke River Basin Assoc./Michael-Moran Assoc. Study - Site-Specific Assessment Of The Proposed Uranium Mining And Milling Project At Coles Hill, Pittsylvania County, VA (Moran, 2011);

4. National Academy of Sciences Study - Uranium Mining in Virginia: Scientific, Technical, Environmental, Human Health and Safety, and Regulatory Aspects of Uranium Mining and Processing in Virginia (NAS, 2011);

5. Baker Study - A preliminary Assessment of Potential Impacts of Uranium Mining in Virginia on Drinking Water Sources (Baker, 2011);

6. SENES Study - Assessment of Risk From Uranium Mining In Virginia (Senes, 1984);

7. National Resource Defense Council Study - Environmental Damage and Public Health Risks From Uranium Mining in the American West (NRDC, 2012);

8. Earthworks Study - Predicting Water Quality at Hardrock Mines: Methods and Models, Uncertainties, and State-of-the-Art (Earthworks, 2004); and

9. Earthworks Study - Comparison of Predicted and Actual Water Quality at Hardrock Mines: The reliability of predictions in Environmental Impact Statements (Earthworks, 2006).

Based on the literature review, specific points for consideration have been developed that are relevant to Virginia's existing regulatory framework or to a potential future framework for uranium mining. These points are summarized below and are categorized by the topic areas identified in the RFP.

- Water Issues
- Air Issues
- Adequacy of Virginia's Water Quality Standards for Groundwater and Surface Water
- Necessary Components of a Full Environmental Impact Analysis
- Standards for the Safe Disposal of Mine Waste
- Engineering Designs and Best Management Practices
- Methods for Addressing Risk of Catastrophic Events
- Methods for Incorporating "As Low as Reasonably Achievable (ALARA)"
- Identification and Analysis of Life Span Financial Assurance Mechanisms

These topic areas, as well as others that may be identified by the UWG with input from stakeholders and the public, will be the focus of more detailed analyses developed for Work Task B.

A complete summary of key findings from each study, comments regarding the study findings, and specific points for consideration developed by Wright Environmental Services are provided in Appendix A of this report. The points for consideration, compiled from the comparison of regulatory frameworks, review of emerging international standards and from the collective experience of the Wright Environmental Services Team, are compiled in outline format organized by mine life-cycle phase. The outline of points for consideration is presented in Section 5.0 of this report. A summary of the major points for consideration is presented in Section ES 5.0 of this Executive Summary.

ES 3.0 Comparison of Existing Regulatory Programs

This comparison addresses existing federal, state, and International uranium mining regulatory programs and recommends provisions from existing regulatory programs that would be relevant to and effective in Virginia. The comparison is not all-inclusive, as treatment of all existing uranium mining and milling regulatory programs would have been a larger action than the timing

for this task allowed. However, the comparison of existing regulatory programs assesses the programs of most relevance and includes a variety of federal, state, and international regulations. In addition, the collective experience of the Wright Environmental Services Team has been applied to the comparison of existing regulatory programs to develop points for consideration regarding a potential future regulatory framework for uranium mining in Virginia.

The federal agencies addressed in the comparison of existing regulatory programs are the U.S. Environmental Protection Agency (EPA), and the Mine Safety and Health Administration (MSHA). The NRC has no jurisdiction over uranium mining. State uranium mining regulatory programs from Colorado, Utah, and Wyoming are addressed, as well as the uranium mining regulatory program in Canada. Table 3-1 may be used to identify mining regulatory topics and the entities that may exercise authority over them. The related report sections discuss the Agencies' methods for addressing the topics within their regulatory frameworks.

Uranium mining has traditionally been administrated in a manner essentially the same as other mineral mining, as it had been developed in response to the U.S. government's quest for materials related to weapons programs. Uranium mining is generally regulated by most states/commonwealths under their mineral mining regulations and by MSHA. The EPA has developed most of the public health, occupational health, and environmental health standards, though other agencies such as MSHA may implement the standards. MSHA regulates occupational (worker) health and safety for underground and surface mines. Most states/commonwealths, such as Virginia, have developed their individual statutes and regulations to be generally consistent with MSHA. States/commonwealths have also aligned their regulatory programs with the requirements of the federal Clean Water Act and Clean Air Act and/or have been delegated formal authority over those programs by the EPA.

The NRC has no jurisdiction over uranium mining. In addition, most mine waste solids (waste rock, overburden, etc.) are exempt from the EPA hazardous waste regulations in the Resource Conservation and Recovery Act (RCRA). RCRA was amended by adding section 3001(b)(3)(A)(ii), known as the Bevill exclusion, to exclude "*solid waste from the extraction, beneficiation, and processing of ores and minerals*" from regulation as hazardous waste under Subtitle C of RCRA (EPA, 1976).

Virginia currently prohibits uranium mining. Therefore, Virginia has no regulatory framework for permitting or administering uranium mining beyond regulations that apply in general to any mineral mining operation. Virginia's Title 45.1§283 (Mines and Mining/Uranium Mine Permit Applications) indicates that applications will not be accepted until a program for permitting uranium mining is established by statute. A new statute must be promulgated specifically to establish a program for permitting and oversight of uranium mining. To develop their policy analysis and conceptual regulatory framework, the Departments will draw on information in this

report, previous and subsequent reports, stakeholder and public input, as well as their collective experience.

ES 4.0 Emerging International Standards

Over the past several decades, the international community has continued to consider methods and systems appropriate to the oversight of uranium mining, and the mitigation of the residual effects of past uranium development. In particular, the International Atomic Energy Agency, the World Nuclear Association, and the International Commission on Radiological Protection have developed a number of publications focused on environmental and human health protection and best practices associated with uranium production. This section of the Initial Report summarizes pertinent information and summaries from these international organizations. This information is incorporated in points for consideration, which recommend best practices and other emerging standards for uranium mining and milling pollution prevention and reduction.

ES 5.0 Summary of Points for Consideration

The PFC were developed for the DEQ and DMME based on the literature review, comparison of regulatory programs, assessment of emerging international standards, and relevance to Virginia. Additional issues may be identified by the UWG with input from stakeholders and the public.

ES 5.1 Organization of Points for Consideration

The PFC are tiered toward different levels of the regulatory framework that would have to be modified or developed should Virginia lift the moratorium on uranium mining and/or choose to regulate uranium recovery and control of byproduct material. The first tier is general in nature, and the PFC address the approach for scoping regulatory changes. The general PFC are presented below. The second tier is more specific and addresses individual aspects of the regulatory framework. The specific PFC are not presented for this Executive Summary due their length and specificity. The PFC from assessment of international programs, which are numerous, are presented as a third section of Chapter 5.0 and are condensed for this Executive Summary.

The PFC are focused to uranium mining, though many components of these points would be applicable to uranium milling. Based on literature review, effective existing programs, and emerging standards recommended by international experts, the following regulatory components provide an effective basis for a regulatory framework and should be considered in Virginia if the moratorium were lifted. These recommendations should be evaluated in conjunction with analysis of actual conditions in Virginia, so that their appropriateness for use in Virginia could be fully ascertained.

The PFC are not intended to suggest a preferred approach to potential future uranium mining regulation. Rather, they are intended to assist the Departments in creating a conceptual regulatory framework that might be appropriate should the General Assembly decide to lift the existing moratorium. This conceptual framework is expected to be useful for communicating information concerning potential statutory requirements, and will provide a foundation for subsequent reports to be developed as part of this study.

ES 5.1.1 General Points for Consideration Related to Uranium Mining

The PFC listed below address programmatic considerations for the Departments and the UWG.

General PFC-1: Clearly identify a single lead agency for oversight, coordination, and enforcement of specific licensed/permitted mining activities. A single agency should have lead responsibility for accepting a complete uranium mining application that addresses all media, wastes and effluents, as well as potential impacts. Delegation of secondary authority to a specific agency for specific areas associated with the license application (e.g., air permitting) should be triggered by the expertise of that agency.

General PFC-2: Uranium Projects in Virginia should be regulated "complete life cycle" in scope, whether the project consists of uranium mining, uranium milling operation, or a combined operation.

General PFC-3: Regulation of In Situ Recovery (ISR) operations. Virginia should assess if a conceptual regulatory framework is needed for ISRs at this time, given that there are no know uranium deposits in Virginia which are amenable to ISR recovery methods.

General PFC-4: In developing environmental standards, Virginia should consider a) specifically addressing uranium decay chain radionuclides in the conceptual regulatory framework; b) establishing water classes of use; c) developing guidance on adequate sampling and analytical methods, and quality assurance/quality control (QA/QC) standards for all media.

General PFC-5: Virginia should consider requirements for permitting fees and regulatory oversight cost recovery (e.g., U.S. NRC annual recalculation model) and an agency funding plan for the oversight of uranium mining projects that is independent of the general treasury.

General PFC-6: For its process of Environmental Impact Evaluations/Analysis/Statements (EIE/EIA/EA/EIS), Virginia should consider a) expanding existing EIA requirements to uranium mining, regardless of land ownership; b) expanding public participation opportunities for EIA to be more robust (i.e., federal National Environmental Policy Act [NEPA] model); and c) establishing criteria for determining the significance of impacts in the EIA process.

General PFC-7: In establishing its public involvement program, Virginia should consider the items listed below.

1. Coordinate public comment opportunities on specific uranium mining projects among the agencies responsible for primary and ancillary permits (Mine Permit, Air Permit, Storm Water Permit, VPDES Permit, Construction Permit, Water Supply Permits, Well Permits, Sewer/Leach field Permits, etc.).

2. Expand web-based information sharing, comment opportunities, notifications, public outreach and education (i.e., expand/improve use of the "Virginia Regulatory Town Hall" web site).

3. Expand the stakeholders to include those beyond adjacent land holders for uranium mining projects including public involvement in permit review EIA scoping, open access to submitted public documents and data, providing comment opportunities on draft decision documents and draft permits, comment and appeals processes for final documents, and development of Environmental Review Committees for uranium mining projects involving qualified stakeholders, including members of the public.

ES 5.1.2 Specific Points for Consideration Related to Uranium Mining

The specific PFC address all items identified in Table 3-1 of the Initial Report. As mentioned above, the specific PFC are not presented for this Executive Summary due their length and specificity. The reader is referred to Section 5.3 of the Initial Report.

ES 5.1.3 Points for Consideration from the International Community

International PFC-1: Follow the International Commission on Radiological Protection (ICRP) and NRC ongoing revision processes closely, since the regulatory basis may be changing significantly in the near future.

International PFC-2: Carefully reevaluate agency stakeholder involvement programs. Virginia should consider:

1. Maximizing public/stakeholder involvement by identifying stakeholders and then successfully engaging them in a participatory manner is a fundamental building block in the development of a successful project;

2. Requiring thorough impact assessments for uranium mining;

3. Requiring thorough risk assessments for uranium mining;

4. Implementing licensing policies requiring "Designing for Closure";

5. Implementing licensing policies requiring designs based on Best Practice principles (i.e., ISO 9000 and ISO 14000;

6. Implementing in regulation certain Best Practices related to waste management systems; and

7. Specifying in regulation a set of Best Practices related to final site closure.

International PFC-3: Carefully define how an operator develops and implements a comprehensive radiological protection program, with the assistance of U.S. and international experts.

International PFC-5: Request that an IAEA (International Atomic Energy Agency) Uranium Production Site Appraisal Team (UPSAT) review its regulatory development process.

International PFC-6: Follow the principles established by the International Commission on Radiological Protection (justification, optimization and limitation).

International PFC-7: Follow the principles from the World Nuclear Association (more detailed discussions of each are provided in the text of this Initial Report).

1. Adherence to sustainable development

2. Health, safety and environmental protection

3. Compliance systems

4. Social responsibility

5. Management of hazardous materials

6. Quality management systems

7. Accidents and emergencies

8. Transport of hazardous materials

9. A systematic approach to training, focused on necessary end results

10. Security of sealed radioactive sources and nuclear substances

11. Decommissioning and site closure

International PFC-8: Continue current policy of discussions with USNRC staff.

International PFC-9: Hire staff with specific skills to complete its expertise set.

International PFC-10: Enter into discussions with the U.S. Department of Energy's (DOE's) Legacy Management (LM) Long Term Surveillance and Maintenance (LTSM) group in Grand Junction, Colorado.

International PFC-11: Enter into discussions with the IAEA concerning the invitation of an expert international group to convene in Richmond to discuss emerging international thought on uranium extraction.

International PFC-12: Actively encourage current and future staff members to participate in national and international conferences on various aspects of uranium extraction and long-term surveillance. Staff should develop papers for presentation at such meetings, since such presentations are effective in the development of professional relationships with experts in the field. These connections will be a valuable source of information during the development of any future regulatory systems.

International PFC 13-18: Canadian example. The Canadian and specifically the uranium mining operations in Saskatchewan provide practical examples of one way of putting the IAEA principals into operation. The environmental review process clearly defines the baseline and the potential impacts on the environment. A series of license conditions define requirements through all phases of mine development, exploration, test mines, construction, operation, closure and abandonment. There are strongly defined public consultation processes throughout the mine life. Processes are in place to ensure that the benefits of mining accrue locally. Strong radiation protection/monitoring systems have been put in place to protect the workers and local community.

Many of the uranium mines in Saskatchewan require test mining for metallurgical and engineering purposes. The bulk samples provide strong technical information on the full scale operations on which to base review and licensing processes.

International PFC-19: Consider whether Virginia will operate on a cost recovery basis with regards to licensing and inspections.

International PFC-20: Regulatory control can be achieved in different ways. Consider the pros and cons of a performance-based-system (licensing can either be standard-based or results/performance based.) Additional regulatory control can be achieved by using multiple licenses covering construction, operation, closure, and abandonment.

International PFC-21: Consider the value of requiring license renewal; more than one license during the life of a project.

International PFC-22: Ensure benefits accrue to Virginia. Saskatchewan has evaluated the social benefits and risks associated with uranium mining and milling. The province has taken steps to ensure that social benefits from the project accrue to Saskatchewan.

International PFC-23: Ensure an ongoing dialogue about the environment with the local community and how to establish and maintain such a dialogue. Saskatchewan has established Environmental Quality Committees to ensure an ongoing dialogue between local communities and mines.

1.0 INTRODUCTION

In response to renewed interest in uranium mining and milling, and concerns regarding the potential environmental and public health risks versus potential economic benefit, Virginia has undertaken studies assessing the range and form of possible regulatory frameworks that might be adopted should the existing moratorium on uranium mining be lifted. On January 19, 2012, the Governor directed members of his cabinet to form a Uranium Working Group (UWG) to provide a scientific policy analysis to help the General Assembly assess whether the moratorium on uranium mining in Virginia should be lifted, and if so, how best to do so.

A study by the National Academy of Sciences (NAS) titled "Uranium Mining in Virginia: Scientific, Technical, Environmental, Human Health and Safety, and Regulatory Aspects of Uranium Mining and Processing in Virginia" (NAS, 2011) and other recent studies on uranium mining and milling in Virginia have identified issues related to the protection of public and occupational health and safety, as well as the environment and potential socioeconomic impacts. Consequently, the UWG has been directed to develop a conceptual regulatory framework that would address these issues, as well as other issues identified by the UWG, the public and other stakeholders.

In order to respond to this directive, the UWG issued two requests for proposal (RFP) to solicit expert advice. Due to the different areas of focus and responsibility of the staff within the UWG, two procurements were developed - one to address issues related to the Virginia Department of Environmental Quality (DEQ) and Virginia Department of Mines, Minerals, and Energy (DMME) areas of responsibility, and one to address the areas of responsibility related to VDH. This Initial Report has been developed in response to the DEQ/DMME procurement. The DEQ/DMME procurement is briefly described below.

1.1 Procurement Summary

On March 2, 2012, the Department of Environmental Quality issued the RFP # 12-06-PJ (Uranium Study). The purpose of the procurement was to acquire contractor services to provide information and expert analysis of uranium mining and milling issues in Virginia relevant to the statutory jurisdictions of DEQ and DMME. Sealed bids were submitted by April 3, 2012, and contract EP8811027 was awarded on May 21, 2012.

The Contract identifies two major work Tasks (A and B). Work Task A involves the development of an initial report based on 1) a review of studies related to uranium mining and milling in Virginia, 2) a comparison of other existing regulatory programs for uranium mining and milling, and 3) a review of emerging standards from international organizations. This initial report is developed in response to Work Task A.

Work Task B involves ongoing technical advice and assistance to the UWG. The efforts of Work Task B will result in a series of interim reports, analyzing a range of issues identified in the RFP, as well as other issues identified by the UWG. The efforts of Work Task B will provide additional detail to the issues and recommendations addressed in this initial report.

1.2 Purpose and Objective

The purpose of this Initial Report is to respond to Work Task A in Contract EP881027. Based on a review of existing studies, existing regulatory programs, and emerging international standards, this report presents an initial analysis and recommendations concerning issues and provisions that a potential future regulatory framework for uranium mining and milling in Virginia might encompass.

2.0 INITIAL LITERATURE ANALYSIS

The initial analysis of uranium mining issues within Virginia focused on review of select uranium-related studies and literature that relate directly to uranium mining and/or milling issues relevant to Virginia. This review will assist Virginia in considering policies and program elements or program provisions that would be effective and applicable to potential future regulation. Special attention was given to studies and literature that raised concerns regarding effective control of uranium mining and milling and protection of environmental and human health. There is an extensive body of literature regarding environmental and human health protection associated with uranium mining and milling. Review of this entire body of literature is beyond the scope of this Initial Report. The studies addressed herein only represent the most recent works specifically focused on the issues and concerns related to uranium mining in Virginia, since the initial literature review was limited in time and scope. However, it is very likely that all of the major issues faced by the UWG and the General Assembly on this topic have been identified.

Based on this review, the Wright Environmental Services (WES) team developed points for consideration that are relevant to a conceptual framework for uranium mining in Virginia. The points for consideration are presented in Section 5.0 of this report. The points for consideration are based on a review of the identified literature, the comparison of regulatory programs assessed in Section 3.0, the assessment of emerging international standards discussed in Section 4.0, and the collective experience of the WES team. The WES team includes the perspectives of state, federal, and Canadian regulatory agencies, academia, environmental consulting groups, and industry. A more complete summary of key findings from the uranium-related studies, comments regarding the study findings and the associated points for consideration are provided in Appendix A.

The following studies were addressed as part of this review:

1. Chmura Study - The Socioeconomic Impact of Uranium Mining and Milling in the Chatham Labor Shed, Virginia (Chmura, 2011);

2. RTI Study - Proposed Uranium Mine and Mill, Coles Hill Virginia: An Assessment of Possible Socioeconomic Impacts (RTI, 2011);

3. Roanoke River Basin Assoc./Michael-Moran Assoc. Study - Site-Specific Assessment Of The Proposed Uranium Mining And Milling Project At Coles Hill, Pittsylvania County, Virginia (Moran, 2011);

4. National Academy of Sciences Study - Uranium Mining in Virginia: Scientific, Technical, Environmental, Human Health and Safety, and Regulatory Aspects of Uranium Mining and Processing in Virginia (NAS, 2011);

5. Baker Study - A preliminary Assessment of Potential Impacts of Uranium Mining in Virginia on Drinking Water Sources (Baker, 2011);

6. SENES Study - Assessment of Risk From Uranium Mining In Virginia (Senes, 1984);

7. National Resource Defense Council Study - Environmental Damage and Public Health Risks From Uranium Mining in the American West (NRDC, 2012);

8. Earthworks Study - Predicting Water Quality at Hardrock Mines: Methods and Models, Uncertainties, and State-of-the-Art (Earthworks, 2004); and

9. Earthworks Study - Comparison of Predicted and Actual Water Quality at Hardrock Mines: The reliability of predictions in Environmental Impact Statements (Earthworks, 2006).

3.0 COMPARISON OF EXISTING REGULATORY PROGRAMS

Virginia currently has a moratorium on uranium mining, does not have laws and regulations in place that would adequately address uranium mining, and has explicit requirements to establish a new statute to address the specific issues associated with uranium mining, if the moratorium is lifted (Code of Virginia Title 45.1 § 283). In order to support legislative decision-making regarding whether or not to lift the existing moratorium, the UWG is developing a conceptual regulatory framework, and has sought additional information regarding other existing regulatory programs. The UWG has sought input on this conceptual regulatory framework from other states, the federal government, the public and other experts in this area.

This section of the report provides a summary and comparison of selected federal, state, and international uranium mining regulatory programs (see Table 3-1). The comparison is used to identify provisions from those programs that are relevant to Virginia, should it lift the existing moratorium on uranium mining. This report supplements the Departments' own extensive experience and expertise with regulating mining. This cannot be an all-inclusive comparison, because to address all existing uranium mining regulatory programs exceeds the scope, time and budget allocated for this task. However, the report addresses the programs of primary importance and most relevance to the issues in Virginia and includes a variety of federal, state, and international regulatory bodies.

This report section is organized by regulatory topic. First, the report addresses only mining regulation. The U.S. regulates mining and milling using different regulatory bodies under different statutes. The regulation of milling and licensing for possession and control of Byproduct Material will be addressed in other reports later in the UWG uranium study. Second, the regulation of mining is broken down into key regulatory areas that should be addressed in a comprehensive regulatory program. Table 3-1 presents a list of key regulatory areas, indicates which of these areas are addressed by the identified regulatory bodies, and locates additional references for each regulatory area found within this report. This section is not intended to be read sequentially, although it can be. The intent is for readers to use Table 3-1 to identify mining regulatory topics and the associated mining regulatory authorities or entities. The reader is intended to use the table to identify the specific report sections that address the areas of interest. Those sections then present brief discussions of how the agencies identified in Table 3-1 address those topics in their regulatory framework.

Federal regulatory agencies with jurisdiction over uranium mining include the EPA and the MSHA. The Nuclear Regulatory Commission (NRC) does not have regulatory jurisdiction over uranium mining, and therefore, The NRC's role and practices are addressed in other related reports that cover uranium milling. The Bureau of Land Management (BLM) regulates the mining of uranium on most western federal lands, and although discussed briefly, it is not included in Table 3-1 or in the specific comparisons, as BLM requirements are either specific to

federal lands or duplicated by the selected states. Uranium mining regulatory programs in the States of Wyoming, Colorado, and Utah are addressed in this comparison. Colorado and Utah represent Agreement States for uranium recovery regulation, i.e., states that have entered into agreements with NRC that give them the authority to license and inspect byproduct, source, or special nuclear materials (including uranium recovery activities). Canada is compared separately since there are significant differences between the Canadian program and those of the United States. However, Canada is a major producer of uranium, has a robust regulatory program, and its program is relevant to the purpose of this report.

At the state level, Virginia regulates mining through the DMME. This agency regulates oil and gas, mineral mining, and coal mining but currently does not have the authority to permit or regulate uranium mining. The DMME also conducts geologic research and offers assistance on the use of Virginia's mineral resources. The DMME serves the citizens living near mining operations, labor groups, other regulatory agencies, the educational community, the mineral industry, consumer groups, and environmental special interest groups. Both Mine Safety and Health Administration (MSHA) and DMME conduct inspections of mining operations and have enforcement capability for non-compliance with laws, regulations, and requirements contained in permit and license documents.

MSHA has national oversight of uranium mining operations. MHSA's mission, which is to prevent the death, disease, and injury of miners by providing them a safe and healthful workplace, is solely focused on occupational health and safety of miners and does not address public health or environmental protection. In contrast, the DMME's mission overlaps with MSHA's for occupational health and safety but also includes the elimination of off-site environmental and public health impacts and addresses the proper restoration of disturbed lands. Unlike Virginia, MSHA does not have any regulations or mandates that govern mine design, planning, or permitting. In addition, there are no requirements that compel mine operators to demonstrate the ability to meet air and water quality standards, land restoration standards, or provide for financial assurance that these standards will be met.

3.1 Regulation of Uranium Mining

Uranium mining regulations have evolved as the understanding and awareness of the associated potential hazards of uranium mining have grown. Uranium mining has traditionally been regulated essentially the same as other mineral mining, as it developed in response to the U.S. government's quest for materials related to weapons programs. Early in the history of uranium mining, the health effects of uranium and radioactivity on biological systems were not as well understood as they are today, and thus, industry explored, developed, and produced the uranium much as it had other strategic metals. Since the late 1950's, the uranium industry has shifted from being largely driven by government procurement for weapons to being driven by the international demand for nuclear fuel.

Starting in the 1970's and continuing through to the present day, it became apparent that uranium mining required additional regulation as environmental impacts from the pre-law mining period became better known and concerns regarding health effects in uranium miners grew. Uranium mines are still largely regulated by states under their respective mineral mining regulations, and by MSHA under federal regulations.

The EPA has developed most of the public health, occupational health, and environmental health standards; although different agencies like MSHA implement many of the standards. Where the federal government has not established specific standards, states have developed individual statutes and regulations to address mining within their borders.

3.2 Overview of Mining Regulatory Frameworks

Both the state and federal governments have regulatory responsibilities over mining operations on federal and private lands. Federal lands comprise a significant portion of the lands within the western states where uranium mining occurs, while federal lands represent a very small fraction of lands used for mining in the eastern U.S. The federal government has a much smaller role in the regulation of uranium mining on state and private lands, restricted primarily to occupational health and safety oversight by MSHA, as well as public health and safety regulation by EPA for areas such as air and water quality. Because the vast majority of modern uranium mining and the associated regulation occur in the western U.S., this discussion focuses extensively on the components of federal and western states regulation of uranium mining.

Federal regulations were established in the General Mining Law of 1872. The BLM has responsibility for permitting uranium mining operations on most western federal lands. The BLM has various agreements with the western states to coordinate and reduce duplication of uranium mining regulation. As shown in Table 3-1, the states reviewed for this report have varying levels of regulatory authority over their own uranium mining. Normally, the state regulations are more specific than BLM's, and the BLM/state agreements allow the states to take the lead in the regulation of uranium mining. The National Environmental Policy Act (NEPA) is one area for which BLM retains lead responsibility, though some states have their own public notice and comment processes implemented in parallel. Because there are very few federal lands in Virginia that could be subject to uranium development, the federal program addressing uranium mining (e.g., BLM) is not discussed in detail herein.

Figure 3-1 generally illustrates the current relationship of the primary regulatory entities and their focus with respect to uranium mining in the U.S. This figure focuses on the wastes, effluents, and products developed from these industries, as these are the radiological and/or hazardous materials which drive most, though not all, of the regulatory process. From this figure it is evident that, like most other countries in the world, uranium mining in the U.S. is regulated by a variety of entities, both state and federal.

A uranium mining applicant in the western states would be subject to the many federal laws, regulations, and policies listed below. Some of these programs have been delegated to individual states. These regulations and policies would be applicable to any potential uranium mine in Virginia except for those noted as relating solely to federal lands or minerals.

- 27 Code of Federal Regulations (CFR) 555 Commerce in Explosives – authorizes the Bureau of Alcohol, Tobacco and Firearms to regulate the sale, transportation, and storage of explosives.
- 43 CFR 3715 Use and Occupancy Under the General Mining Laws (federal lands only) – regulates residency or seasonal occupancy of mining claims by mining claimants and requires that BLM concur with the use and occupancy of public lands for the development of locatable mineral deposits by limiting such use or occupancy to that which is reasonably incident.
- 43 CFR 3809 Mining Claims under the General Mining Laws (federal lands only) – requires proper permits and authorizations for mineral exploration, mining, and reclamation actions on the public lands administered by BLM and sets performance standards for preventing undue and unnecessary degradation of federal lands.
- Clean Air Act – establishes National Ambient Air Quality Standards to control air pollution. Impacts to air quality from mineral development are controlled by mitigation measures developed on a case-by-case basis.
- Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) - requires owners/operators to report to the government any release of hazardous substances to the environment, and to inventory chemicals handled.
- Endangered Species Act – mandates protection for plants and animals that are federally listed as threatened with or in danger of extinction. Concurrence from the U.S. Fish and Wildlife Service would be required, were the Proposed Action to potentially or adversely affect any threatened, endangered, or candidate species, as determined by the authorizing agency.
- Executive Order 12898 of 1994, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations – requires federal agencies to ensure that proposed projects under their jurisdictions do not cause a disproportionate environmental impact that would affect any group of people because of a lack of political or economic strength. Environmental justice requires the fair treatment of people of all races, cultures, incomes, and educational levels with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

- Federal Land Policy and Management Act (FLPMA) (federal lands only) – requires the Secretary of the Interior to manage public lands under principles of multiple use and sustained yield and authorizes the Secretary to regulate the use of public land for the prevention of unnecessary or undue degradation.
- Federal Mine Safety and Health Act – authorizes the MSHA to regulate more effective means and measures to improve the working conditions and practices in the nation's mines, in order to prevent death and serious physical harm, and in order to prevent occupational diseases originating in such mines. To comply with these standards, an applicant would be required to obtain the necessary MSHA mine Identification Number and to provide information and plans required under 30 CFR.
- Federal Water Pollution Control Act (Clean Water Act [CWA]) – directs standards to be set for surface water quality and for controlling discharges to waters of the U.S. Under Section 402 of the CWA (as amended), the EPA was directed to develop a phased approach to regulate storm water discharges under the National Pollutant Discharge Elimination System (NPDES) program. Industrial activities disturbing more than one acre of land may require an NPDES permit for storm water discharge. Depending on the acreage disturbed, either a Phase I industrial activity (5 or more acres of disturbance) or a Phase II small construction activities (between 1 and 5 acres of disturbance) permit may be required. Additionally, a U.S. Army Corps of Engineers Section 404 permit and associated Section 401 certification for the discharge of dredge and fill materials into waters of the U.S. may be required.
- General Mining Law of 1872 – (federal lands and minerals) allows private U.S. citizens and businesses to prospect for, discover, locate and extract certain valuable minerals on federal public domain lands that are open for that purpose. Later amendments, including the Hard Rock Mining Act, withdrew particular public lands from mining.
- Migratory Bird Treaty Act – prohibits the taking, killing, or possessing of migratory bird species.
- National Environmental Policy Act (NEPA) (federal lands only) – requires interdisciplinary approach to ensure disclosure of proper consideration being given to the environment prior to undertaking any federal action that may impact the environment. NEPA requires that the discussion of issues and concerns are commensurate with the potential impacts. Federal Council on Environmental Quality (CEQ) Regulations (1500.5(c)) state that impacts shall be discussed in proportion to their significance. Other CEQ Regulations (1501.7 (3)) make it clear that discussion of all resources is not necessary, only those that are significant.

- National Historic Preservation Act (NHPA) – requires federal agencies to inventory and protect historic and archaeological resources. Concurrence from the State Historic Preservation Officer is required, if any historic properties may be affected by the Proposed Action.
- Resource Conservation and Recovery Act (RCRA) – regulates the generation, storage, and disposal of hazardous waste and management of solid, non-hazardous waste. Under the Bevill Amendment, wastes that are uniquely associated with the extraction of ores and minerals are exempt from RCRA requirements, but not wastes generated at mining sites that are not uniquely associated with the mining operations, such as solvents, lubricants, or degreasers (EPA, 2009).
- Safe Drinking Water Act – directs standards to be set for quality of drinking water supplied to the public (states are primary authorities) and regulates underground injection operations.
- 40 CFR Part 61, Subpart B – The general public would be protected by monitoring of radiation emissions from a uranium mine using EPA approved methods and adhering to ore transportation regulations established by the U.S. Department of Transportation. Radon monitoring and reporting procedures consistent with the National Emission Standards for Hazardous Air Pollutants (NESHAP) Subpart B standards as outlined at 40 CFR Part 61 are required depending on mine size. Pursuant to NESHAP standards, emissions of radon-222 to the ambient air from an underground uranium mine shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 millirems per year (mrem/y). Monitoring data are to be analyzed via an EPA air-modeling program to predict radiation levels at the nearest residence.
- 49 CFR Part 172 and Part 173 – The general public would be protected from hazards associated with the transportation of uranium ores and milling products by transportation regulations established by the U.S. Department of Transportation.

3.3 Comparison of Mining Regulatory Frameworks

3.3.1 Permitting/Licensing

The current common practice between applicants and agencies is for applicants to meet with relevant agencies during the company's internal scoping process to develop a working relationship with the agency staff, to identify agency impressions and concerns early in the process and to establish clear lines of communication and clear understanding of process between the parties. Wyoming and Utah do not require by law or statute any such meetings, though they are encouraged. Colorado requires a pre-application conference with the state

agency only for in situ recovery (ISR) mining operations, though it is not required for other types of mining. Pre-application meetings are required in Canada as part of the exploration phase.

MSHA

MSHA requires that operators of metal and non-metal mines apply for an Identification Number prior to initiating work on a proposed facility. Any changes in company officials, ownership, addresses, and contact information must be reported to MSHA within 30 days.

WYOMING

Wyoming regulates all types of mining under the Wyoming Environmental Quality Act (Title 35, Chapter 11) through the Wyoming Land Quality Division (WLQD) of the Wyoming Department of Environmental Quality (WDEQ). The range is from small sand and gravel operations to the largest coal mines in the United States, and includes open pit, underground and in situ recovery uranium operations. For underground mining, the surface above the vertical projection of underground workings must be within the permitted boundary. In contrast, some other states only require actual surface disturbances be encompassed within the permit area and allow some underground workings to extend beyond the mine permit boundary. The WLQD generally takes the lead on surface and groundwater issues relating to mining operations but coordinates those issues with the Water Quality Division (WQD) within the WDEQ. The same is true of the disposal on site of domestic waste, while RCRA wastes are under the jurisdiction of the Solid and Hazardous Waste Division within WDEQ. Air quality permitting is through the Air quality Division of WDEQ.

UTAH

Under Utah Code Title 40, Chapter 8, Utah Mined Land Reclamation Act, the Board and Division of Oil, Gas and Mining regulate mining operations. Mining operations are subject to a wide range of federal, state, and local requirements. Many of these require permits, approvals or consultations before the mining operations commence, whereas others mandate the submission of various documents, or establish specific prohibitions or standards.

Other requirements include building permits from the local county building department; submission to the Utah Division of Oil, Gas and Mining (UDOGM) of a Notice of Intent to Conduct Small or Large Mining Operations and issuance of a Small or Large Mine Permit by the UDOGM. The Utah Division of Air Quality may require a New Source Review, including an Approval Order and an Operating Permit.

Prior to commencement of operations, a Notice of Intention to Commence Small or Large Mining Operations containing all the required information must be filed with and approved by the UDOGM and the Division must have approved the form and amount of reclamation surety.

COLORADO

There are two primary agencies in Colorado that regulate uranium mining operations, including ISR facilities. Under the Colorado Mined Land Reclamation Act (C.R.S. § 34-32-101, *et. seq.*), the Colorado Division of Reclamation, Mining and Safety (CDRMS) regulates and issues permits for conventional uranium mining projects (both surface and underground mines). CDRMS implementing regulations are found in 2CCR 407-1. The Colorado Radiation Control Act (C.R.S. § 25-11-101, *et. seq.*) together with an agreement with the NRC dictates that the Colorado Department of Public Health and Environment (CDPHE) is the primary regulatory agency responsible for regulating all radioactive materials in Colorado, including uranium in-situ recovery operations, through its Radiation Management Unit (RAM), (C.R.S. § 25-11-102). CDPHE implementing regulations are found in 6CCR 1007-1.

Both CDPHE and CDRMS regulate ISR operations in Colorado. CDHPE regulates those portions that involve radioactive materials. CDRMS is responsible for implementing the state's groundwater quality standards (C.R.S. § 25-8-202(7)) and regulates uranium extraction from its natural occurring place in nature (i.e., the wellfield).

Other state agencies directly involved with the regulation of uranium mining in Colorado include the Water Quality Control Division (CWQCD), which permits discharges to surface water and permitting and enforcement of point source discharges to surface waters of the state, the Air Quality Control Division (CAQCD), which issues air quality permits and enforces the state's air quality standards, and the Department of Transportation (CDOT) which regulates the transport of ore to the mill. Other divisions or programs may also provide regulatory oversight and permitting as appropriate.

3.3.1.1 Environmental Baseline

The programs and requirements for environmental baseline are similar in these three states; all are basically consistent with current national or federal programs (i.e., BLM) with minor differences. Uranium mine permits are regulated by a single agency, which oversee mineral mines as well, and require baseline studies covering all major media (groundwater, surface water, wildlife, soils, vegetation and meteorology/climatology and air quality). Air quality and some engineering permits (i.e., septic sewer and leach field, dam stability, etc.) are typically regulated by sister agencies (i.e., Division of Air Quality, State Engineers Office).

Canada has a similar structure where the Provinces regulate most aspects of the mining, though the national government regulates radiation hazards. Requirements for Provincial baseline studies include most of the NEPA topics including noise, transportation, power sources, and socio-economic considerations.

WYOMING

Wyoming has a mine permitting program that follows national norms such that baseline environmental studies are required prior to the submission of the mine permit application. Some studies are seasonally dependent (such as vegetation) or require sampling events spread over a twelve-month period (such as groundwater). Of particular interest to this effort is the detail concerning groundwater including quantity, quality, potentiometric surface maps, flow rates and direction for each potentially affected aquifer. Also important is the characterization of overburden and waste rock (See W.S. §35-11-401 thru 437).

UTAH

Most uranium mining in Utah occurs on federal lands and/or involves federal minerals. The Division of Radiation Control (DRC)/BLM requires baseline water, wildlife, soils, vegetation, and climate studies for conformance to state/federal requirements per 43 CFR 3809.420. Sufficient detail must be provided for BLM to determine that the plan of operations prevents unnecessary or undue degradation of public lands. This detail includes a description of the equipment, devices, or practices proposed for use during operations. Required information, where applicable, includes the following:

- maps of the project area at an appropriate scale showing the location of exploration activities, drill sites, mining activities, processing facilities, waste rock and tailings disposal areas, support facilities, structures, buildings, and access routes;
- preliminary or conceptual designs, cross sections, and operating plans for mining areas, processing facilities, and waste rock and tailing disposal facilities;
- water management plans;
- rock characterization and handling plans;
- quality assurance plans;
- spill contingency plans;
- a general schedule of operations from start through closure;
- plans for all access roads, water supply pipelines, and power or utility services; and
- examples of monitoring programs that may be necessary include surface and groundwater quality and quantity, air quality, re-vegetation, stability, noise levels, and wildlife mortality.

In addition to the above requirements, BLM may require operational and baseline environmental information to analyze potential environmental impacts as required by the NEPA and to determine if the plan of operations will prevent unnecessary or undue degradation. This could include information on public and non-public lands needed to characterize the geology,

paleontological resources, cave resources, hydrology, soils, vegetation, wildlife, air quality, cultural resources, and socio-economic conditions in and around the project area. Also, BLM may require information on the results of static and kinetic testing to characterize the potential for operations to produce acid drainage or other leachate.

COLORADO

Pursuant to 2 CCR 407-1, CDRMS requires baseline studies and information regarding the affected environments listed below.

- Water – If surface and/or groundwater are to be affected, the application shall 1) Locate all surface waters on the affected lands and adjacent lands, identify all known aquifers and explain how water from dewatering operations or from runoff from disturbed areas will be managed to prevent pollution during and after the mining operation; 2) Provide an estimate of the project water requirements; 3) Indicate the projected amounts of ground and surface water required for operation and reclamation (Rule 6.4.7).
- Wildlife – Describe the game and non-game resources on and in the vicinity of the application area and request input from the Division of wildlife (Rule 6.4.8).
- Soils – Provide general type, thickness, and distribution of soil over the affected area and address topsoil suitability for establishment and maintenance of plant growth; consult with the Soil Conservation Service or other qualified person(s) (Rule 6.4.9).
- Vegetation – Provide vegetation types, estimates of cover and height, relationship of vegetation types to soil types, estimates of average annual crop production (Rule 6.4.10).
- Climate – Provide description of climatological factors for the locality of the application area (Rule 6.4.11). Also provide a characterization of the ore body and overburden to be removed, including thickness and type of material, and the nature of the geologic material immediately underlying the mining zone if the material is a sedimentary deposit (Rule 6.4.4).

3.3.1.2 Historical and Cultural Resources

The programs and requirements for historical and cultural resources required by states are often equal to or less stringent than those required by federal agencies and are typically not more stringent. Utah regulations require historical and cultural surveys for any mine permit, whether on state or private lands while the Wyoming Office of State Lands requires surveys on state lands but it remains discretionary with the WLQD for private lands. In contrast, Colorado requires such surveys for state lands, but surveys are only requested on private land if requested by the landowner.

Federal requirements under NEPA and the NHPA require historical and cultural surveys for all uranium mining projects involving federal lands and/or minerals. In Canada, both federal and provincial legislation requires that the developers of uranium mines conduct archeological surveys prior to construction as part of the normal environmental review.

WYOMING

WLQD non-coal Rules &Regulations (R&R) Chapter 2, Section 2(a)(i)(J), require that the applicant provide "a description of any significant artifacts, fossil or other article of cultural, historical, archaeological or paleontological value. Upon recommendation by a qualified archaeologist or a qualified paleontologist, the Administrator may require an evaluation of the proposed permit area prior to the time that a permit or license is issued". The regulation specifies this for ***each*** [emphasis added] permit application, not just those on federal lands. WLQD Guideline 11 details what is needed in a cultural/paleontological resources inventory and report. The Wyoming State Historic Preservation Office (WySHPO) does not have specific regulations or requirements other than for federal projects. Therefore, it is WDEQ/WLQD that requires SHPO clearance for historical and cultural surveys.

UTAH

Though most uranium mining in Utah involves federal lands and/or minerals, which then are subject to federal (i.e., BLM) rules and regulations, uranium mining solely on state or private land would require historical and cultural surveys as per Utah Code Title 9, Chapter 8, Section 404. Mining involving federal land and/or minerals are addressed by BLM regulations; 43 CFR 3809.410 notes that information concerning affected cultural resources may be required, suggesting consultation with BLM.

COLORADO

Rule 6.3.6, Exhibit F 6.4.13-Other Permits and Licenses, and Exhibit M-Other Permits and Licenses of the CDRMS regulations require the applicant to contact the State Historic Preservation Office (i.e., History Colorado) to seek a clearance permit. Colorado enacted the Historical, Pre-historical and Archaeological Resources Act (CRS 24-80-401 to 410) in 1973, which created the Office of the State Archaeologist within the Colorado Historical Society. The Act authorized the implementation of rules to protect cultural and historical properties within the state of Colorado. The regulations (8CCR 1504-7) require an applicant to apply for a permit from the state archaeologist for any proposed surface disturbance on any state lands, and on private lands if the landowner requests it and the state archaeologist concurs. The only exception is that the excavation of any unmarked human burial older than 100 years, regardless of ethnic affiliation, shall require a permit if such burial is located within any (state or private) nonfederal land in Colorado.

3.3.1.3 Mine Operations Plan

MSHA

MSHA requires several plans related to operation of a mineral mine. Emergency firefighting, and evacuation and rescue plans are required for all mines. Additionally, diesel particulate matter control, escape and evacuation, firefighting, rock burst, and ventilation plans are required for all underground mines. These plans provide specific operating procedures, equipment, mining methods and mine design requirements that must be met in order to protect the health and safety of miners.

WYOMING

The Wyoming regulatory program is "complete life cycle", and holistic in approach, encompassing public, occupational and environmental health from pre-operational planning to post-reclamation of the mine. The mine plan must consider the reclamation requirements during the planning process and there are situations where the reclamation requirements drive the mine planning. The mine plan provides details such as method of mining, equipment used, temporary and permanent stockpile areas, environmental protection, and mining sequence (See W.S. §35-11-406[b]).

UTAH

The UDOGM enforces Utah's mining laws and regulations on all lands in the state subject to the state's police power. The UDOGM's responsibility for ensuring reclamation of mined lands is set forth in Utah's Mined Land Reclamation Act, Title 40, Chapter 8 (Reclamation Act). The Reclamation Act requires that all mining operations in the state include plans for reclaiming the affected land. Before an operator may begin mining operations, notice of intent must be filed with the UDOGM, providing a description of the extent of operations. Small operations, those encompassing surface disturbance of less than five acres, do not require approval of notice, but must provide a statement that reclamation work will be completed. Large operations, those which will disturb more than five surface acres, are required to submit a notice of operation plan to the UDOGM, including extent of operations, methods and routes of access, proposed surface structures, and mitigation efforts to avoid environmental harm. The UDOGM must approve the operation plan before operations can commence.

Utah requires the operator to provide a narrative description of the proposed operations referencing maps or drawings as necessary. The narrative description is to include the following components:

- Type of mineral(s) to be mined;

- Type of operations to be conducted, including the mining/processing methods to be used on-site, and the identification of any deleterious or acid forming materials present or to be left on the site as a result of mining or mineral processing;
- Estimated acreages proposed to be disturbed and/or reclaimed annually or sequentially;
- Description of the nature of the materials to be mined or processed including waste/overburden materials and the estimated annual tonnages of ore and waste materials to be mined;
- Description of existing soil types, including the location and extent of topsoil or suitable plant growth material. If no suitable soil material exists, an explanation of the conditions shall be given;
- Description of the plan for protecting and re-depositing existing soils;
- Description of existing vegetative communities and cover levels, sufficient to establish re-vegetation success standards in accordance with Rule R647-4-111;
- Depth to groundwater, extent of overburden material and geologic setting;
- Proposed location and size of ore and waste stockpiles, tailings facilities and water storage/treatment ponds; and
- Information regarding the amount of material (including mineral deposit, topsoil, subsoil, overburden, waste rock, or core hole material) extracted, moved or proposed to be moved.

COLORADO

CDRMS requires a mining plan in accordance with Title 34, Article 32, Colorado Mined Land Reclamation Act and Rule 6.4.4 of 2 CCR 407-1 of the Hard Rock Metal Mining Rules and Regulations. As a minimum, the mining plan must describe the earthmoving and mining methods to be employed during each stage of the operation and the size of the area(s) to be mined at any one time; describe and show on a map(s) all water diversions and impoundments; provide a table describing the different phases of the operation, establishing the relationship between mining and reclamation, and including estimates of time involved for the various stages of mining and reclamation, the size and location of each mining area, and the mining sequence; describe the primary and secondary commodities to be mined and their intended use; identify if and what type of explosives will be used; and provide a Geotechnical Stability Exhibit that demonstrates that offsite areas will not be adversely affected by proposed blasting. The mining plan must include maps and narrative that provide the nature, depth and thickness of the deposit and the thickness and type of overburden material; and, for sedimentary deposits, the nature of the geologic units immediately underlying the mining zone.

3.3.1.4 Reclamation/Closure Plan

All states require detailed reclamation and closure plans for uranium mines and have general guidance applicable to all mineral mines. These plans and the associated guidance require the plans to address reclamation sequence, details of contouring, topsoil cover, and seeding to meet post mining land use. No state has any specific requirements for control of radon flux, direct gamma radiation or radio-particulates. The states require that reclaimed facilities (i.e., waste rock piles) are stable against erosion, and consistent with area natural landforms.

In Canada, two processes exist. At the provincial level a closure plan with bonding is required; the plan is reviewed every 5 years during operation. At the national level a closure license is required, which includes a comprehensive environmental assessment.

WYOMING

The reclamation plan required by Wyoming includes the sequence of reclamation, post mining land use, post mining topography, a description of topsoil application and seeding species, and an evaluation of success (See W.S. §35-11-406[b]).

UTAH

In Utah, all mining operations, large and small, must provide a reclamation plan before beginning operations, and following cessation of operations, must conduct reclamation work as prescribed by the UDOGM's regulations (Reclamation Act). The UDOGM requires that operators provide surety for the reclamation plan before operations can begin. The UDOGM determines the amount of surety required, based upon the nature and extent of the proposed mining operation, and the magnitude and type of reclamation required.

The UDOGM's reclamation guidelines require that operators "minimize hazards to the public safety and welfare" by reclaiming the areas disturbed by mining operations. Operators are required to seal any adits, remove all buildings and other debris, restore natural drainages so as not to harm the hydrological cycle, provide erosion control, redistribute disturbed topsoil and re-vegetate, and remove all "deleterious materials".

COLORADO

In Colorado, a reclamation plan (decommissioning plan) is required by Title 34, Article 32, Colorado Mined Land Reclamation Act and Rule 6.4.5 of 2 CCR 407-1. The Plan must include planned activities, radiation safety procedures, radiation surveys for decommissioning, decommissioning cost estimates, and a decommissioning schedule. The plan should be specific in terms of addressing final grading, seeding, fertilizing, and placement of topsoil, and compare the proposed post-mining land use to other land uses in the vicinity. Rule 3.1 of 2 CCR 407-1 provides reclamation performance standards for land use, materials handling, protection of surface and groundwater quality, safety and protection of wildlife, habitat management and

creation, topsoil protection and conservation, re-vegetation with native or non-native species to a diverse cover that is capable of self-regeneration, preservation or demolition of buildings and structures, and toxic or hazardous materials spills or releases. The reclamation plan should describe how each of the reclamation performance standards in Rule 3.1 is met. The plan must include a schedule that shows how and when reclamation will be implemented, and that is tied to completion of the different stages of the mining operation. The plan should include a map(s) showing all proposed affected lands and indicating the proposed final topography and proposed final land use. Each phase of reclamation must be completed within five years after the date of commencement.

3.3.1.5 Mine Worker Health and Safety Plan

MSHA requires initial and ongoing miner safety training, and limited specific plans. Colorado, Utah and Wyoming mine safety programs meet the MSHA requirements established in Title 30 of the federal Code of Regulations for safety and training. In Canada, federal radiation management is required through the operating licenses. The province enforces other aspects of mine safety through the Provincial Mine Safety Act. The comparison of how these agencies address these worker health and safety plans is the subject of other reports developed as part of this Study. OSHA is responsible for worker health and safety at ISR facilities.

MSHA

MSHA has regulations that limit miner exposure to gamma radiation and radon. Miners must be protected from radiation exposure through the establishment of adequate mine ventilation (30 CFR Part 57.2223). A radon-daughter monitoring program must be established, in accordance with Title 30 CFR Part 57.5037, in which exposure levels would be monitored and recorded. If radiation levels in a working area are found in excess of MSHA standards (in excess of 0.3 working level units in an active working area), the ventilation is corrected. Gamma radiation surveys of underground workings are required by regulations at Title 30 CFR 57.5047, and workers would wear dosimeters to monitor gamma radiation exposure and ensure that MSHA standards are not exceeded.

WYOMING

Mineworker health and safety is regulated by the State Mine Inspector's Office within the Wyoming Department of Workforce Services (See Title 30, Chapters 2 and 3).

UTAH

Mineworker health and safety requirements are as per Parts 46, 48, and 49 of CFR Title 30, and other federal and state safety regulations. At the federal level, MSHA regulates the health and safety aspects of conventional mines.

COLORADO

Mineworker health and safety training is conducted by the CDRMS Mine Safety and Training Program and is designed to meet the requirements of Parts 46, 48 and 49 of CFR Title 30 and other federal and state safety regulations. At the federal level, MSHA regulates the health and safety aspects of conventional mines.

3.3.1.6 Financial Assurance

Wyoming, Utah, and Colorado all require reclamation performance sureties that cover all costs for a third party (non-mine owners) to complete all phases of reclamation. These sureties include costs for additional items such as; pre-design investigation; design; construction management; contractor profit; site security; and monitoring and administration by the state. The surety amounts are reviewed at least annually. In addition, any significant permit amendment requires a review and appropriate revision to the surety amount. Sureties typically do not encompass costs for potential future impacts but rather only known conditions. Canada requires a closure bond based on the proposed mine plan for the surface lease to mine.

WYOMING

Financial assurance or reclamation performance bond is key to any effective mining regulatory program. All facets of reclamation are required to be fully covered. The costs are required to be developed using standard engineering practices and based on having a third party conduct the reclamation. Wyoming has developed a guidance document that contains typical equipment used in reclamation with acceptable owning and operating costs. The bond amount is required to include costs for design; contractor profit, preconstruction investigation and stabilization; construction management; continuation of monitoring programs; site security and liability; long-term administration; and finally funds to cover unknowns. These are commonly called contingency costs and cumulatively they add a significant amount to the bond total. Wyoming requires the reclamation performance bond estimate to be updated and reviewed annually [See W.S. §35-11-406(b) (vi) and 417 thru 423].

UTAH

Utah/BLM policy per CFR Title 30, 3809.555 allows use of any of the following instruments for an individual financial guarantee, provided that the BLM State Director has determined acceptability, and that certain other specific conditions, noted in the regulations, are met for surety bonds; cash deposited in a federal depository account; irrevocable letters of credit; certificates of deposit; negotiable U.S., state or municipal securities; investment grade securities; and insurance with enforceable pledges of funding. Funding must be sufficient to cover all costs for a third party to complete all phases of reclamation.

After receiving notification that the notice of intention has been approved, but prior to commencement of operations, the operator must provide the reclamation surety to the UDOGM. Failure to furnish and maintain reclamation surety may, after notice and opportunity for Board hearing, result in a withdrawal of the approved notice of intention. As part of the review of the notice of intention, the UDOGM will determine the final amount of surety required to reclaim the mine site. The surety amount will be based upon (a) the technical details of the approved mining and reclamation plan, (b) the proposed post mining land use, and (c) projected third party engineering and administrative costs to cover UDOGM expenses incurred under a bond forfeiture circumstance. An operator's surety estimate will be accepted if it is accurate and verifiable. The UDOGM must approve the form and amount of the surety.

COLORADO

Title 34, Article 32, Sections 117 and 118, of the Colorado Mined Land Reclamation Act describe the requirements for financial assurance. Rule 4 of 2 CCR 407-1 provides details of what is required for financial assurance. The Mined Land Reclamation Board requires that a performance or financial warranty be provided prior to permit approval. Financial warranty instruments can be in the form of a corporate surety bond, irrevocable letter of credit, certificate of deposit, individual reclamation fund, cash escrow account, or a deed of trust or other security agreement encumbering real or personal property, creating a first priority lien in favor of the state. The bond estimate is calculated on an annual basis and is based on the actual third party costs of reclamation. Within 60 days after notification that reclamation has been completed, the agency will perform an inspection to ensure that the reclamation and closure activities and substantive vegetative growth standards have been developed to measure re-vegetation efficacy.

3.3.1.7 Public Notice and Comment

Wyoming has a fairly robust two-stage public notice and comment process including initial public notice and final public notices, as well as mailings to nearby (1/2 mile) surface owners and a public comment period though not necessarily public meetings or hearings. Colorado requires that applicants file application copies for public review and publish public notices several times a week for four consecutive weeks. Utah publishes notices offering the opportunity to comment and request to speak at a public hearing.

In Wyoming, if objections are received concerning the final notice, a hearing is held before an appointed Citizen Council whose decision may be appealed to District Court. In Colorado, any person may submit statements supporting or objecting to the application, and petition for a hearing before the agency.

Federal agencies typically have the most robust public notice and comment process in which there are notices and public meetings associated with their implementation of the NEPA process. These include public scoping meetings, public comment processes on draft and final documents.

Meetings with applicants/permittees are open to the public. In addition, the federal processes have robust appeal mechanisms.

In Canada, extensive public consultation is required as part of the Canadian version of an EIS, and the licensing processes in Canada have special consultation requirements associated with the constitution and concerning aboriginal peoples. Ongoing public comments are received through Environmental Quality Committees that meet several times a year.

WYOMING

The Wyoming regulatory program requires new mine permits, amendments and major mine permit revisions to go through a public notice process with the opportunity for public comment and a hearing before an administrative body. The public notice is a two-stage process. Once a satisfactory application is received, an initial notice is published alerting the public that an application is under review. When the application is declared technically adequate the final public notice is given to allow comment and hearing [See W.S. §35-11-406(g) thru (k)]. The final public notice includes a mailing to surface owners within a half-mile of the proposed permit boundary and a public comment period but not necessarily public meetings or hearings. If objections are received on the final notice, a hearing is held before an appointed Citizen Council whose decision may be appealed to District Court.

UTAH

Utah's R313-15-405, Public Notification and Public Participation requires that upon the receipt of a license termination plan or decommissioning plan from the licensee, or a proposal by the licensee for release of a site pursuant to Sections R313-15-403 or R313-15-404, or whenever the Executive Secretary deems such notice to be in the public interest, the Executive Secretary shall take the following actions:

1) Notify and solicit comments from (a) Local and state governments in the vicinity of the site and any Indian Nation or other indigenous people that have treaty or statutory rights that could be affected by the decommissioning; and (b) Federal, state and local governments for cases where the licensee proposes to release a site pursuant to Section R313-15-404; and
2) Publish a notice in a forum, such as local newspapers, letters to state or local organizations, or other appropriate forum, that is readily accessible to individuals in the vicinity of the site, and solicit comments from affected parties.

Utah Executive Order 12898 of 1994, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, addresses protection of specific groups.

Starting May 8, 2012 public comment is a prerequisite to challenging permitting decisions.

Under Section 19-1-301.5, effective May 8, 2012, a person who wishes to challenge a Permit Order may only raise an issue or argument during an adjudicatory proceeding that was raised during the public comment period and was supported with sufficient information or documentation to enable the director to fully consider the substance and significance of the issue.

COLORADO

Section 1.6 of 2 CCR 407-1 provides the requirements for public notice, comment and petitions for a hearing. A copy of the application must be filed with the county clerk(s) of the county or counties in which the project is located. Within ten days after the application has been considered filed, the agency will notify the applicant to publish a public notice once a week for four consecutive weeks in a newspaper within the locality of the proposed mining operation. The notice will be provided to owners of record of surface and mineral rights within the affected land and surface owners within 200 feet of the affected lands boundary. In an ISR operation, all surface owners within three miles of the permit boundary must be notified. Proof of publication will be provided to the agency.

Any public person may submit statements supporting or objecting to the application and petition for a hearing before the agency.

3.3.2 Operations

3.3.2.1 Mine Sequence

WYOMING

Wyoming requires operators to follow the mine plan including the sequence of disturbance. Any changes to the sequence require pre-approval from the regulatory authority [See W.S. §35-11-415].

UTAH

Utah/BLM, per CFR 30: 3809.420, requires that an operator must avoid unnecessary impacts and facilitate reclamation by following a reasonable and customary mineral exploration, development, mining and reclamation sequence as specified in an approved plan of operations.

COLORADO

Mine sequence is part of the mining plan in accordance with Title 34, Article 32, Colorado Mined Land Reclamation Act and Rule 6.4.4 of 2 CCR 407-1. The mine sequence described in the application must be followed unless altered through an amendment of the existing permit.

3.3.2.2 Erosion/Sediment Control

WYOMING

The Wyoming mining regulatory program requires erosion to be controlled, but for non-coal mines sedimentation control is not specifically required. The non-coal program relies on the Storm Water Protection Plan of the WQD. Wyoming's coal program requires sediment control structures to be constructed and functioning prior to an area being disturbed [See W.S. §35-11-415 and WQD Rules and Regulations Chapter 2].

UTAH

Per 43 CFR 3809.420, access routes shall be planned for only the minimum width needed for operations and shall follow natural contours, where practicable to minimize cut and fill. When the construction of access routes involves slopes that require cuts on the inside edge in excess of 3 feet, the operator may be required to consult with the authorized officer concerning the most appropriate location of the access route prior to commencing operations. An operator is entitled access to his operations consistent with provisions of the mining laws. Where a notice or a plan of operations is required, it will specify the location of access routes for operations and other conditions necessary to prevent unnecessary or undue degradation [See also 3.1.3.3 below].

COLORADO

Neither the Colorado Mined Land Reclamation Act nor the regulations specifically address erosion and sediment control at hard rock mining properties. Title 34, Article 32, Section 116 of the Colorado Mined Land Reclamation Act and Rule 3.1.5 of 2 CCR 407-1 both require a plan for grading, constructing earthen dams, re-vegetation, topsoil segregation and conservation and minimization of disturbance to surface and groundwater systems. The rule requires that all backfill and grading be done in a manner to control erosion and siltation of affected lands, protect areas outside the affected lands from slides and other damage. Slope requirements will be such as to prevent slides and will be compatible with the configuration of surrounding conditions and selected land uses.

3.3.2.3 Topsoil Salvage and Protection

WYOMING

Wyoming requires topsoil to be salvaged and safely stockpiled before an area is disturbed. Topsoil stockpiles are required to be protected from wind and water erosion and identified with a sign [See W.S. §35-11-406 (b)(viii)].

UTAH

30 CFR 3809.420 specifies that at the earliest feasible time, the operator will reclaim the area disturbed, except to the extent necessary to preserve evidence of mineralization, by taking

reasonable measures to prevent or control on-site and off-site damage of the federal lands. Reclamation will include saving topsoil for final application after reshaping of disturbed areas have been completed; taking measures to control erosion, landslides, and water runoff; taking measures to isolate, remove, or control toxic materials; reshaping the area disturbed; placing the topsoil; and re-vegetating disturbed areas, where reasonably practicable.

COLORADO

Title 34, Article 32, Section 116, of the Colorado Mined Land Reclamation Act and Rule 3.1.9 of 2 CCR 407-1 presents topsoil salvage and protection requirements. Topsoil must be removed and segregated from other materials. If not immediately replaced on a backfill area of the mine, it must be stockpiled and vegetated or protected by other means from wind and water erosion and kept free of contamination by toxic or acid-forming materials. Topsoil will be stockpiled in a manner that will minimize erosion and disturbance by ongoing mining operations. When placed on the reclaimed areas, measures will be taken to assure the stability of the replaced topsoil on graded slopes such as roughing in final grading to eliminate slippage zones that may develop between the deposited topsoil and heavy textured spoil surfaces.

3.3.2.4 Temporary Storage Areas

MSHA

MSHA has no requirements for review of waste disposal sites.

WYOMING

Wyoming requires topsoil to be salvaged and safely stockpiled before an area is used as a temporary storage area. For temporary storage areas such as waste rock from the mining process, ore, or other waste material, Wyoming requires containment structures to prevent the material from entering stream channels or on undisturbed areas. Measures are required to keep any contaminants from impacting unaffected areas [See W.S. §35-11-406 (b)(v) and (ix)].

UTAH

See Section 3.3.1.3, above. The operations plan must include information on proposed location and size of ore and waste stockpiles, tailings facilities and water storage/treatment ponds.

COLORADO

Title 34, Article 32, Section 116 of the Colorado Mined Land Reclamation Act and Rule 3.1.5 of 2 CCR 407-1 require a plan for grading, constructing earthen dams, re-vegetation, topsoil segregation and conservation, and minimization of disturbance to surface and groundwater systems. Rule 3.1.9 requires topsoil removal and segregation from other spoil material at any time it is necessary to remove overburden in order to mine the mineral. Topsoil salvage is

performed when removing overburden from the pit, prior to stockpiling waste rock on the surface, at building foundations, parking areas, access roads, etc.

3.3.2.5 Waste Management/Permanent Waste Stockpiles

EPA

EPA, in its Part 440, Subpart C sets requirements applicable to discharges from mines, either open-pit or underground, from which uranium is produced. Part 440.34 requires that the concentration of certain pollutants discharged in mine drainage from new mines, either open-pit or underground, that produce uranium ore, excluding mines using in situ leach methods, shall not exceed established limits (see table at 440.35).

In 40 CFR Parts 122-124, EPA implements the NPDES Program under the CWA. The NPDES program requires permits for the discharge of pollutants from any point source (in this case the mining operation) into waters of the U.S. The provisions in these parts cover basic EPA permitting requirements, what a state must do to obtain approval to operate its program in lieu of a federal program and minimum requirements for administering the approved state program, and procedures for EPA processing of permit applications and appeals.

WYOMING

For permanent storage or stockpile areas in addition to the requirements for temporary storage areas, Wyoming requires the pile to be constructed to blend with the surrounding topography, to be covered with topsoil, and to have vegetation established and be stable. Any material that could be potentially harmful to the public and the environment must be adequately buried or encapsulated [See W.S. §35-11-406 (b)(v) and (ix)].

UTAH

Per 30 CFR 3809.420, mining wastes, including all tailings, dumps, deleterious materials or substances, and other waste produced by the operations, will be disposed of so as to prevent unnecessary or undue degradation and in accordance with applicable federal and state laws. All operators will comply with applicable federal and state standards for the disposal and treatment of solid wastes, including regulations issued pursuant to the Solid Waste Disposal Act as amended by the Resource Conservation and Recovery Act (42 U.S.C. 6901 et seq.). All garbage, refuse or waste will either be removed from the affected lands or disposed of or treated to minimize, so far as is practicable, its impact on the lands.

The operations plan must include information on proposed location and size of ore and waste stockpiles, tailings facilities and water storage/treatment ponds.

COLORADO

Rule 6.3 describes the exhibit requirements for any reclamation permit application. The applicant must specify the thickness of overburden or the quantity of waste rock to be removed in order to reach the mineralized zone. The dimensions of all stockpiles and waste disposal areas must be specified. The applicant must describe how waste rock and acid or toxic producing materials will be handled and disposed of to control unsightliness and protect the surface drainage system from pollution (Rule 6.3.2).

In the Reclamation Plan, the applicant must specify the treatment of any waste rock dumps and tailings impoundments that will be necessary to prevent off site damage and provide for a stable configuration with the proposed future land use (Rule 6.3.4).

Rule 6.4.21 requires the applicant to develop a site specific Environmental Protection Plan. The plan must describe the procedures for the disposal, decommissioning, detoxification or stabilization of all designated chemicals and toxic or acid-forming materials and the measures that will be taken to prevent unauthorized release of pollutants to the environment. The plan must provide a geochemical evaluation of any material exposed by mining that will be placed in on-site liquid containment systems or solids that will be stockpiled or disposed of on the affected land.

Rule 6.5 requires that a geotechnical stability evaluation be performed for all geologic hazards that have the potential to adversely affect any proposed impoundment, slope, embankment, high-wall or waste pile. The applicant must also demonstrate that blasting will not adversely affect any off-site areas.

3.3.2.6 Environmental Monitoring

MSHA

MSHA requires occupational health monitoring in terms of its potential to assure the health and safety of miners. The purpose of the Federal Mine Safety and Health Act of 1977, United States Public Law 9595-164 is to protect miners and not the natural environment. In regard to the health and safety of miners, MSHA requires operators to have several MSHA-approved plans that require monitoring, such as a HAZCOM Program, a Dust Program, and a Noise Monitoring and Abatement Program.

WYOMING

Throughout the life of the operation, Wyoming requires the operator to conduct monitoring activities to confirm the impact, or in some instances lack of impact, the operation is having on the environment and public. Monitoring is also required to confirm that the assumptions made in the application are valid. Monitoring covers a wide variety of media from wildlife to hydrology to weather conditions. For non-coal operations, the monitoring requirements are flexible and are

tailored to the specific site conditions. The monitoring results are reported in an annual report presented to the state regulatory authority.

UTAH

Applications must conform to the state/federal requirements per 43 CFR 3809.420. A plan for monitoring the effect of operations must include demonstration of compliance with the approved plan of operations and other federal or state environmental laws and regulations to provide early detection of potential problems and to supply information that will assist in directing corrective actions should they become necessary. Where applicable, monitoring plans must include details on type and location of monitoring devices, sampling parameters and frequency, analytical methods, reporting procedures, and procedures to respond to adverse monitoring results. Monitoring plans may incorporate existing state or other federal monitoring requirements to avoid duplication. Examples of monitoring programs that may be necessary include surface- and ground-water quality and quantity, air quality, re-vegetation, stability, noise levels, and wildlife mortality.

COLORADO

Title 34, Article 32, Section 116.5 and 2 CCR 407-1, Rule 6.4.21 require an Environmental Protection Plan for all environmental media. Monitoring is performed throughout the life of the operation, from pre-operational baseline through post reclamation. On a site-specific basis monitoring may cover a wide array of media including groundwater, surface water, wildlife and climate. Additionally, ISR facilities must design and implement an approved monitoring plan for affected lands, surface waters and groundwaters. The plan must be sufficient to detect any subsurface excursions of groundwater containing chemicals used in or mobilized by the operation and must be sufficient to evaluate the effectiveness of the post-mining reclamation and groundwater restoration plans (Rule 6.4.24).

3.3.2.7 Inspection and Enforcement

MSHA

All aspects of a metal and non-metal mining operation including mining and milling operations are inspected by MSHA and subject to enforcement action.

WYOMING

The Wyoming program requires periodic inspections of the mining operation and various enforcement tools are available to compel compliance. Civil fines and penalties may be assessed but for non-coal operations these must be through a court action. The program does allow negotiated settlements, including the payment of a penalty, in lieu of litigation [See W.S. §35-11-411 (c), W.S. §35-11-701 and W.S. §35-11-901, 903 and 904].

UTAH

30 CFR 57.2223 specifies MSHA requirements. 30 CFR 3809.421, enforcement of performance standards, specifies that failure of the operator to prevent unnecessary or undue degradation or to complete reclamation to the standards described in this subpart may cause the operator to be subject to enforcement as described in parts 3809.600 through 3809.605. § 3809.600 specifies that BLM may inspect the operations at any time, including all structures, equipment, workings, and uses located on the public lands. The inspection may include verification that operations comply with this subpart. At least four times each year, BLM will inspect operations where there is significant potential for acid drainage. BLM may issue various types of enforcement orders. If operations do not comply with any provision of the facility's notice, plan of operations, or specific requirements, BLM may issue a noncompliance order. BLM may order a suspension of all or any part of operations after failure to timely comply with a noncompliance order for a significant violation. A significant violation is one that causes or may result in environmental or other harm or danger or that substantially deviates from the complete notice or approved plan of operations. Criminal penalties and fines up to $100,000 may be imposed.

The UDOGM will conduct inspections of each mining operation and reclamation under its jurisdiction to enforce the provisions of Title 40, Chapter 8. UDOGM representatives must be allowed to enter upon and through any minerals mining operation and reclamation without advance notice. UDOGM representatives must be allowed to inspect any monitoring equipment or method of exploration, operation or reclamation and have access to and may copy any records required under the Utah Mined Land Reclamation Act.

The UDOGM will immediately order a cessation of mining operations and reclamation or of the relevant portion thereof, if it finds, on the basis of any UDOGM inspection, any violation of the Utah Mined Land Reclamation Act, or any condition of a permit under the Utah Mined Land Reclamation Act, which 1) Creates an imminent danger to the health or safety of the public; or 2) Is causing or can reasonably be expected to cause significant, imminent environmental harm to land, air, or water resources. When a notice of violation has been issued under R647-6-102.2 and the permittee or operator fails to abate the violation within the abatement period fixed or subsequently extended by the UDOGM then the UDOGM will immediately order a cessation of mining operations and reclamation, or of the portion relevant to the violation. A cessation order issued under R647-6-102.1.14 will require the permittee or operator to take all steps the UDOGM deems necessary to abate the violations covered by the order in the most expeditious manner physically possible.

Civil penalties are assessed under Section 40-8-9.1 of the Utah Mined Land Reclamation Act and R647-7 to deter violations and to ensure maximum compliance with the terms and purposes of the Utah Mined Land Reclamation Act on the part of the minerals mining industry.

COLORADO

Rule 3.3 of 2 CCR 407-1 provides Enforcement procedures, and Rules 3.2 and 7.4 describe facility inspection requirements. Agency representatives may enter the mining operation at any reasonable time, with prior notification to the Operator, to inspect the affected lands for compliance with the permit requirements and state laws and regulations. Potential violations are reported to the Mined Land Reclamation Board and a Notice of Possible Violation is mailed to the Operator. An inspection report is written for each inspection describing the inspection and any possible violations. A follow up report describing how and when the violation was resolved and any subsequent inspection to verify compliance are also completed. At least one inspection is performed after the application has been filed and before it has been reviewed. Operational inspections are performed a sufficient number of times each year to ensure compliance with the permit, law, and regulations.

Enforcement actions are taken against operators who are mining without a valid permit and those that have a valid permit but are out of compliance. Either offense is documented by a written Notice of Violation followed by a formal hearing before the Mined Land Reclamation Board, should the operator request it. Should an Operator not comply with any enforcement order, the Attorney General may bring suit against the Operator for a temporary restraining order, a preliminary injunction, or a permanent injunction to prevent additional or continued violation. If the Operator violates a Cease and Desist Order, the Board may institute proceedings of bond forfeiture. The Mined Land Reclamation Board or the Office of Mined Land Reclamation may require the violator to appear before the board no sooner than 20 days after the issuance of the cease-and-desist order. If the results of the hearing uphold the alleged violation, the board may suspend, modify or revoke the permit. The violator also may be subject to a civil penalty of not less than $100 per day or more than $1,000 per day, for each day the violation occurred. Fines for Limited Impact Operators (2 acres or less) are not less than $50 and not more than $200 per day for each day that the violation occurred.

3.3.2.8 Public and Occupational Health and Safety

EPA

Under its NESHAPS Program, EPA has requirements in 40 CFR Part 61 Subpart B for control of radon from underground uranium mines. Emissions of radon-222 to the ambient air from an underground uranium mine must not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem/y. Compliance with the emission standard is to be determined and the effective dose equivalent calculated using the EPA computer code COMPLY-R or an equivalent model approved by the EPA. The mine owner or operator must annually calculate and report the results of the compliance calculations and the input parameters used in making the calculations. The owner or operator of a mine must maintain records documenting the source of input parameters including the results of all

measurements upon which they are based, the calculations and/or analytical methods used to derive values for input parameters, and the procedure used to determine compliance. The owner or operator must keep these records for at least five years.

MSHA

MSHA requires environmental monitoring in terms of its potential to affect the health and safety of miners. The purpose of the Federal Mine Safety and Health Act of 1977, United States Public Law 9595-164 is to protect miners. MSHA regulations require that in all mines at least one sample shall be taken in exhaust mine air by a competent person to determine if concentrations of radon daughters are present. Sampling shall be done using suggested equipment and procedures described in section 14.3 of ANSI N13.8-1973, entitled "American National Standard Radiation Protection in Uranium Mines," approved July 18, 1973, pages 13-15, by the American National Standards Institute, Inc., which is incorporated by reference and made a part of the standard or equivalent procedures and equipment acceptable to the Administrator, Metal and Nonmetal Mine Safety and Health, Mine Safety and Health Administration.

WYOMING

Wyoming states as one of the purposes of the Wyoming Environmental Quality Act is the protection of public health and safety. For mining operations this is accomplished by preventing or minimizing off site impacts, removing safety hazards when mining is completed and returning the land to a condition similar of better than its pre mining condition [See W.S. §35-11-102]. The protection of miners is the responsibility of the State Mine Inspector's office as stated previously in Section 3.3.1.5.

UTAH

Utah's R313-15-301 specifies that licensees will conduct operations so that dose limits for individual members of the public are not exceeded and are maintained ALARA. The total effective dose equivalent to individual members of the public from the licensed or registered operation does not exceed 1 mSv (0.1 rem) in a year, exclusive of the dose contributions from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material, and certain other specific exclusions. During all operations, the operator will maintain structures, equipment, and other facilities in a safe and orderly manner. Hazardous sites or conditions resulting from operations will be marked by signs, fenced, or otherwise identified to alert the public in accordance with applicable federal and state laws and regulations.

COLORADO

In enacting the Colorado Mined Land Reclamation Act, the general assembly declared that the Act and ensuing regulations would be intended to protect and promote the health, safety and

general welfare of the people of Colorado. This is accomplished by ensuring that mining operations prevent or minimize off-site impacts and that the affected land is reclaimed and able to be put to a use that is beneficial to the people of Colorado. The Act also provides the Board with the right to respond to any reported emergency situation at a mining operation that may constitute an immediate, undue, and unwarranted risk of serious harm to persons or property or to the environment.

3.3.2.9 Training

MSHA

30 CFR, Parts 46 and 48 address training and retraining of miners. Each operator of an underground mine shall have an MSHA approved plan containing programs for training new miners, training experienced miners, training miners for new tasks, annual refresher training, and hazard training for miners. Each operator shall submit to the District Manager the information listed below.

- The company name, mine name, and MSHA Identification Number of the mine.
- The name and position of the person designated by the operator who is responsible for health and safety training at the mine. This person may be the operator.
- A list of MSHA approved instructors with whom the operator proposes to make arrangements to teach the courses, and the courses each instructor is qualified to teach.
- The location where training will be given for each course.
- A description of the teaching methods and the course materials that are to be used in training.
- The approximate number of miners employed at the mine and the maximum number who will attend each session of training.
- The predicted time or periods of time when regularly scheduled refresher training will be given. This schedule shall include the titles of courses to be taught, the total number of instruction hours for each course, and the predicted time and length of each session of training.

COLORADO

Within the CDRMS, the Office of Active and Inactive Mines provides a Mine Safety and Training Program for all mining projects in the state. The training and safety program conforms to the MSHA requirements set forth in 30 CFR Parts 46, 48 and 49 as well as other federal and state safety regulations. The Program provides training in all aspects of coal and hardrock surface and underground mining activities. Training instructors are MSHA certified and

qualified. The training can be conducted at the mine site or other location as designated by the Operator. The only costs to the Operator for the training are lodging costs for the instructor and any course materials.

WYOMING

The purpose of the Wyoming Mine Inspection and Safety Office is to set safety and health standards for mines subject to the Federal Mine Safety and Health Act. The Office requires certification for Foreman/Examiner for different types of mineral and surface or underground operations. The Office also requires certification for Shot-Firers. Through the Wyoming MSHA Grant Program, the office offers the required MSHA classes:

- New Miner;
- Annual Refresher;
- Electrical Recertification;
- Impoundment Recertification;
- Dust and Noise Recertification; and
- First Aid/CPR.

Training performed by mining companies must be approved by the State Mine Inspector and evaluated periodically.

3.3.2.10 Public Participation

WYOMING

Citizens are allowed to file a complaint if they have a reason to suspect a mine operation is in violation of state laws or regulations [See W.S. §35-11-701]. This requires the agency to conduct an investigation and publish it findings.

UTAH

R313-15-405, Public Notification and Public Participation, specifies that upon the receipt of a license termination plan or decommissioning plan from the licensee, or a proposal by the licensee for release of a site pursuant to Sections R313-15-403 or R313-15-404, or whenever the Executive Secretary deems such notice to be in the public interest, the Executive Secretary shall 1) Notify and solicit comments from local and state governments in the vicinity of the site and any Indian Nation or other indigenous people that have treaty or statutory rights that could be affected by the decommissioning; and federal, state and local governments for cases where the licensee proposes to release a site pursuant to Section R313-15-404, and 2) Publish a notice in a forum, such as local newspapers, letters to state or local organizations, or other appropriate

forum, that is readily accessible to individuals in the vicinity of the site, and solicit comments from affected parties.

During operations, any person may file a complaint against the Operator if they suspect that the Operator is in violation of the permit or state laws and regulations.

3.3.3 Closure

3.3.3.1 Neutralization/Encapsulation of Waste

WYOMING

Wyoming requires that unsuitable wastes be disposed in a manner that protects the public and the environment. Some wastes only require to be buried a certain depth. Other wastes may require special actions to either neutralize its potential to impact the pubic or environment or be isolated from potential transport pathways. Radioactive materials are specifically mentioned in the statute [See W.S. §35-11-406 (b)(v) and (ix)].

UTAH

Uranium mine wastes are considered to be Naturally Occurring Radioactive Materials (NORM) or Technologically Enhanced Radioactive Materials (TENORM). Because federal laws do not regulate uranium mine wastes as radioactive waste, they do not require mine wastes to be disposed of as regulated wastes. Neither the NRC nor the U.S. Department of Energy (DOE) regulate the disposal of conventional mining wastes. EPA does have authority to protect the public and the environment from exposures to NORM and TENORM and frequently extends this authority to individual states or federal land management agencies, which regulate the environmental effects under the clean air and clean water statutes. DRC has the responsibility for ensuring that mine wastes are disposed properly during the mine reclamation process in accordance with the Utah Mined Land Reclamation Act.

COLORADO

Mine wastes are considered to be NORM or TENORM. Because federal laws do not regulate uranium mine wastes as a radioactive waste, they do not require mine wastes to be disposed of as regulated wastes. Neither the NRC nor the DOE regulate the disposal of conventional mining wastes. EPA does have authority to protect the public and the environment from exposures to NORM and TENORM and frequently extends this authority to individual states or federal land management agencies, which regulate the environmental effects under the clean air and clean water statutes. In Colorado, CDRMS has the responsibility for ensuring that mine wastes are dispose properly during the mine reclamation process in accordance with the Colorado Mined Land Reclamation Act.

3.3.3.2 Shaft, Adit, and High-Wall Elimination

MSHA

When a mine is closed or shut down, all surface openings through which persons could fall or through which persons could enter must be closed or fenced off (30 CFR 57.2002).

WYOMING

Safety issues such as shaft and adit openings are required to be sealed. Wyoming does allow some high-walls (no more than half of the proposed shoreline) around pits to be left under certain conditions. The remaining high-walls must be sloped and demonstrated to be stable [See W.S. §35-11-406 (b)(ii) and 415(b)(viii)].

UTAH

Provided for under the Mined Land Reclamation Act and ensuing regulations, 30 CFR 3809.401 requires development of a reclamation plan to meet the standards in 3809.420, with a description of the equipment, devices, or practices proposed including, where applicable, plans for (i) Drill-hole plugging; (ii) Re-grading and reshaping; (iii) Mine reclamation, including information on the feasibility of pit backfilling that details economic, environmental, and safety factors; (iv) Riparian mitigation; (v) Wildlife habitat rehabilitation; (vi) Topsoil handling; (vii) Re-vegetation; (viii) Isolation and control of acid forming, toxic, or deleterious materials; (ix) Removal or stabilization of buildings, structures and support facilities; and (x) Post-closure management.

High-walls must be reclaimed and stabilized by backfilling against them or by cutting the wall back to achieve a slope angle of 45 degrees or less.

COLORADO

All adits and shafts are to be closed, and where practicable, backfilled and graded in a manner consistent with the post mine land use (Rule 3.1.5(6)). High-walls, if not eliminated, must be stabilized to control erosion and siltation and to protect off-site land from slides and other damage. Maximum slopes and slope combinations must be compatible with the configuration of surrounding conditions and selected land use. In cases where a lake or pond is part of the reclamation plan, all slopes should be no steeper than 2:1 except 5 feet above and 10 feet below the expected water line where slopes must be no greater than 3:1. If a swimming area is proposed, the slope must be no steeper than 5:1 throughout the proposed swimming area and 2:1 everywhere else (Rule 3.1.5).

3.3.3.3 Re-contouring Surface Areas

WYOMING

The surface is required to be re-contoured to blend with the surrounding topography; not to exceed the pre-mining slopes and to be stable. Drainages, which were disturbed, are to be reconstructed to blend with the undisturbed portions [See W.S. §35-11-406 (b)(ii)].

UTAH

30 CFR 3809.401 requires development of a reclamation plan to meet the standards in 3809.420, with a description of the equipment, devices, or practices proposed including, where applicable, plans for (i) Drill-hole plugging; (ii) Re-grading and reshaping; (iii) Mine reclamation, including information on the feasibility of pit backfilling that details economic, environmental, and safety factors; (iv) Riparian mitigation; (v) Wildlife habitat rehabilitation; (vi) Topsoil handling; (vii) Re-vegetation; (viii) Isolation and control of acid forming, toxic, or deleterious materials; (ix) Removal or stabilization of buildings, structures and support facilities; and (x) Post-closure management.

Slopes - Waste piles, spoil piles and fills must be re-graded to a stable configuration and must be sloped to minimize safety hazards and erosion while providing for successful re-vegetation. Dams and Impoundments - Water impounding structures must be reclaimed so as to be self-draining and mechanically stable unless shown to have sound hydrologic design and to be beneficial to the post-mining land use. Trenches and Pits - Trenches and small pits must be reclaimed. Drainages - If natural channels have been affected by mining operations, then reclamation must be performed such that the channels will be left in a stable condition with respect to actual and reasonably expected water flow so as to avoid or minimize future damage to the hydrologic system. Erosion Control - Reclamation must be conducted in a manner such that sediment from disturbed areas is adequately controlled. The degree of erosion control must be appropriate for the site-specific and regional conditions of topography, soil, drainage, water quality or other characteristics

COLORADO

A reclamation plan is required by Title 34, Article 32, Colorado Mined Land Reclamation Act and Rule 6.4.5 of 2 CCR 407-1; Procedures for re-contouring surface areas would be a part of this plan. The surface must be graded so as to create a final topography appropriate to the final land use (Rule 3.1.5(1). All grading must be done in a manner that will control erosion and siltation of the affected lands and to protect off-site lands from slides and other damage.

3.3.3.4 Replacing Topsoil

WYOMING

Topsoil that was required to be salvaged prior to disturbing an area is must be spread over the disturbed area [See W.S. §35-11- 415(b)(vi)].

UTAH

30 CFR 3809.401 requires development of a reclamation plan to meet the standards in 3809.420, with a description of the equipment, devices, or practices proposed including, where applicable, plans for (i) Drill-hole plugging; (ii) Re-grading and reshaping; (iii) Mine reclamation, including information on the feasibility of pit backfilling that details economic, environmental, and safety factors; (iv) Riparian mitigation; (v) Wildlife habitat rehabilitation; (vi) Topsoil handling; (vii) Re-vegetation; (viii) Isolation and control of acid forming, toxic, or deleterious materials; (ix) Removal or stabilization of buildings, structures and support facilities; and (x) Post-closure management.

Topsoil Redistribution - After final grading, soil materials shall be redistributed on a stable surface, so as to minimize erosion, prevent undue compaction and promote re-vegetation. This is followed by a period of stability monitoring, typically at least 3 years, during which erosional stability is monitored and the state either accepts and release the reclamation bond or rejects and requires additional stabilization efforts. There are no specific design events or conditions assumed for reclamation stability.

COLORADO

A reclamation plan is required by Title 34, Article 32, Colorado Mined Land Reclamation Act and Rule 6.4.5 of 2 CCR 407-1; procedures for replacing topsoil would be a part of this plan. Topsoil that has been removed and stockpiled during the operation must be replaced evenly across the disturbed areas during reclamation (Rule 3.1.9).

3.3.3.5 Re-vegetation

WYOMING

Native or approved vegetation species must be planted. Wyoming requires the planting of approved vegetation species but does not require that trees or shrubs be planted unless requested by the surface owner or required by state or federal wildlife agencies. Newly seeded areas must be protected from livestock grazing for at least two years [W.S. §35-11- 415(b)(vii) and WLQD Noncoal Rules and Regulations Chapter3, Section 2(d)].

UTAH

30 CFR 3809.401 requires development of a reclamation plan to meet the standards in 3809.420, with a description of the equipment, devices, or practices proposed including, where applicable,

plans for (i) Drill-hole plugging; (ii) Re-grading and reshaping; (iii) Mine reclamation, including information on the feasibility of pit backfilling that details economic, environmental, and safety factors; (iv) Riparian mitigation; (v) Wildlife habitat rehabilitation; (vi) Topsoil handling; (vii) Re-vegetation; (viii) Isolation and control of acid forming, toxic, or deleterious materials; (ix) Removal or stabilization of buildings, structures and support facilities; and (x) Post-closure management.

Re-vegetation requirements specify that the species seeded must include adaptable perennial species that will grow on the site, provide basic soil and watershed protection, and support the post-mining land use. Re-vegetation is considered accomplished when 1) the re-vegetation has achieved 70 percent of the pre-mining vegetative ground cover. If the pre-mining vegetative ground cover is unknown, the ground cover of an adjacent undisturbed area that is representative of the pre-mining ground cover will be used as a standard. Also, the vegetation has survived three growing seasons following the last seeding, fertilization or irrigation, unless such practices are to continue as part of the post-mining land use; or 2) the UDOGM determines that the re-vegetation work has been satisfactorily completed within practical limits.

COLORADO

A reclamation plan is required by Title 34, Article 32, Colorado Mined Land Reclamation Act and Rule 6.4.5 of 2 CCR 407-1; re-vegetation would be a part of this plan. For most post mining land uses, approved native vegetation species will be emphasized. Non-native species may be proposed for intensely managed forestry and range uses. In forested areas, approved tree species may be used. The re-vegetation goal is to establish a diverse, effective, and long lasting vegetative cover that will be capable of self-regeneration without dependence on irrigation, soil amendments or fertilizer and will be at least equal in extent of cover to the natural vegetation in the surrounding areas (Rule3.1.10).

3.3.3.6 Environmental Monitoring for Surety Release

WYOMING

Wyoming requires a minimum five-year waiting period after seeding for non-coal mines (ten years for coal) before a release from reclamation liability may be requested. Monitoring continues during this period and the operator must demonstrate the site is stable and contaminates are not moving off site [See W.S. §35-11- 415(b)(viii) and W.S. §35-11- 417(e)].

UTAH

Surety release conditions are specified in 30 CFR and include compliance with the reclamation plan requirements, including (i) Drill-hole plugging; (ii) Re-grading and reshaping; (iii) Mine reclamation, including information on the feasibility of pit backfilling that details economic, environmental, and safety factors; (iv) Riparian mitigation; (v) Wildlife habitat rehabilitation;

(vi) Topsoil handling; (vii) Re-vegetation; (viii) Isolation and control of acid forming, toxic, or deleterious materials; (ix) Removal or stabilization of buildings, structures and support facilities; and (x) Post-closure management.

Surety is required until the UDOGM deems reclamation is complete. The UDOGM will promptly conduct an inspection when notified by the operator that reclamation is complete. The full release of surety must be with evidence that the operator has reclaimed as required by the Act. A partial release of surety can be made by the UDOGM if it determines that a substantial phase or segment of reclamation such as demolition, backfilling, re-grading or vegetation establishment has been successfully performed and the residual amount of retained surety is determined adequate to insure completion of reclamation.

COLORADO

There is a time requirement for ensuring vegetation success prior to bond release that is described in the Reclamation Plan. After re-vegetation, grazing on the reclaimed lands will be restricted until the Agency, in consultation with the landowner and the local Soil Conservation District, determine that grazing can start. When the Operator believes he has completed all reclamation requirements provided in the permit, the law and the regulations, he may request from the Board a release of the reclamation bond. Prior to bond release, the Board will conduct an inspection of the site to ensure that reclamation has been completed in compliance with all laws and regulations.

3.3.3.7 Public Notice and Comment

WYOMING

Wyoming does not require a public notice and comment process except for surface owner approval prior to the release of the reclamation performance bond.

UTAH

R313-15-405, Public Notification and Public Participation, notes that upon the receipt of a license termination plan or decommissioning plan from the licensee, or a proposal by the licensee for release of a site pursuant to Sections R313-15-403 or R313-15-404, or whenever the Executive Secretary deems such notice to be in the public interest, the Executive Secretary shall 1) notify and solicit comments from local and state governments in the vicinity of the site and any Indian Nation or other indigenous people that have treaty or statutory rights that could be affected by the decommissioning; and federal, state and local governments for cases where the licensee proposes to release a site pursuant to Section R313-15-404, and 2) Publish a notice in a forum, such as local newspapers, letters to state or local organizations, or other appropriate forum, that is readily accessible to individuals in the vicinity of the site, and solicit comments from affected parties.

COLORADO

The closure process is managed between the agencies and the permittee/licensee without public involvement. Once the Operator files a written notice of reclamation completion and request for bond release, the Agency will notify all owners of record to the affected lands and to the county. Any appeal against the bond release will result in a formal hearing before the Board.

3.3.3.8 Groundwater Cleanup/Restoration (ISRs)

For the ISR uranium extraction process, wells are drilled into rock formations containing uranium ore. Water, usually fortified with oxygen and sodium bicarbonate, is injected down the wells to mobilize the uranium in the rock so that it dissolves in the groundwater. The uranium-bearing solution is pumped to a central processing plant to separate the uranium and concentrate it. Unlike conventional mining, tailings (spent ore solids with leachate) are not generated at ISR facilities. Also, unlike for conventional mining, NRC has concluded that ISR operations are defined as processing and therefore are regulated by the NRC as is conventional milling. Monitoring and restoration of groundwater is important to protect public health and the environment and is an important focus of the NRC. All contaminated materials and wastes are typically removed from the site and sent to an existing licensed disposal facility elsewhere in the country.

U.S. NUCLEAR REGULATORY COMMISSION

The 10 CFR Part 40, Appendix A, 5D requires that if the ground-water protection standards are exceeded at a licensed site, a corrective action program must be put into operation. The licensee will continue corrective action measures to the extent necessary to achieve and maintain compliance with the groundwater protection standard. The Commission (or Agreement State) will determine when the licensee may terminate corrective action measures based on data from the groundwater monitoring program and other information that provide reasonable assurance compliance with groundwater protection standards.

If groundwater cannot be returned to either the site-specific background values or the maximum contaminant level (MCL) (40 CFR Part 264.94 or 10 CFR Part 40, Appendix A, 5C, Table 5C) then applicants can apply for alternate concentration limits. However, this component of groundwater corrective action and compliance related more to milling and control of licensed material than to the typical mining addressed in this report.

U.S. ENVIRONMENTAL PROTECTION AGENCY

If the groundwater standards established under provisions of 40 CFR Part 192.32(a)(2) are exceeded at any licensed site, a corrective action program as specified in 10 CFR Part 264.100 must be put into operation as soon as is practicable.

WYOMING

The WLQD has jurisdiction over ISR operations. This includes the issuance of permits, reclamation/restoration performance bonds and the restoration of groundwater [See W.S. §35-11-426 thru 434]. Groundwater impacts must be remediated and water quality returned to the pre-mining aquifer class of use, as determined from baseline monitoring or, in the case of pre-law operations, based on surrogate back ground from comparable systems, as determined by the state.

COLORADO

For ISR restoration, the Radioactive Materials License will require containment of contaminated solutions within a defined area. Releases of contaminants outside this area during, or following, mining are identified through points of compliance, where WQCC groundwater standards must be met. If releases occur, the license requires corrective actions to be evaluated and implemented as appropriate. Decommissioning requirements include decontamination of the mined zone and return to conditions consistent with the WQCC standards, or pre-mining conditions.

3.4 Canadian Regulatory System for Uranium Mining

Uranium mining in Canada is controlled through legislation (Acts and Regulations), regulatory orders, licenses, certificates, leases, and standards. Additional advice is embedded in guidance documents, policy statements, agreements and general information documents. Please refer to Appendix B for specific legislation, instruments, guides and policies. Recommendations from a joint Canada/Saskatchewan panel, which reviewed three uranium mines and the construction of a new mill from 1991-1998, are found in Appendix C. Many of the recommendations can be considered best practices. An example of an agreement is provided in Appendix D, which contains a copy of the Midwest Project Agreement between federal agencies and Areva Resources Corporation Limited. Links to the Millennium Project Description, a Cameco Corporation project, are located in Appendix E.

3.4.1 Background and Context

3.4.1.1 Nature of Saskatchewan and Uranium Deposits

There are major differences between the operating conditions and ore types of the Canadian mines and the proposed operation in Virginia. Key factors influence the regulatory practices in Saskatchewan.

- Climate - Relatively low levels of precipitation and a cold sub-arctic temperature range.
- Ecology - Typical boreal forest conditions with lakes, swamps and bogs.

- Socio-economic - The land is relatively undisturbed with the exception of a few isolated aboriginal communities. All mines are located outside municipalities or townships. The mines are not associated with any permanent communities. The provincial government handles municipal government functions. The mines operate on a fly-in and fly-out basis.
- Geology - The deposits occur in faults at, or near, the contact between old rocks (pre-Cambrian) and younger sandstones. The sandstones are typically water saturated. Commonly, the ore system has an alteration halo that contains clay rich units.
- Implications of Ore Grades - The ore contains up to 15% uranium, almost 10 times what is anticipated in Virginia. The high grade ore requires special handling when it comes to mining and transportation. For health and safety reason and to ensure full uranium recovery, some of the ore must be diluted prior to processing in the mill. Under regulation, there are four types of material produced: ore that is processed, tailings, waste rock (minimal impact on the environment) and special waste (low grade material or acid generating).
- Engineering Challenge - Because of the presence of a water saturated cap rock, overlying rocks must be either dewatered or frozen prior to mining. Many mines have had severe water issues. Additionally, special techniques are often required to stabilize mining entrances due to the alteration zone of clays. In a number of cases, lakes were drained or dammed to operate the mines. Most mines carry out an engineering feasibility study prior to beginning actual mining operations. The results of this "test mine" can be an important component of the licensing process.
- Associated Minerals - In most cases, the uranium ore zones contain a wide variety of heavy metals such as iron, nickel, cobalt, etc., in the form of sulfides and arsenide. The Saskatchewan ore is often acid generating. Most of the public is concerned about the impact of uranium on the environment. The Canadian Government treats the deposits holistically and examines all the potential impacts not just those associated with uranium.

3.4.2 Division of Mandate between Federal and Saskatchewan Government

In Canada, the division of authorities between the federal and provincial government is different than in the U.S.

3.4.2.1 Land Ownership

Ownership of land and minerals is one of the most significant differences between Virginia and Canada.

When Saskatchewan became a province in 1903, the federal government transferred control of all surface rights including water and forestry to the province. In the 1930s, the federal government transferred mineral rights to the province. In Saskatchewan, about 80% of the mineral rights are held by the province (Crown Land Minerals). In northern Saskatchewan, the province holds more than 95% of the mineral and surface rights (Crown Lands). Private land ownership is rare.

There is no equivalent of the BLM in Canada. The provincial rights are leased, not sold, to companies developing minerals. These leases give the province significant authority over mineral development as they retain ownership of the land and of the mineral rights. In Virginia, a significant portion of the land is held privately with water, surface, mineral and forestry rights potentially held in the hands of different owners.

3.4.2.2 Aboriginal Rights

Canada has a large aboriginal population, particularly in the north. The relationship with the Aboriginal and Métis people is defined by a series of treaties. These establish reserves that, in some cases, include shared Aboriginal/government land management on adjacent Crown lands. The Aboriginal communities have arguably surrendered mineral and surface rights to the Crown on the lands outside of reserves with the exception that they retain the right to hunt and fish on all Crown lands. There have been a number of Supreme Court of Canada decisions that address issues of aboriginal consultation. When carrying out public consultation related to mining, it is essential to undertake meaningful consultation with First Nations. Negotiations must include potential financial compensation for any future impact on hunting and trapping rights.

3.4.2.3 Federal Mandate

In Canada, the provinces manage all minerals with the exception of uranium. The Canadian federal government has retained regulatory control over uranium mining. Originally federal control was implemented over concerns about the role of uranium in nuclear weapons and the control of processed uranium on the international stage. Canada limits foreign ownership of uranium mines to 49%. Many of the occupational health and safety (OHS) regulations have been transferred to the province with the exception of the radiation related OHS regulations.

3.4.2.4 Environmental

The Government of Canada retains control of the environmental review process through the Canadian Environmental Assessment Agency (CEAA), which has some powers similar to those of the EPA in the US. Saskatchewan has a parallel environmental review system. Many other EPA-like authorities are found throughout a number of federal agencies including Fisheries and Oceans Canada, Natural Resources Canada and Environment Canada. The most usual split of authorities exists between Fisheries Canada and their provincial counterparts. The provinces manage the actual fish while the federal government is in charge of fish habitat. Both the

Canadian federal government and provincial governments are involved with issues related to endangered species.

Transport Canada manages water crossing through the Navigable Waters Act. Navigable water is defined as any waterway that can be navigated by a canoe. Consequently, almost all roads that cross waterways require a permit.

3.4.2.5 Managing Overlapping Mandates

The overlaps between federal and provincial agencies create delays in processes. Through agreements and regulation amendments, solutions have been found and implemented to ease the situation.

- *Saskatchewan Uranium Mines and Mills Exclusion Regulations* – This regulation delegates many of the OHS functions for uranium to the Saskatchewan Government.
- *Canada-Saskatchewan Agreement on Environmental Assessment Cooperation (1999)* – This agreement creates a joint panel that simultaneously collects the information required under both federal and provincial legislation although approvals are still required by both levels of government.
- *Canada-Saskatchewan Administrative Agreement for the Canadian Environmental Protection Act* – The agreement helps the Canadian federal government and the provincial government develop common standards, process, etc.
- *Cabinet Directive on Improving the Performance of the Regulatory System for Major Resource Projects* and the corresponding Memorandum of Understanding (MOU) – This agreement clarifies the role of the federal agency, defines major processes in the Environmental Impact Statement (EIS) and licensing process, as well as timelines and joint processes.

The issue of overlap is currently being addressed and there are a number of proposed changes outlined in the 2012 Federal Budget process (See Appendix B for details.)

Note that, even with all efforts made to minimize overlap and clarify mandates, the average CEAA EIS process usually take two years while licensing can take an additional two years.

3.4.3 Lead Agencies

The Canadian Nuclear Safety Commission (CNSC) is the lead Canadian government agency and functions in much the same way as the NRC. The CNSC reports to the Canadian government through Natural Resources Canada and is an independent regulatory body that administers the regulation of all parts of the uranium fuel cycle with the exception of mineral exploration. Other federal Canadian departments/agencies of noteworthy involvement include the Canadian

Environment Assessment Agency; Environment Canada (EC); Fisheries and Oceans Canada, Natural Resources Canada and Transport Canada.

The only province in Canada with current active uranium mines is Saskatchewan. British Columbia and Nova Scotia have a formal moratorium on uranium exploration and development. Aboriginal groups have raised significant concerns in the Northwest Territories, Nunavut, Quebec, and Newfoundland and Labrador. The lead Saskatchewan ministry for the regulation of uranium mines is Saskatchewan Environment. Other major players in the regulatory system include Saskatchewan Labour Relations and Workplace Safety; Saskatchewan Energy and Resources; Saskatchewan Tourism, Parks, Culture and Sport; Saskatchewan Watershed Authority; Saskatchewan First Nations and Métis Relations and SaskWater.

3.4.4 Environmental Impact Statements

Many licenses and permits will not be issued without an EIS. EIS regulation and related processes are an area where federal and provincial authorities overlap. There are significant differences between the federal and Saskatchewan systems. Often, the Canadian federal government requires more detailed information than its provincial counterpart. The province will deal with the more specific data during the licensing process. In Saskatchewan, the purpose of an environmental assessment is to determine if a project can proceed with minimal damage to the environment and means by which to mitigate this impact. The differences between the federal and provincial EIS systems result in a very convoluted review process.

3.4.4.1 EIS Triggers

In general terms the trigger, or what requires initiation of an environmental review by the Canadian federal government, is the application for a permit or license. Internally, the federal agency responsible for the permit or license determines if the project can significantly impact the environmental or if it falls under the "comprehensive study list" or "exclusion list", as defined in the regulation. If the impact is significant, it is referred to the CEAA. CEAA will then make a decision if the project requires a "Comprehensive Review" (largely done by officials) or a "Panel Review" (quasi-judicial with the inclusion of an outside expert panel). A new uranium mine/mill will go to CEAA and the lead agency will be CNSC. Proposed new mines and mill operations will likely undergo panel reviews while mining projects will probably be subject to comprehensive reviews. In some cases, a lease, permit renewal or change to existing permits may also trigger a federal environmental review, typically a comprehensive review. Some uranium mines will have to go through multiple environmental assessments during the life of their operation.

Provincially (Saskatchewan), the Ministry of Environment triggers an environmental review if the project can have a potential significant impact on the environmental or if there is significant public concern. Usually the federal trigger occurs first.

3.4.4.2 Content of EIS and Comprehensive Reviews

Saskatchewan scopes any potential impact by the mine including related infrastructure such as roads, airstrips, power lines; direct mine structures, open pits and underground structures. The EIS also includes the analysis of cumulative impacts from other mines, and/or other industries in the same area. In general, the Canadian federal EIS scope is narrower but requires a greater depth of information.

3.4.4.3 Project Description

Includes ownership, road construction, power, nature of the deposit, acid generation tests, metallurgical testing, mineralogy, mining method, tailings facilities, waste storage, construction time lines, ownership, sewage systems, water needs for mill, impact on surface drainage, groundwater, drinking water, camp details and milling process.

3.4.4.4 Baseline Environmental

Includes detail on the wildlife, both on land and in water, endangered species, forestry information, heritage reviews, climatic data, water drainage patterns, social economic information, water quality, and air quality.

3.4.4.5 Mitigation Processes

Deals with the potential impact on the existing environment, monitoring systems and standards for water and air testing, emergency response systems, OHS processes, fire suppression, evaluation of alternate sites for major mine infrastructure, and training requirements.

3.4.4.6 Closure Plans

The closure plan outlines the process for closure, risks and potential costs for closure.

3.4.4.7 Communications Plan

Provides detail about community and aboriginal consultation.

3.4.4.8 Joint Federal Saskatchewan Review and Processes

Under an agreement between CEAA and Saskatchewan, a joint process is established to secure all the information required at both the provincial and federal level.

3.4.4.9 Internal Processes related to the Environmental Impact Statement

As a matter of process, Saskatchewan Environment has a standing group of officials from a number of ministries who evaluate and coordinate the provincial government's response to any environmental review, including uranium mines and mills. Saskatchewan Environment speaks for the government on environmental review related matters. Disagreements and concerns are ironed out internally prior to the airing the Government of Saskatchewan's public position.

On the federal side, a uranium mine is referred to the major project review office of Natural Resources Canada. A Deputy Minister's committee determines the lead federal agency and defines related processes. In the case of a uranium mine, the lead agency is always CNRC.

An agreement is signed between the federal government departments and the proponents. It defines the EIS process, timelines, and consultation with aboriginal community, EIS processes and monitoring. The agreement and associated documents are available online. Please refer to The Midwest Project Agreement found in Appendix E. The agreement Appendices are available on line.

3.4.4.10 Scoping of the Environmental Impact Statement

Although some of the items covered by an EIS are specified in the legislation and guidelines, many are not. Saskatchewan requires an intermediate step in the EIS process. The proponent must submit a project description that contains an expanded index of the full EIS. Refer to Appendix E that includes the web links to the Millennium Project Description. EA related reviews would not begin until the project description is approved. This saves the government and industry valuable time and money.

The full EIS documents typically describe the project, alternative sites considered for major facilities, studies carried out by the proponent related to wildlife, heritage, groundwater, drainage, and water balances, along with social-economic studies to define the environmental baseline. The proponent then estimates the impact on the environment and mitigation techniques. The proponent will be required to verify accepted standards and how these will be met. The proponent also provides a closure plan and demonstrates the ability to meet the bonding requirements. These studies typically cost from $2-10 Million in Canada and often fill a filing cabinet.

In Canada, the EA process is focused on the mine impact, although broader issues often arise during public discussions/consultations:

- Comparison of alternative energy sources such as wind power verses nuclear power;
- A project's economics (no economic feasibility study is required in Canada);
- The option of the project not proceeding; and
- Moral issues of atomic weapons and the use of depleted uranium in standard munitions.

The press and non-government organizations often draw the proponent and government representatives into these types of discussions.

3.4.5 Major Licenses and Permits

The number of permits, licenses and authorizations to operate uranium mines numbers in the hundreds and only major licenses with links to uranium mines have been detailed in this report. In a mining company, three or four staff members are typically required to provide all documents and reports associated with pertinent licenses as well as prepare renewals. Note that the CNSC charges the operator for these licenses on a cost recovery basis and the proponent may pay hundreds of thousand dollars a year to cover the costs of inspection. Saskatchewan does not operate on a direct cost recovery basis.

3.4.5.1 Federally Mandated Licenses and Permits

CANADIAN NUCLEAR SAFETY COMMISSION

There are four major licenses required by CNSC.

1. **License to prepare a site and construct a mine**:

   The first part of the application includes a general overview of the proposed mine plan and description of the mine; site evaluation process and investigations including a surface plan, existing buildings and planned structures; description of the mine, geology and mineralization; activities that may impact operation of mine including previous operations, proposed operating methods, materials to be mined, duration of activities and a quality assurance plan.

   The second part includes health and safety aspects of the operation - the effect on health and safety of individuals and measures to mitigate those impacts, proposed program for selecting, using and maintaining radiation detection devices, proposed worker health and safety policies and programs, proposed positions and qualifications and responsibility of radiation protection workers, proposed training program for workers, proposed measures to control the spread of any radioactive contamination, proposed ventilation and dust control methods and design and maintenance of eating areas.

   The third part describes how security is to be managed including proposed measure to alert licensee to acts of sabotage or attempted sabotage at the mine or mill.

   The final part of the license deals with a code of practice that contains action levels that indicate the operator may have lost control of the wastes and/or control of potential hazards and a description of actions to be taken and reporting structure.

2. **License to operate mine:**

   The operating license builds on the commissioning license by requiring the results of commissioning (construction) work, any changes to equipment and design during commissioning. In addition, the operating license requires the policies, methods and

programs for operation and mine maintenance to be stated. The license also requires the proposed methods for handling storing, loading and transporting nuclear substance and hazardous substances.

3. **A license to decommission a mine:**

   The license to decommission a mine proposes the schedule of decommission work and rationale for the schedule. How the land, buildings, structures, and hazardous substance will be returned to as natural conditions as possible and a description of the site on completion of the work.

4. **A license to abandon mine:**

   The abandonment license builds on the decommission license by describing the impact on those living in the area as a result of decommissioning work, and long term environmental monitoring program.

Each of the CNSC licenses has a set of "general requirements" as defined in the *General Nuclear Safety and Control Regulations*. See Appendix C for a list of regulatory policies and guidelines which provide details on specific requirements. General requirements for the licenses are listed below.

- General requirements involve posting of code of practice, developing operating procedures, training of workers, safety certificates, audits, ventilation systems, warning of failure, response and protective gear for repair, use of respirators only to be used in emergence situation but must have on site. Safety requirements include posting sites with radiation greater than 25 uSv/hr and direct reading dosimeter for areas greater than 100 uSv/hr.
- Specific records are required to be maintained, including operating and maintenance procedures, mine plans, schedules of mining, plans of tailing damns and facilities, design of components, radiation dosage, inspection and maintenance logs, air quality by each main fan, the performance of each dust control, and training records.

The break between the license to prepare a site and construct the mine and the license to operate the mine gives the government an opportunity to adjust the license conditions prior to actual production. The break between the license to decommission a mine and the abandonment license provides the government the chance to determine if ongoing or addition steps are required in the decommissioning process.

There is an ongoing debate surrounding the value of listing detailed conditions in the regulation versus more general conditions often termed as "results-based system" or standards system. The government of Saskatchewan has issued a discussion paper on this issue and is in the process of

developing environmental codes (Clifton and Associates, 2009). The industry prefers a results-based system for ease of administration; however, the detailed requirements are seen to provide more security and cross checks from a political point of view.

Within the guidance documents are general recommendations on the qualifications of people preparing reports, generally professional engineers, and the potential role of International Organization for Standardization (ISO) type standards. Although the regulation set standards, the companies operate using an "As Low as Reasonably Achievable (ALARA)" method.

Fisheries and Oceans Canada

Habitat Compensation Agreement: Canada has a policy of "no net loss" of fish habitat. If a tailings facility uses a lake or damages a body of water, Fisheries and Oceans Canada requires that the fish habitat be created or improved to compensate for the loss.

Additionally, a change to the Mines and Metals Regulations is required if a body of water is destroyed. A change to regulation must follow a formal process that takes in to account public comments and can take six month or more to complete.

3.4.5.2 Saskatchewan Mandated Licenses

Mineral Rights

The Mineral Lease is implemented through the Mineral Disposition Regulations. A mineral lease is required prior to production, and triggers lease rentals and the general royalty regulations.

Surface Lease Agreements

Since Saskatchewan owns the land, many of the provincial government's terms and conditions for operating a mine are included in surface leases. The general contents of a surface lease are outlined in Uranium Mining in Northern Saskatchewan, Part 3, (Parsons G.F. and Barsi, R, 2001). The actual leases are confidential. Appendix F presents the general terms and conditions of a Provincial surface lease.

The surface lease is used to implement three major provincial policies. The first policy ensures benefits from mining accrue to Saskatchewan's North through a Human Resource Development Agreement and related business activities. This is an affirmative action program that gives preference to local people who are largely of aboriginal ancestry. The federal-provincial governments provide funding program for training and skills upgrading. The funding is administered through a tri-party (federal-provincial government, local communities and industry) agreement.

The second policy guarantees that environmental monitoring results are shared and explained to the local communities through the establishment of Environmental Quality Committees (EQC). The regulations require that monitoring be done by industry and both levels of government to ensure that the environmental standards are met. The EQC ensure the results are shared and explained with the local communities. In some cases committee members can raise local environmental concerns and have them addressed.

The third policy is Financial Security for Decommissioning. This policy ensures funding is available to close the mine and pay any ongoing costs. The standards for closure are addressed in the regulations but the details and costs are negotiated with provincial government officials. Typically, the bond is reviewed every five years to ensure that the correct level of resources is available to close the operation should the company fail.

3.5 Implications for Virginia's Regulatory Framework for Uranium Mining

Coal and mineral mining in Virginia are currently authorized under Title 45.1 of the Code of Virginia. However Title 45.1 Section 283 states:

§ 45.1-283. Uranium mining permit applications; when accepted; uranium mining deemed to have significant effect on surface.

Notwithstanding any other provision of law, permit applications for uranium mining shall not be accepted by any agency of the Commonwealth prior to 1, 1984, and until a program for permitting uranium mining is established by statute. For the purpose of construing § 45.1-180 (a), uranium mining shall be deemed to have a significant effect on the surface.

This provision not only prohibits DMME from accepting or approving any uranium mining permit applications but also requires that a specific program for regulating uranium mining be established by an entirely new statute. Therefore, though the DMME has extensive experience with successfully regulating most aspects of mineral mines, it does not currently have the authority to regulate all aspects of uranium mining. Should the General Assembly elect to develop authorization for uranium mine regulation, provisions of Virginia's existing mining and environmental statutes, regulations and guidance could be incorporated in to a new regulatory framework.

If regulation of uranium mining is authorized in Virginia, each department DMME, DEQ, and VDH would need to adapt its existing regulations to include radionuclides and address any issues specific to uranium mining or develop new regulations. Each Department has already developed and refined regulations that govern mining and activities associated with almost every anthropogenic compound and naturally occurring element into all media (air, surface water, groundwater, vapor phase) except uranium and its radiological cousins. Therefore, while each

regulatory section will need modification to incorporate the relevant radionuclides into their existing programs, the basic regulatory building blocks are present.

4.0 INTERNATIONAL EMERGING GUIDANCE AND BEST PRACTICES

The international community has continued the development of uranium mining, milling and waste disposal regulatory and operational systems during a period that U.S. uranium regulatory system development was nearly dormant. In this section, the Wright Environmental Services Inc. (WES) team has reviewed lessons learned from the following sources that reflect much of the recent thought in this area.

- The International Atomic Energy Agency
- The International Commission on Radiological Protection
- The World Nuclear Association

4.1 The International Atomic Energy Agency

4.1.1 Emerging Guidance and Best Practices

In the context of uranium resource extraction, the focus of the IAEA, an internationally-funded organization based in Vienna and involving some 150 nations, is ideally suited to the development of a new regulatory structure encompassing current concepts. The IAEA provides both documentation and on-the-ground assistance to member states, with a great deal of its work dedicated to the collection of historical information identifying, defining and illustrating past mistakes, and the polling of experts to define current best practice. The IAEA does not emphasize the development of sets of regulations as such, instead it provides bases for such development, and techniques to implement, for example, remedial actions using optimal technologies. Note that the term "optimal" may not imply "best", if a competing technique is adequate for the specific task and available at lower cost. Much of the work done by the Agency is focused on the developing countries, and resources are limited both at the Agency and in the countries themselves. This is, in fact, helpful even for member states with greater resources, since it discourages inefficient use of funds.

The IAEA has sponsored a number of symposia, working groups, field activities and publications during the last decade that are of direct interest in the context of this review. We summarize below some of the key findings of a very useful and recent IAEA report, titled, "Best Practice in Environmental Management of Uranium Mining" (IAEA Report NF-T-1.2, Vienna, 2010). An excellent preface, taken from the publication, is quoted below. It encapsulates the reasons behind the condition of many uranium-related regulatory structures (well out of date), and an introduction to the ways in which the system (in the U.S. and elsewhere) is now being revised to correspond to current thought and technology.

"The modern uranium mining industry was born in the middle of the 20th century at a time of rapid industrial and social change and in an atmosphere of concern over the development of nuclear weapons. At many uranium mining operations, the need to produce uranium far outweighed the need to ensure that there were any more than vestigial efforts made in protecting the workers, the public and the environment from the impacts of the mining, both radiological and non-radiological. In the last quarter of the 20th century, the world began to take greater care of the total environment with the introduction of legislation and the development of operating procedures that took environmental protection into account. The uranium mining industry was part of this change, and standards of environmental management began to become of significance in corporate planning strategies. However, by the 1980s, as uranium mining companies began to address the issues of environment protection, the industry began to suffer a cyclical slowdown. By the 1990s, the industry was at a nadir, but the surviving uranium producers continued to develop and implement a series of procedures in environmental management that were regarded as best practices. This, in part, was necessary as a means to demonstrate to the regulators, governments and the public that the mining operations were being run with the intention of minimizing adverse impacts on the workers, people and the environment. This ensured that mining would be allowed to continue.

The decline in uranium mining activity bottomed out in the 1990s, but a resurgence of activity began in the new century that is likely to continue for some time. This has been, in part, due to market conditions and concerns about the shortfall of current production from primary sources (uranium mines) against current reactor fuel demands; the anticipated decrease in future availability of secondary sources such as stockpiles; and the increased interest in nuclear power generation as an integral part of the strategy of many countries to mitigate their impacts on climate change.

The existing uranium mining industry has raised environmental standards through the introduction and development of best practices. One concern is that some of the newer, junior, mining companies and producer nations entering the market in the present expansion phase may not be aware of these best practices and current international standards. Failure to maintain the current high levels of environmental management may see the uranium mining industry's development hampered through the poor performance of a few new, but inexperienced companies, which would result in adverse reactions from the public and regulating authorities. This could be especially damaging to the straightforward development of the new resources demanded by the market." (IAEA, 2010).

4.1.2 IAEA 2010 Report on Best Practices: Key Concepts

Relevant summaries and direct quotations from the 2010 IAEA report are provided below:

"Recognition and adoption of best practice principles are considered fundamental cornerstones of sustainable development for the uranium industry. Best practice in the context of this report covers the social, environmental and economic aspects of an operation; and includes the active search, documentation and implementation of those practices and principles that are most effective in improving the social, environmental and economic performance of an operation. The principles of best practice are universal, but their application is site specific."

"Best practice is the development of site/operation specific methodologies that integrate global and local knowledge, which enables planning to produce the best available and most practicable methods to address an operation's site specific requirements and conditions. This enables the operator to achieve production goals and a sustainable operation while minimizing social, environmental and economic impacts. Best practice principles should be applied to every aspect of a mine/mill operation and extend from the exploration and initial development phase through to post-closure stewardship. The successful application requires corporate and regulatory leadership, as well as long-term commitment.

"Best practices, by nature, are not static but continuously evolve in response to new technology, increased understanding and awareness of environmental and social impacts, and increasing regulatory requirements and public expectations."

"Mining and/or processing operations can have both positive and negative environmental, economic and social impacts on communities. They can provide employment and business opportunities to local communities and may provide the opportunity to remediate legacy sites. However, improperly managed activities can adversely impact the environment, affect the local population, and, in the worst cases, result in severe or catastrophic social and/or environmental impacts as evidenced by many legacy sites still awaiting remediation. Implementation of the best practice principles outlined in this document will minimize the potential for adverse environmental, social and economic impacts.

By minimizing potential adverse impacts, key benefits that result are:

- *Improved environmental management;*
- *Improved socioeconomic outcomes;*
- *Demonstrated good corporate governance and accountability;*
- *Improved liability management;*

- *Improved quality control; and*
- *Reduced operational costs and increased profitability."*

"Humanity has the ability to make development sustainable — to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs." (UN, 1987).

This concept can be broken down into four conditions for sustainable development (UN, 1987):

- Material and other needs for a better quality of life have to be fulfilled for people of this generation;
- The process should be as equitable as possible;
- Respecting ecosystem limits; and
- Building the basis on which the needs of future generations can be met.

Expanding on this concept and conditions, "*..not only should this generation not totally deplete resources that will be vital to future generations, the environment must not be adversely impacted so as to leave the Earth, or significant portions of it, with severe constraints on future human use. This imposes constraints on the manner in which uranium resources are exploited."*

"Applying best practice guiding principles to a project will require that each of the four cornerstones of sustainable development is put into practice with the following as key objectives:

"Environmental aspects:

- *promote responsible stewardship of natural resources and the environment, including remediation of past damage;*
- *minimize waste and environmental damage throughout the whole supply chain;*
- *exercise prudence where impacts are unknown or uncertain; and*
- *operate within ecological limits and protect critical natural capital."*

"Social aspects:

- *ensure a fair distribution of the costs and benefits of development for all those alive today;*
- *respect and reinforce the fundamental rights of human beings, including civil and political liberties, cultural autonomy, social and economic freedoms, and personal security;*

- *seek to sustain improvements over time by ensuring that depletion of natural resources will not deprive future generations through replacement with other forms of capital; and*
- *optimize utilization of human resources.*

Economic aspects:

- *maximize human well-being;*
- *ensure efficient use of all resources, natural and otherwise, by maximizing returns;*
- *seek to identify and internalize environmental and social costs; and*
- *maintain and enhance the conditions for viable enterprise.*

Governance aspects:

- *ensure transparency by providing all stakeholders with access to relevant and accurate information;*
- *ensure accountability for decisions and actions;*
- *encourage cooperation in order to build trust and shared goals and values; and*
- *ensure that decisions are made at the appropriate level as close as possible to and with the people and communities most directly affected."*

"Baseline data collection is undertaken in order to adequately document the environmental conditions that exist at a site prior to commencing activities that may alter the existing environment. Accurate and comprehensive baseline data will enable a company to reliably demonstrate the environmental and social impacts and performance of the operation as well as remediation works undertaken. Furthermore, it is only with good baseline data that early detection of deviations from expected or predicted performance can be identified."

"The scope of a baseline data collection program must clearly define the baseline parameters required. Examples of baseline data include those outlined below. It must be noted that the data sets required will be site-specific as is the timeframe over which they are collected. Often information may need to be collected at different times of the year to account for seasonal variation:

Socioeconomic characterization:

- *current and historic land uses;*
- *archeological and heritage surveys;*

- *identification of all stakeholders;*
- *identification of beneficial uses of land and water; and*
- *documentation of regulatory regime under which the project would operate.*

Environmental characterization:

- *hydrological and hydrogeological conditions;*
- *geological and geochemical characterization;*
- *flora and fauna surveys;*
- *climate data;*
- *soil surveys;*
- *radiological surveys; and*
- *contaminated site assessments."*

4.1.3 IAEA Best Practices

The IAEA 2010 report on best practices provides detailed discussions of the following topics:

1. Public/stakeholder involvement;
2. Impact assessment;
3. Risk Assessment;
4. Design;
5. Operation;
6. Waste; and
7. Closure.

The reader is referred to the full IAEA 2010 Best Practices report for full detail concerning these areas. Examples of the Report's content for each of the above seven topics are discussed, or directly extracted below.

4.1.3.1 IAEA Best Practices: 1) Stakeholder Involvement

"Identifying stakeholders and then successfully engaging them in a participatory manner is a fundamental building block in the development of a successful project. Without stakeholder involvement, there is a significant risk that the project or components thereof may be rejected by the stakeholders, potentially leading to economic loss for the operator as well as ill feelings between the parties that could develop into an adversarial relationship.

A truly effective program will involve full stakeholder participation in the planning process at all levels and stages. Stakeholder participation goes beyond the stages of informing or consulting stakeholders and requires the development of high levels of openness and trust between the various parties. Stakeholders are those individuals or organizations which may have an interest in or be affected by the project at any stage, whether directly or indirectly. Examples of groups or individuals that may be considered stakeholders include:

- *project operator;*
- *shareholders;*
- *owners of the land impacted by the operation;*
- *surrounding landowners;*
- *local communities economically dependent on the operation or the land impacted;*
- *local government;*
- *regulators;*
- *employees;*
- *unions;*
- *NGOs;*
- *contractors; and*
- *suppliers.*

As can be seen from the above list, the stakeholder group is likely to consist of an extensive group of individuals, businesses and organizations with vastly different skill sets, technical abilities and, most importantly, expectations. Each operation and location will have its own unique group of stakeholders. Bringing these together in order to achieve an outcome that meets most of their expectations is an enormous task that will require specialized skills and resource commitments on the part of the company. It is also a time-consuming process that needs to be given as much time as possible if satisfactory outcomes are to be achieved: hence starting it as early as possible in an operations life cycle is highly desirable. Key points to consider in bringing about constructive stakeholder participation in the project include:

- ***Selection of participants*** *— participants are representative of the identified stakeholder groups and speak with their authority.*
- ***Timing*** *— engagement of stakeholders and their involvement in the project begins as early as possible.*

- ***Establishing objectives*** *for the participation process early will assist in ensuring that the activities of those participating are focused on results.*
- ***Commitment to stakeholder involvement*** *— if the stakeholders sense that the decision makers are not actively listening and acting on their input, the involvement program will likely breakdown and may increase mistrust.*
- ***External constraints*** *on the project should be clearly communicated to stakeholders. Examples of these may include financial resources and regulatory obligations.*
- ***Participation*** *— different stakeholders will have differing levels of skills and resources. To ensure fairness and appropriate representation, it may be necessary to consider allocating additional resources (including information and training) to some groups or individuals in order that they can participate on an equal footing with other stakeholders.*
- ***Flexibility*** *— the participation process must remain flexible as the project proceeds in order to allow for input from stakeholders.*

The above points demonstrate that effective participation needs to be a dynamic two-way process. Simply dictating to the public or informing the public of decisions cannot be considered stakeholder participation."

"It is imperative for project developers to consider the core values, needs and concerns of local communities in order to be able to demonstrate that the operation of the facility will be consistent with their expectations. There are numerous cases where a mining or industrial operator has not adequately addressed local expectations and has then failed to secure stakeholder support for the project, and consequently failed to secure the necessary approvals to proceed with the project. Where there has been inadequate engagement or consultation with stakeholders or where there has been a failure to identify all legitimate stakeholders, the following can result:

- *project delays or cancellation;*
- *lack of public support in the project's implementation phase;*
- *loss of public trust, which may lead to difficulty in implementing future initiatives;*
- *media criticism;*
- *legal action; and*
- *social conflict and violence."*

"Sustainable community development planning is another aspect that must be considered and addressed initially during the project planning phase; however its importance continues throughout the life of the operation and beyond. It may include:

- *Adopting a strategic approach: Development of activities at the operational level are linked to long term strategic objectives for the company and are also aligned with existing and future community and/or regional and national development plans.*
- *Ensuring consultation and participation: Local communities are actively involved in all stages of project conception, design, and implementation, including closure and post-closure.*
- *Working in partnership: Private, governmental, NGO and community organizations bringing different skills and resources yet shared interests and objectives can achieve more through working together than individually. Formal or informal partnerships can also reduce costs, avoid duplication of existing initiatives and reduce community dependency on the mining operation.*
- *Strengthening capacity: Programs that emphasize strengthening of local community, NGO and government capacity are more sustainable in the long term than the supply of cash, materials or infrastructure without a properly designed forward looking participatory framework. While infrastructure is often essential for the development of remote communities, it will only be sustained if there is an adequate maintenance program supported by a well-designed participatory process including local communities and governments.*

"Stakeholder involvement and consultation requires a communication strategy that addresses the following as a minimum:

- *objectives of communication strategy,*
- *business objectives,*
- *communication objectives,*
- *background to the project planning, development and closure process,*
- *historical issues influencing planning,*
- *current communication undertaken or available,*
- *communication environment, relevant factors,*
- *risks,*
- *opportunities,*

- *key issues and concerns,*
- *key messages, and*
- *key audiences (primary, secondary, tertiary).”*

4.1.3.2 IAEA Best Practices: 2) Impact Assessment

“The impact assessment (IA) process identifies potential adverse impacts of the project. This process has evolved into a widely used tool for project planning and decision-making that supports sustainable development. The definition of IA is generally a study of the potential effects or impacts that a proposed project, development or activity will have on the environment. It is also important to note that the term environment is broad, encompassing both biotic (i.e. flora and fauna) and abiotic (i.e. water, soil, air) components including natural resources, human health and socioeconomic security.

IA is a process of identification, communication, prediction and interpretation of information to identify potential (both adverse and beneficial) impacts through the life of a project (i.e. construction, operations and closure) and determine measures to manage these impacts. Impacts are predicted based on the comparison of baseline information and anticipated future conditions both with and without the project occurring. It is at this stage that the identification and consideration of alternative options for mining, processing methodologies and waste management be undertaken. For example, the use of a nearby existing processing facility could be an alternative to building a new facility. Alternative approaches to the project may be found that reduce the production costs and/or overall environmental impact.

Tools for impact assessments range from relatively simple empirical evaluations (e.g. water and geochemical load balances) to very complex deterministic modeling assessments. The objective, regardless of what method or tool is utilized, is to identify potential impacts and issues. Once issues are addressed, analytical methods described and impacts predicted, the significance of the impacts are determined. Determination of ‘significance’ weighs human values against the impacts of the project (environmental, economic or social).”

4.1.3.3 IAEA Best Practices: 3) Risk Assessment

“Undertaking a formal risk analysis is a fundamental component of the decision making process for the sustainable operation of projects. There are a number of formal risk assessment tools that can assist decision makers to evaluate the risks and benefits of the range of options being considered.

“Risk is the probability of an adverse effect occurring as the result of an activity or an event.” A risk assessment considers the combination of:

- *the likelihood of an event occurring;*

- *the consequence of that event; and*
- *and the management measures required to reduce the residual risk (likelihood, severity and/or consequence) to an acceptable level.*

"The probability addresses the likelihood of the event occurring, while the adverse effect is the undesired effect or outcome causing concern (e.g. reduced reproduction in fish or toxic effects to the liver or nervous system). The primary objective of risk management is to provide sufficient information to allow decision makers the ability to do the following:

- *achieve acceptable levels of risk, where benefits flowing from a particular action or decision outweigh the potential loss or damage; and*
- *avoid unacceptable levels of risk, where the likelihood and magnitude of the potential loss or damage outweighs the expected benefits, or where the magnitude of the potential loss or damage, regardless of likelihood, is such that it cannot be reversed or mitigated".*

"There are three possible outcomes of the screening level risk assessment:

- *all potential risks are ruled out;*
- *some potential risks are identified, but risk management decisions are made on the basis of the screening level risk assessment, and no further risk assessment is required; and*
- *some potential risks are identified, but risk management decisions are too uncertain, and further risk assessment is required.*

A screening level risk assessment may show that existing mitigation plans will reduce all potential risks at a facility to levels deemed acceptable. If not, there will be a need to proceed to detailed risk assessment for the identified unacceptable residual risks.

Formal risk assessment processes usually require the following actions:

- *identify and involve stakeholders;*
- *establish the context;*
- *analyze the hazard;*
- *analyze the risk;*
- *evaluate the risk and determine acceptability;*
- *decide to accept or mitigate the risk;*

- *monitor controls and outcomes; and*
- *have contingency plans ready."*

"Sensitivity analysis is used to examine how robust an alternative is to changes in the information or assumptions used in the original analysis. Sometimes the original information or data set may be limited in nature. Additionally, the misuse or selection of parts of a data set can lead to the manipulation of the final solution. The application of sensitivity analysis can help to show in a more transparent nature how varying certain parameters can affect the outcome of a decision making process.

Risk assessment and sensitivity analysis are therefore considered fundamental components of the application of best practice principles to the development and management of projects."

4.1.3.4 IAEA Best Practices: 4) Design

"The IA is the summary document that provides baseline knowledge about the environmental setting, assesses possible impacts for environmental components of concern and recommends mitigation procedures to alleviate or compensate for those impacts. Within the IA, careful consideration should be given to the short and long term social, environmental and economic impacts of a project. The project is designed to minimize the potential impacts. This is often called Designing for Closure."

"Recognizing and allowing for the impacts of evolving standards is compatible with the Sustainable Development Principles; the ten principles are:

1. *Implement and maintain ethical business practices and sound systems of corporate governance.*
2. *Integrate sustainable development considerations within the corporate decision making process.*
3. *Uphold fundamental human rights and respect cultures, customs and values in dealings with employees and others who are affected by our activities.*
4. *Implement risk management strategies based on valid data and sound science.*
5. *Seek continual improvement of our health and safety performance.*
6. *Seek continual improvement of our environmental performance.*
7. *Contribute to conservation of biodiversity and integrated approaches to land use planning.*
8. *Facilitate and encourage responsible product design, use, reuse, recycling and disposal.*
9. *Contribute to the social, economic and institutional development of our communities.*

10. *Implement effective and transparent engagement, communication and independently verified reporting arrangements with our stakeholders."*

4.1.3.5 IAEA Best Practices: 5) Operation

"Best practice principles require that projects incorporate management systems such as an Environmental Management System (EMS) into the operation. A number of EMS standards have been developed for operations to assure they are designed and operated to meet the objectives and specific needs of the project.

Two series of ISO standards are particularly relevant in the area of management systems for environmental performance improvement. They are the ISO 9000 and 14000 series. The ISO 9000 series focuses on quality while the ISO 14000 series defines an EMS based on a commitment to continuous improvement. Companies can achieve certification by meeting the requirements defined in the standards and being audited for compliance by third-party auditors. Certification requires commitment of personnel at all levels and may require the adoption of new technologies and additional employee training. These standards require continuing quality assurance systems, continuing efforts at performance improvement and regular reporting and re-certification. This results essentially in a data management system."

"Another operational management tool is the use of key performance indicators (KPI). KPIs are targets that may be either quantitative or qualitative, and, in contrast to ISO 14000, are used to measure performance against specific objectives or set values.

"Monitoring provides the data that allows comparison of performance against requirements and targets set out within the EMS and KPIs, as well as the license conditions of the operation. The purpose of monitoring is twofold: firstly, to check whether the operation may be impacting on the environment and if so, to what level; and secondly, to determine whether rehabilitation works are performing as predicted.

"The first type is called ***impact or compliance monitoring****, and the second is called* ***performance monitoring****; they serve distinctly different purposes and should not be confused with each other.*

"The purpose of ***impact or compliance monitoring*** *is to check on a regular basis whether the operation is having an impact on the receiving environment and ensure that commitments and statutory obligations are being complied with. For impact or compliance monitoring to be meaningful, it is necessary to have collected sufficient suitable background or baseline data. It is only when compared with the pre-mining (baseline) conditions that the nature of impacts can be assessed. This reinforces the need to begin collecting baseline information early in the exploration phase, before the site undergoes any significant physical disturbances.*

"A correctly designed impact/compliance monitoring program should be able to provide early warning of adverse environmental impacts."

*"The purpose of **performance monitoring** is to check the performance of remediation works against predicted or required outcomes; this will help to ensure that closure criteria will be met. An additional outcome of performance monitoring is to provide actual field-scale data that can be used to refine and calibrate models used in the design of remediation works; this applies in particular to groundwater and cover designs."*

4.1.3.6 IAEA Best Practices: 6) Waste

"Best practice related to the management systems required for waste products associated with a mine or processing facility are site specific and in some cases region specific.

"In certain uranium producing areas, there have been a growing number of waste management facilities within a particular region. As a result of this, some jurisdictions are planning for the use of underutilized waste disposal opportunities at adjacent production sites. For example, this may take the form of:

- *Development of a regional milling facility and associated tailings management to limit the number of mills and tailings disposal sites in a particular area.*
- *Transport of potential contaminants (e.g. waste rock, domestic waste or industrial waste) to a centralized waste disposal location."*

"Typically, regional optimization of waste management is not feasible; each site must manage its waste streams, which generally include:

- *Water*
- *Waste rock*
- *Process residues*
- *Radiologically and chemically contaminated equipment."*

"There was a time when simply placing a 'cap' over the surface of a waste rock dump or tailings dam was considered adequate for remediation and if vegetation was established on it, it was judged successful. Current best practice for cover system design must consider the following questions:

- *Why are we going to cover the waste facility?*
- *What are the issues we are trying to manage/control?*
- *What do we want the cover to do?*

- *How will the cover achieve what we want it to do?*
- *What variables will affect the cover's performance?*
- *How will we measure whether the cover is performing as required?*
- *For how long will the cover remain effective?*
- *Will the cover's performance increase or decrease over time?"*

"Covers can be broken up into two basic types: wet covers and dry covers. Wet covers, as the name implies, are where the waste material is covered by a layer of water (e.g. placed in an open pit then flooded, or contained behind a dam designed to hold a water cover over the waste on closure and into perpetuity). Dry covers vary greatly in design and complexity from simple single layers of uncompacted soils through to multilayered designs that may incorporate low permeability layers, capillary layers, oxygen consumption layers, etc. The choice of a cover layer design will depend on a range of site-specific factors, which include:

- *climatic conditions;*
- *hydrogeological conditions;*
- *acceptable levels of impacts to the receiving environment;*
- *type of cover system selected;*
- *physical, geochemical and radiological properties of the material to be covered; and*
- *physical and geochemical properties of available cover materials."*

4.1.3.7 IAEA Best Practices: 7) Closure

"Continued stewardship of an operation post-closure is also required to meet the best practice of sustainable development. This may consist of but not be limited to:

- *ongoing monitoring;*
- *collection and treatment of contaminated water;*
- *management and storage of water treatment sludge;*
- *maintenance of facilities such as water diversion structures, covers, etc."*

4.1.4 Other IAEA Reports on Good Practice, Emerging Guidance

The following material is extracted and directly quoted from four IAEA reports focused on uranium mining, milling and/or tailings management. We present some of the important points made and concepts developed, and recommend that the entire reports be reviewed during the development of regulations for Virginia.

1) **Guidebook on good practice in the management of uranium mining and mill operations and the preparation for their closure.** (IAEA, 1998).

"Good business practice in the management of a uranium operation involves all aspects of the activities, from exploration, development, exploitation to its closure and decommissioning. It not only applies to recovery of uranium but also addresses all aspects of safety health and environmental protection.

A prerequisite for good mining practice is to have a group of people with well-defined functions and a common culture, with thorough understanding of technologies and know how to apply them. This group must provide leadership in the various disciplines which becomes the foundation for developing the mine.

In recent years, considerable efforts have been made in the design and planning of uranium projects from feasibility studies to decommissioning concepts before any decision was taken to proceed. This development has resulted in detailed assessments of the economic return with increased benefits for environmental protection and the safety and well-being of the employees during the operation.

The key to Good Operating Practice is planning, scheduling and training. This allows the organization to identify critical issues in advance, to anticipate difficulties, to prevent failures and to control the development, operation, and closure process.

A general good exploration practice is the conservation of all data collected at the early stage of exploration to be used later for multipurpose. These data are valuable for describing the geochemical background of region radiometric mapping to be used for land planning surface water quality characterization of soil measurement of ionizing radiation knowledge of the hydrogeological and geotechnical settings is essential for the mining engineer so he can design and plan a mining method which covers beside the excavation and extraction of the ore, the protection of the health and safety of the employees and the environment.

Other good exploration practices are:

- *keep your camp area clean;*
- *manage your drilling with a geostatistical method to optimize the number of holes and reduce environmental impact;*
- *clean the holes before logging;*
- *grout the exploration holes with an approved plugging gel or mud after completion to mitigate the hydrogeological impact and to enhance safety in the future operation, as well as decreasing the amount of water flowing through the mine;*

- *coordinate the activities of underground drilling exploration and mining to avoid interference;*
- *segregate topsoil when constructing drill sites;*
- *close pits, restore topsoil, and re-vegetate;*
- *maintain adequate permanent storage of all drill cores and data; and*
- *electronic forms such as CD disks or diskettes are advantageous.*

Examples of good mining practice for underground mines are:

- *Proper ventilation systems where once through flow ventilation will avoid radon problems. This means that fresh air can go only once through a working place and is immediately exhausted.*
- *Storage of acid generating rocks and low grade ore in specific lined storage areas.*
- *The clear establishment of cut-off grade according to economic situation.*
- *Good lighting.*
- *Good communication.*
- *Clean working places.*
- *A clear and logical reporting system*

Good milling practices include:

- *Minimization of extraction and recoveries; set process standards.*
- *Minimization of reagent consumption.*
- *Addressing all material handling aspects of the process.*
- *Minimization of waste.*
- *Preventive and predictive maintenance to minimize breakdowns.*
- *Easy access to equipment for maintenance.*
- *Establishment of standards for the mill operation and radiation protection.*
- *Training of manpower to follow the standards and gain full understanding of the process.*
- *Flexibility to adapt to changes without negative impact on the process.*
- *Minimize employee exposure to radiation and other health and safety risks.*

The key to Good Practice is planning which allows the organization to identify critical issues in advance, to anticipate difficulties, to prevent failures, and to control the development, operation and closure processes. Following the guidelines described will assist in creating a mine where the health and safety of its employees and the public are protected, the environmental impact of its activities are addressed, and the economical benefits are achieved."

2) **The long-term stabilization of uranium mill tailings. Final report of a coordinated research project, 2000-2004**. (IAEA, 2004.)

"Large volumes of low activity milling residues, such as mill tailings, are produced – sometimes exceeding millions of tons at a single uranium mining/milling facility, in particular, when uranium is only a by-product. The common mode of disposal is in near surface impoundments in the vicinity of the respective mine or mill. Such impoundments were often arranged in a haphazard fashion, utilizing geomorphologic depressions or by filling-in valleys. As a result, there was (is) little or no care taken to isolate the tailing materials from their environment.

Typical environmental problems arising from mill tailings are radon emanation, windblown dust dispersal, and the leaching of contaminants, including radionuclides, heavy metals and arsenic, into surface and groundwaters. Radon (Rn) emissions are due to exhalation from the waste materials and the Rn can reach the ambient atmosphere when free circulation of air in the material and its cover is possible. Emissions to water bodies occur when infiltration of precipitation is unhindered, bottom-liners are absent, and no collection of drainage waters is installed. The leaching of contaminants is usually exacerbated by acid formation from pyrite oxidation under conditions of varying degrees of saturation with water. Additional effects from acid rain have also been observed. In many instances contaminants other than radionuclides may be the real problem, and a comprehensive and holistic assessment of the impoundment inventory and all processes may be necessary.

Based on the objective to keep environmental emissions to a minimum over long times, the task, therefore, is to find conceptual and technical solutions that render tailings more inert over prolonged time-spans, that render impounded materials and engineered structures stable over prolonged time spans, that minimize the need for active maintenance, and that are technically and economically feasible and acceptable to society. It is recognized, however, that the above objectives cannot exclusively be achieved by engineering design, but must involve also adequate management and planning procedures. Hence, the long term stabilization of uranium mill includes, inter alia, the following topical areas:

Planning and management

- *site characterization;*
- *assessment of likely and probable environmental impacts due to radiological and non-radiological contaminants;*
- *identification of processes relevant to the long term performance;*
- *design features that improve long term performance;*
- *conceptualization of time-frame for closure;*
- *conceptualization of remediation goals and techniques;*
- *definition of factors affecting long term care, maintenance and the need for institutional control;*
- *methodologies for quality control and quality assurance (QA/QC); and*
- *design of cost-effective long term surveillance and monitoring programs for environmental and geotechnical performance.*

Technologies

- *identification of properties relevant to the long term environmental and geotechnical performance of tailings and structural materials;*
- *structural integrity of impoundment;*
- *design features controlling the long term stability of engineered structures, e.g. dams;*
- *techniques for ex post improvement of isolation, e.g. bottom seals;*
- *design features controlling erosion resistance;*
- *in situ/on site techniques for post-treatment of tailings, e.g. solidification, de-watering, capping;*
- *techniques for improvement of the long term geotechnical performance of waste materials: biochemical and geochemical resistance of sealants/additives reducing structural degradation;*
- *techniques for cost-effective characterization of radionuclide inventory: determination of source term characteristics;*
- *techniques to minimize long term contaminant release and to improve geochemical stability of tailing materials including in situ/on-site techniques for ex post treatment of existing tailings, i.e. to reduce leachability and/or permeability, or to reduce Rn emanation;*

- *low maintenance/cost or maintenance-free drainage systems and drainage treatment systems for removal of radionuclides and other contaminants;*
- *tools (models) for the assessment/prediction of long term environmental and geotechnical performance;*
- *mechanistic models*
- *systems analyses*
- *fault tree analyses*
- *incident sequence analyses;*
- *Institutional, legal and economic aspects*
    - *site release criteria and use restriction criteria;*
    - *applicable legislative and regulatory regime for radiological and non-radiological issues;*
    - *funding of and liability for remediation/restoration activities."*

3) **Management of Radioactive Waste from the Mining and Milling of Ores**. (IAEA, 2002)

"The radioactive waste generated in mining and milling activities, especially those involving uranium and thorium (U, Th) ores, differs from that generated at nuclear power plants and most other industrial operations and medical facilities. Waste from mining and milling activities contains only low concentrations of radioactive material but it is generated in large volumes in comparison with waste from other facilities. The management methods to be employed are therefore different and will usually involve waste disposition on or near the surface, in the vicinity of the mine and/or mill sites. Furthermore, the waste will contain long lived radionuclides, and this has important implications for its management because of the long time periods for which control will be necessary.

The hazards to humans or to the environment posed by mining and milling waste arise not only from its radioactivity but also from the presence of toxic chemicals and other materials in the waste. Achieving a consistent regulatory approach to protect against these different hazards is a challenge for national regulators. This publication is focused on the management of the radiological hazards associated with the waste, but where there is a particular need for regulators to take account of the non-radiological hazards, this is also indicated.

Workers at mines or mills may receive radiation doses from ores, concentrates, the product of the milling process (for example, U3O8), associated airborne dust, process fluids, industrial and analytical sources (for example, gauges and analytical equipment using X ray fluorescence), radon and thoron daughter products, and radioactive waste. The protection of workers from the radiological hazards of mining and milling waste should not be considered in isolation without

considering these other sources of radiation exposure. The operators of the mine and mill should have in place a comprehensive radiological protection program, in compliance with the requirements of the BSS, which addresses all sources of occupational radiation exposure associated with the mine and mill, including radioactive waste.

Releases of radionuclides from radioactive waste to the environment during mining and milling activities and subsequent waste management activities may result in the radiation exposure of members of the public. Such releases are subject to the criteria that are applicable to releases from any practice in which radioactive material is being handled and, as with occupational protection, national requirements for radiological protection should be consistent. However, since mine and mill tailings will continue to present a potential hazard to human health after closure, additional analyses and measures may be needed to provide for the protection of future generations. Such measures should not be left until closure but should be considered and implemented throughout the design, construction and operation of the mining and milling facilities. The protection of the public, from the beginning of operations to post closure, should be considered in its entirety from the beginning of the design of the facilities. The overall objective and subsidiary criteria developed explicitly for the management of radioactive waste should be consistent with these considerations.

The dose limit established applies to all doses received by members of the critical group from all practices under regulatory control, including practices already current, whether or not relating to mining and milling. Regulatory bodies should therefore allocate an annual dose constraint for each mining and milling operation that will ensure that the overall dose limit will not be exceeded, with account taken of the releases and exposures expected from all other relevant sources and practices, including any known future facility or practice that may result in additional doses.

Owing to the local circumstances at many disposal facilities for mill tailings, the required periods of control may be very long or even indefinite. However, it is recognized that there cannot be absolute certainty and that there is a possibility that, over the long term, failures may occur. Therefore, designs and siting alternatives should be such that they minimize the need for active institutional controls. To ensure that this goal is met, the consequences of the failure of institutional controls and of human intrusion should be evaluated in performance assessments conducted to evaluate the designs. For the purposes of evaluating the performance of the disposal facility, the regulatory body should review the proposed period in the performance assessment calculations for which institutional controls should remain effective before failure is assumed. The impacts of the assumed failure of institutional controls and subsequent human intrusion should be taken into account in establishing the authorization for the disposal facility."

4) **Occupational Radiation Protection in the Mining and Processing of Raw Materials.** (IAEA, 2004)

"An applicant for a license to excavate uranium ore or thorium ore from a site should provide information on the following:

- *proposed work activities;*
- *mining leases;*
- *the site, including geology, mineralogy and extraction techniques;*
- *measures for radiation protection;*
- *procedures for dealing with accidental releases of contaminants;*
- *water treatment;*
- *stockpiles of ore and waste rock;*
- *overburden;*
- *estimates of workplace exposures and individual doses for workers;*
- *impacts on public health and safety; and*
- *proposed decommissioning plans.*

An applicant for a license to site or construct a uranium or thorium mine or processing facility should provide information on the following:

- *the siting or construction (general plan);*
- *the conceptual design of the mining or processing facility;*
- *the siting of tailings and the storage facilities for ore and waste rock (a detailed description as required by the regulatory body);*
- *radiation protection measures;*
- *methods for monitoring air quality;*
- *estimates of workplace exposures and individual doses for workers;*
- *procedures for accident prevention;*
- *the management of effluents; and*
- *environmental impacts.*

An applicant for a license to operate a uranium or thorium mine or processing facility should provide information on the following:

- *the mine or processing facility itself (a detailed description as required by the regulatory body);*
- *mining methods and engineering controls for radiation protection, including methods of shielding, ventilation and control of air quality;*
- *a description of program for operational radiation protection, including equipment and facilities;*
- *estimates of workplace exposures and individual doses for workers;*
- *emergency action plans, as appropriate;*
- *details of the effluent management system and waste management system;*
- *the transport of processed ore;*
- *security measures; and*
- *other relevant information.*

When workplace monitoring combined with a knowledge of occupancy times is used for individual dose assessments:

- *The locations at which workplace monitors are deployed for measuring contaminant concentrations in air should be selected to be representative of the air breathed by workers, particularly where workers move through areas with differing exposure rates.*
- *Instrumentation used to measure dose rates and contaminant concentrations should be calibrated and maintained regularly under a quality assurance program as specified in the local operating instructions.*
- *Where appropriate, the ambient conditions of humidity and temperature should be monitored so as to be able to estimate their influence on the results of the dose assessment.*
- *Where grab sampling is used, it should be demonstrated that the samples are representative of average ambient conditions — as a method, it is only appropriate in environments for which conditions are known to be generally stable.*
- *Records of the period of time spent at each work location should be maintained, with a degree of detail as specified in the local operating instructions.*

- *It may be appropriate to undertake occasional individual monitoring to verify that the results obtained are representative.*

Control measures such as quality in design, installation, maintenance, operation, administrative arrangements and instruction of personnel should be used to the maximum extent possible before personal protective equipment for the safety and protection of workers is used. In circumstances in which control measures are not sufficient to provide safe working conditions, or in circumstances in which emergency work has to be carried out, protective equipment should be provided to restrict the exposures of the workers.

Adequately designed and properly controlled ventilation systems are the most effective means of minimizing the exposure to airborne radioactive substances in underground mines and in processing plants. In underground mines surface coatings and/or barriers may also be effective in restricting exposure to radon and its progeny."

4.1.5 Inviting an International Team: The IAEA UPSAT Review

One way to ensure that the most up to date standards are being considered during regulatory development, and during license application review, is to take advantage of the Uranium Production Site Appraisal Team (UPSAT) process offered by the IAEA. The IAEA states that:

"An UPSAT mission is a peer review of one or more phases of a uranium production cycle by a team of selected international experts having direct experience in the technical areas specific to that operation. The review is a technical exchange of experience and work practices aimed at strengthening the programs and procedures and their implementation at the subject facility. The benefit of such a review for the requesting member state or organization is to obtain independent, international expert opinion and advice on proposed or ongoing resource development programs and their implementation; on upgrading present and future safety programs; and on regulatory matters. An UPSAT mission may also be useful in improving communication with the community." (Extracted/condensed from IAEA.org, UPSAT, 2012).

A central goal of the IAEA is the safe use of nuclear power; applying expert review to development of new regulatory programs is a powerful way to focus on best, most current practices. We highly recommend application of this process to the development of Virginia's regulatory structure, since it represents an efficient and effective way to encourage the incorporation of current best practice into those regulations as they evolve.

4.1.6 Additional Notes from the IAEA on Guidance and Best Practices

"An aging workforce is also one of the challenges facing the industry. Panelists emphasized the need to replenish the nuclear industry´s talent pool through mentoring programs and increasing the number of graduates in nuclear science." IAEA.com conference: "Prospects and Challenges For Uranium Production", (Heiser, S. IAEA.org, 2009).

"Considering environmental remediation and decommissioning only at the end of operations does not allow for proper development of mining and milling activities in such a way that use of natural resources is optimized, waste generation minimized and contamination of environmental media avoided." (IAEA Environet Network, 2011). "Supporting the Remediation of Uranium Mining and Milling Sites", H. Fernandes, P. Carson, in "The New Uranium Mining Boom", edited by B. Merkel, M. Schipek. Springer 2011.

"In uranium mining, prevention is better and cheaper than the cure, although it could appear to be costly at the beginning," (Jan Slezak, IAEA.org, 2009).

An International Symposium on Uranium Raw Material for the Nuclear Fuel Cycle (URAM, 2009) was hosted at the IAEA´s headquarters in Vienna, Austria, from 22-26 June, 2009. The meeting considered issues ranging from exploration and mining to economics and environmental issues. The event was organized in cooperation with the Organization for Economic Co-operation and Development, the Nuclear Energy Agency (OECD/NEA), the Nuclear Energy Institute (NEI) and the World Nuclear Association (IAEA, 2009). Materials from this Symposium may be relevant to Virginia agencies.

4.2 The International Commission on Radiological Protection: Summary of International Commission on Radiological Protection Recommendations

Documents published recently by the ICRP may influence development of regulations by Virginia to address uranium recovery operations. The ICRP is an international consensus body of radiation protection experts tasked with developing and maintaining an International System of Radiological Protection. The recommendations of the ICRP are generally adopted by most nations. A detailed review of the ICRP recommendations is provided as Appendix G to this report.

4.2.1 ICRP Recommendations

The ICRP's Publication 103 (ICRP, 2003) maintains the basic principles of radiation protection initially recommended in the 1990 Recommendations (ICRP, 1990).

- *Justification.* The benefit of a planned activity involving radiation or a proposed remedial action in an emergency or existing exposure situation must be greater than the detriment.
- *Optimization.* Radiation exposures should be kept as low as reasonably achievable, economic and societal factors being taken into account.
- *Limitation.* Dose limits from planned exposures must be implemented to avoid undue risk to individuals.

Table 4-1 compares the 2007 ICRP recommended dose limits to current radiation protection regulations in the Code of Federal Regulations (10 CFR 20).

The ICRP distributed for consultation draft radon protection recommendations in December 2011 (ICRP, 2011a). The Report re-affirms the reference level of 300 Bq/m^3 for dwellings and recommends a reference level of 300 Bq/m^3 for the workplace. The draft report cites a detriment-adjusted risk coefficient of 8 x 10^{-10} per Bq-h/m^3 (5 x 10^{-4} per working level month) and states that there is no consistent evidence of any excess cancer risk for tumors other than lung cancer due to inhalation of radon decay products. The draft recommendations specific to the uranium mining industry note that the optimization process should control regulatory exposures. The ICRP recommends a dose constraint or optimized dose below a dose limit. The recommendations also include use of real-time monitors and personal dosimeters in situations with high and variable radon concentrations. Periodic monitoring would be sufficient where radon concentrations are low and stable.

4.2.2 Nuclear Regulatory Commission Response to International Commission on Radiological Protection 103 Recommendations

The NRC issued a Staff memo to the Commission, Recommendations for Policy and Technical Direction to Revise Radiation Protection Regulations and Guidance (NRC, 2012), in April, 2012. In general, the NRC staff recommends that the Commission approve development of policy and technical information to accomplish the following tasks:

1) Update the regulations to recognize and use current scientific information models, numerical values, and terminology for radiation exposure;
2) Reduce the occupational dose limit for effective dose, lens of the eye, and the embryo/fetus of a declared pregnant worker; and
3) Consider the benefits and impacts of increased use of the International System (SI) of units and the reporting of occupational exposure information by additional categories of licensees.

The ICRP 2007 Recommendations and the NRC responses applicable to the uranium recovery industry along with a discussion of the implications for the State of Virginia are summarized in Table 4.2 of this report.

4.2.3 Brief Glossary (summarized from ICRP 103)

- Absorbed dose (Gy): Energy imparted to matter by ionizing radiation (1.0 Gray (Gy) = 1 joule per kilogram).
- Becquerel (Bq): International System (SI) unit of activity – 1 disintegration per second (d s-1).

- Dose constraint: Prospective source-specific restriction on an individual dose that provides a basic level of protection for the most highly exposed individuals and serves as an upper bound on the dose in optimization of protection for that source.
- Effective dose (Sv): Tissue-weighted sum of the equivalent doses to all tissues and organs of the body.
- Emergency situation: Non-routine situation or event that necessitates prompt action to mitigate a hazard or adverse consequences for human health, safety, quality of life, property, or the environment.
- Equivalent dose (Sv): The absorbed dose to a tissue or organ weighted by the type of radiation.
- Existing exposures: Exposures resulting from existing conditions including natural background and residues from past practices.
- Planned exposures: Radiation exposures resulting from planned operation of sources or use of radioactive materials.
- Reference level: Level of dose (or exposure) above which it is judged to be inappropriate to plan to allow exposures to occur.
- Sievert (Sv): SI unit for dose – 1.0 Sv = 100 rem.
- Working Level Month (WLM): unit of exposure to radon decay products in equilibrium with 100 pCi/L Rn-222, for a period of 170 hours.

4.3 The World Nuclear Association: Summary of Emerging Guidance and Best Practices

The World Nuclear Association (WNA) is an international organization that supports the global nuclear industry. The WNA sees its roles as 1) raising public awareness of the environmental necessity of nuclear power, 2) fostering cooperation within the world nuclear industry, and 3) acting as a global forum and commercial meeting place for leaders and specialists representing all aspects of the industry and representing the nuclear industry in world forums that shape the regulatory and policy environment in which the industry operates.

The WNA indicates that it interacts with international standard-setting bodies to challenge unbalanced and unwarranted regulation that hinders the beneficial use of nuclear power, and it coordinates industry action to surmount impediments that block or hinder efficiency in the responsible mining of uranium and the safe transport of nuclear fuel.

WNA has produce a pocket guide titled “Uranium, from Mine to Mill” that may be of general interest. It includes a flow chart of the mill process, a table of world uranium production, some uranium production history, and other facts. It can be viewed with the following link:

http://www.world-nuclear.org/uploadedFiles/Pocket%20Guide%202009%20Uranium.pdf (WNA, 2011).

In addition, the WNA has produced some documents that would be of interest in Virginia's regulation of uranium mining and milling. These documents are summarized on the pages that follow.

4.3.1 World Nuclear Association Policy Document

Sustaining Global Best Practices in Uranium Mining and Processing

Principles for Managing Radiation, Health and Safety, Waste and the Environment

From the document's introduction:

The worldwide community of professionals engaged in uranium mining and processing recognizes that managing radiation, health and safety, waste and the environment are of paramount importance for the protection of workers, the public and the environment. Such responsible management of uranium mining and processing projects applies at all stages of planning and activities – from exploration through development, construction and operations, and on to decommissioning.

This document sets out principles for the management of radiation, health and safety, waste and the environment applicable to sites throughout the world. In national and regional settings where activities of the nuclear fuel cycle have reached advanced stages of development, these principles already serve as the underpinning for "Codes of Practice" that govern uranium mining and processing. The principles are equally relevant for operators, contractors, and regulators newly engaged in uranium mining and processing. Moreover, experience shows that close cooperation among these three parties is a key to successful management of radiation, health and safety, waste and the environment.

The following is a list of the 11 principles presented in the document with details provided for those principles that are of interest and relevant to Virginia's regulation of uranium mining and milling.

4.3.1.1 Principle 1: Adherence to Sustainable Development

This is a principle focused on basic sound business practices for operators.

4.3.1.2 Principle 2: Health, Safety and Environmental Protection

In all management practices, ensure adequate protection of employees, contractors, communities, the general public, and the environment.

Mining Safety: Ensure safe, well maintained site conditions for the protection of employees and the public from all conventional mining hazards, including those related to airborne contaminants, ground stability and structure, geological and hydro-geological conditions, storage and handling of explosives, mine flooding, mobile and stationary equipment, ingress and egress, and fire.

Radiation Safety: Ensure compliance with the occupational and public dose limits laid down by the appropriate national and international regulatory and advisory bodies. In so doing, classify, according to risk, site personnel and work areas that are subject to radiation exposure. Plan and carefully monitor employee and contractor doses, radioactive discharges and emissions as well as resulting environmental concentrations and exposure rates. Estimate potential radiological impacts on the public and the environment.

Personal Protective Equipment: Ensure that employees and visitors are provided personal protective equipment (PPE) appropriate for the hazard being controlled and compliant with relevant standards or specifications to control exposure to safe levels. Ensure that relevant personnel remain properly trained on the use and maintenance of this equipment.

Ventilation: Ensure that workplaces are adequately ventilated and that airborne contaminants are minimized in workplaces. Pay particular attention to controlling radon and related radiation exposures in uranium mines and processing facilities.

Water Quality: Develop and implement site-specific water management practices that meet defined water-quality objectives for surface and groundwaters (focusing particular attention on potable water supplies). Subject water-quality objectives to periodic review to ensure that people and the environment remain protected.

Environmental Protection: Avoid the pollution of water, soil and air; optimize the use of natural resources and energy; and minimize any impact from the site and its activities on people and the environment. In so doing, include considerations of sustainability, bio-diversity and ecology in guarding against environmental impact.

4.3.1.3 Principle 3: Compliance

Ensure that all activities are authorized by relevant authorities and conducted in full compliance with applicable conventions, laws, regulations and requirements, including in particular the Safety Standard Principles of the IAEA.

4.3.1.4 Principle 4: Social Responsibility

At all stages of uranium mining and processing, properly inform – and seek, gain and maintain support from – all potentially affected stakeholders, including employees, contractors, host

communities, and the general public. Establish an open dialogue with affected stakeholders, carefully consider their views, and provide feedback as to how their concerns are addressed.

4.3.1.5 Principle 5: Management Of Hazardous Materials

Act systematically to establish and implement controls to minimize risks from such wastes and contaminated materials.

Control and minimize any releases into the environment, using carefully planned strategies that involve pollution control technologies, robust environmental monitoring, and predictive modeling to ensure that people and the environment remain well protected.

Focus particular attention on managing ore stockpiles and such potentially significant sources of contamination as waste rock, tailings, and contaminated water or soils. With tailings, concentrate special effort on the design and construction of impoundments and dams and on the application of a recognized tailings management system for operations, monitoring, maintenance and closure planning.

As an integral aspect of mining and processing, characterize ore and waste rock. Consider the geochemistry and assess the risk of acid rock drainage.

To the extent practicable, recover, recycle and re-use such wastes and materials, regarding waste disposal as a last-resort option.

4.3.1.6 Principle 6: Quality Management System

Employ a recognized quality management system – including the quality-assurance steps of Plan, Do, Check and Act (PDCA) – in administering the management of all activities pertinent to radiation, health and safety, waste and the environment.

At all development and operational stages, plan for the management of radiation, health and safety, waste and the environment.

In developing a uranium mining or processing project, prepare a formal EIA that deals with all questions and concerns related to radiation, occupational and public health and safety, waste and the environment, as well as socio-economic impact.

Apply risk assessment and management procedures to radiation, occupational and public health and safety, waste and the environment.

4.3.1.7 Principle 7: Accidents and Emergencies

Identify, characterize and assess the potential for incidents and accidents, and apply controls to minimize the likelihood of occurrence. Develop, implement and periodically test emergency

preparedness and response plans. Ensure the availability of mechanisms for reporting and investigating all incidents and accidents so as to identify "root cause" and facilitate corrective actions.

4.3.1.8 Principle 8: Transport of Hazardous Materials

Package and transport all hazardous materials (radioactive and non-radioactive) – including products, residues, wastes, and contaminated materials – safely, securely, and in compliance with laws and regulations. With radioactive materials, adhere to IAEA Regulations for the Safe Transport of Radioactive Material, relevant IAEA Safety Guides, applicable international conventions, and local legislation.

4.3.1.9 Principle 9: Systematic Approach to Training

In each area of risk, provide systematic training to all site personnel (employees and contractors) to ensure competence and qualification; include in such training the handling of non-routine responsibilities. Extend such training, where appropriate, to visitors and relevant persons in communities potentially affected by these risks. Regularly review and update this training.

4.3.1.10 Principle 10: Security of Sealed Radioactive Sources and Nuclear Substances

Ensure the security of sealed radioactive sources and nuclear substances, using the chain-of-custody approach where practicable and effective. Comply with applicable laws, international conventions and treaties, and agreements entered into with stakeholders on the safety and security of such sources and substances.

4.3.1.11 Principle 11: Decommissioning and Site Closure

In designing any installation, plan for future site decommissioning, remediation, closure and land re-use as an integral and necessary part of original project development. In such design and in facility operations, seek to maximize the use of remedial actions concurrent with production. Ensure that the long-term plan includes socio-economic considerations, including the welfare of workers and host communities, and clear provisions for the accumulation of resources adequate to implement the plan. Periodically review and update the plan in light of new circumstances and in consultation with affected stakeholders. In connection with the cessation of operations, establish a decommissioning organization to implement the plan and safely restore the site for re-use to the fullest extent practicable. Engage in no activities or acts of omission that could result in the abandonment of a site without plans and resources for full and effective decommissioning, or that would pose a burden or threat to future generations.

4.3.2 World Nuclear Association Public Information Paper

Environmental Aspects of Uranium Mining (updated February 2011)

In many respects uranium mining is much the same as any other mining. Projects must have environmental approvals prior to commencing, and must comply with all environmental, safety and occupational health conditions applicable.

4.3.2.1 Wastes

Uranium minerals are always associated with more radioactive elements such as radium and radon in the ore which arise from the radioactive decay of uranium over hundreds of millions of years. Therefore, although uranium itself is not very radioactive, the ore that is mined, especially if it is very high-grade such as in some Canadian mines, is handled with some care, for occupational health and safety reasons.

Solid waste products from the milling operation are tailings. They comprise most of the original ore and they contain most of the radioactivity in it. In particular they contain all the radium present in the original ore. Because radon and its decay products (daughters) are radioactive, measures are taken to minimize the emission of radon gas. During the operational life of a mine the material in the tailings cell is often kept covered by water to reduce surface radioactivity and radon emission. On completion of the mining operation, it is normal for the tailings cell to be covered with soil and rock layers to reduce radiation levels to near those normally experienced in the region.

Run-off from the mine stockpiles and waste liquors from the milling operation are collected in secure retention ponds for isolation and recovery of any heavy metals or other contaminants. The liquid portion is disposed of either by natural evaporation or recirculation to the milling operation. Most countries adopt a "zero discharge" policy for any pollutants.

For ISR operations, the ore body stays in the ground and uranium is recovered by circulating oxygenated and acidified groundwater through it, using injection and recovery wells. The main environmental consideration with an ISR is avoiding pollution of any groundwater away from the ore body, and leaving the immediate groundwater no less useful than it was initially.

4.3.2.2 Health of Workers

In the U.S., standards for radiation control are found in the CFR at 10 CFR Part 20, and are enforced by the NRC. In Australia all uranium mining and milling operations are undertaken under the Code of Practice and Safety Guide: *Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing* (ARPANSA, 2005), which sets strict health standards for radiation and radon gas exposure, for both workers and members of the public. In Canada the Canadian Nuclear Safety Commission is responsible for regulating uranium mining as well as other aspects of the nuclear fuel cycle. In Saskatchewan, provincial regulations also

apply concurrently, and set strict health standards for both miners and local people. Similar standards are set in other countries.

At the concentrations associated with uranium mining and milling, radon is a potential health hazard, as is dust. Precautions taken during the mining and milling of uranium ores to protect the health of the workers include:

- good forced ventilation systems in underground mines to ensure that exposure to radon gas and its radioactive daughter products is as low as possible and does not exceed established safety levels;
- efficient dust control, because the dust may contain radioactive constituents and emit radon gas;
- limiting the radiation exposure of workers in mine, mill and tailings areas so that it is as low as possible, and in any event does not exceed the allowable dose limits set by the authorities. In Canada this means that mining in very high-grade ore is undertaken solely by remote control techniques and by fully containing the high-grade ore where practicable;
- the use of radiation detection equipment in all mines and plants; and
- imposition of strict personal hygiene standards for workers handling uranium oxide concentrate.

At any mine, employees likely to be exposed to radiation or radioactive materials are monitored for alpha radiation contamination and personal dosimeters are worn to measure exposure to gamma radiation. Routine monitoring of air, dust and surface contamination is undertaken.

4.3.3 World Nuclear Association Public Information Paper

Occupational Safety in Uranium Mining (updated January 2011)

In practice, radiation protection is based on the understanding that small increases over natural levels of exposure are not likely to be harmful but should be kept to a minimum. To put this into practice the ICRP has established recommended standards of protection (both for members of the public and radiation workers) based on three basic principles.

Justification: No practice involving exposure to radiation should be adopted unless it produces a net benefit to those exposed or to society generally.

Optimization: Radiation doses and risks should be kept as low as reasonably achievable (ALARA), economic and social factors being taken into account.

Limitation: The exposure of individuals should be subject to dose or risk limits above which the radiation risk would be deemed unacceptable.

These principles apply to the potential for accidental exposures as well as predictable normal exposures.

Underlying these principles is the application of the "linear hypothesis" based on the idea that any level of radiation dose, no matter how low, involves the possibility of risk to human health. This assumption enables "risk factors" derived from studies of high radiation dose to populations (e.g., from Japanese bomb survivors) to be used in determining the risk to an individual from low doses (ICRP Publication 60, 1991). However the weight of scientific evidence does not indicate any cancer risk or immediate effects at doses below about 50 mSv per year.

Based on these conservative principles, ICRP recommends that the additional dose above natural background and excluding medical exposure should be limited to prescribed levels. These prescribed levels are one mSv per year for members of the public and 20 mSv per year averaged over 5 years for radiation workers who are required to work under closely monitored conditions.

A number of precautions are taken at a uranium mine or mill to protect the health of workers.

- Dust is controlled, so as to minimize inhalation of gamma- or alpha-emitting minerals. In practice dust is the main source of radiation exposure in an open cut uranium mine and in the mill area.
- Radiation exposure of workers in the mine, mill, and tailings areas is limited. In practice radiation levels from the ore and tailings are usually very low.
- Radon daughter exposure is minimal in an open cut mine because there is sufficient natural ventilation to remove the radon gas. In an underground mine a good forced-ventilation system is required to achieve the same result.
- Strict hygiene standards are imposed on workers handling the uranium oxide concentrate. If it is ingested it has a chemical toxicity similar to that of lead oxide (Both lead and uranium are toxic and affect the kidney. The body progressively eliminates most Pb or U, via urine). In effect, the same precautions are taken as in a lead smelter, with use of respiratory protection in particular areas identified by air monitoring.

4.3.4 WNA Recommendations/Observations

The WNA provides some valuable documentation as references in developing a regulatory framework. Of particular note is its position statement on Best Practices in Uranium Mining and Processing (WNA, 2008). This document sets out principles for the management of radiation, health and safety, waste, and the environment applicable to sites throughout the world. Although the principles hold special relevance for emerging uranium producing countries that do not yet have fully developed regulations for the control of radiation, health and safety, waste, and the

environment, they can provide a good focus for any regulators newly engaged in uranium mining and processing.

The principles set out by the WNA provide a good summation of important considerations in any operation and regulation of a uranium mining and milling facility, particularly Principle 2 (Health, Safety, and Environmental Protection), Principle 5 (Management of Hazardous Materials), and Principle 11 (Decommissioning and Site Closure). However, the WNA is an international organization that supports the nuclear industry. Therefore, although it supports responsible operation of facilities from the perspectives of radiation control, occupational and public health and safety, waste management, and environmental protection, it is not independent of the objectives of industry success and profit. As such, the WNA (and its website) is not a source for development of new emerging standards. Therefore, Virginia should instead look upon the WNA information as another good source for summarizing operational/regulatory considerations, and not as a source for assistance in regulatory standards development.

5.0 POINTS FOR CONSIDERATION BY THE COMMONWEALTH OF VIRGINIA

There are two central issues before Virginia related to the development of uranium resources in Virginia. The first issue relates to the lifting of the moratorium on uranium mining and development of a regulatory program for that mining. The second issue relates to uranium milling and whether to a) the NRC will retain primacy over the regulation of milling activities and the associated Byproduct Material or b) seek authority for Virginia to regulate uranium milling through expansion of the existing Section 274 Agreement with the NRC under the Atomic Energy Act of 1954, as amended.

We have developed the following PFC by the Uranium Working Group based on our collective experience, review of the literature (Section 2.0 of this report), comparison of regulatory programs (Section 3.0) and examination of emerging international standards (Section 4.0). The PFC from the review of international standards have been kept separate from the other points due to their more programmatic and less specific nature. The experience of the authors represents a diverse assemblage of perspectives and we have made significant efforts to ensure that the resulting points for consideration do not reflect a bias toward any one perspective.

These points have been developed to support formulation of a conceptual regulatory framework to assist decision-making by the Departments and the General Assembly. These points are relevant to Virginia's existing regulatory framework and could be effective for regulating uranium mining in Virginia should the Commonwealth lift the existing moratorium.

5.1 Organization of Points for Consideration

The following PFC are tiered toward different levels of the regulatory framework that would have to be modified or developed should Virginia lift the moratorium on uranium mining and/or choose to regulate uranium recovery and control of byproduct material. The first tier is general in nature, and the PFC address the approach for scoping regulatory changes. The second tier is more specific and addresses individual aspects of the regulatory framework.

The PFC are focused to uranium mining, though many components of these points would be applicable to uranium milling. Based on literature review, effective existing programs, and emerging standards recommended by international experts, the following regulatory components provide an effective regulatory framework and should be considered in Virginia if the moratorium were lifted. Although there was some variation in approaches among the resources consulted, the provisions below appear to be supported by the weight of experience and expert opinion. These general recommendations should be evaluated in conjunction with analysis of actual conditions in Virginia, so that their appropriateness for use in Virginia can be fully ascertained.

5.2 General Points for Consideration Related to Uranium Mining

The following general PFC address programmatic considerations for the Departments and the UWG.

General PFC-1: If the moratorium on uranium mining is lifted, revisions to the existing regulatory framework should clearly identify a single lead agency for oversight, coordination, and enforcement of specific licensed/permitted mining activities. A single agency should have lead responsibility for accepting a complete uranium mining application that addresses all media, wastes and effluents, as well as potential impacts. Delegation of secondary authority to a specific agency for specific areas associated with the license application (e.g., air permitting) should be triggered by the expertise of that agency.

General PFC-2: Uranium Projects in Virginia should be regulated "complete life cycle" in scope. This is true whether it is a uranium mining operation, a uranium milling operation, or a combined operation. A "complete life cycle" regulatory program should be organized into three general phases: construction, operation and reclamation.

General PFC-3: Regulation of ISR operations. Virginia should assess if a conceptual regulatory framework is needed for ISRs at this time, given that there has been debate on whether ISR operations are mining or milling.

General PFC-4: In developing environmental standards, Virginia should consider the following:

1. Specifically address radionuclides in the conceptual regulatory framework;

2. Consider establishing water classes of use (i.e., Class I Domestic drinking water, Class II agricultural/recreational, Class III Livestock, Class IV Industrial, etc.); and

3. Consider developing guidance on adequate sampling and analytical methods, and QA/QC standards, addressing:

   3.1. all media;
   3.2. acceptable methods (i.e., EPA, Standard Methods); and
   3.3. lower limits of detection, practical quantitation limits, method detection limits.

General PFC-5: Virginia should consider the following in evaluating its regulatory program cost recovery:

1. Develop requirements for permitting fees and regulatory oversight cost recovery (e.g., NRC annual recalculation model); and

2. Consider an agency funding plan for the oversight of uranium mining projects that is independent of the general treasury.

General PFC-6: For its process of Environmental Impact Evaluations/Analysis/Statements (EIE/EIA/EA/EIS), Virginia should incorporate the following:

1. Consider expanding existing EIA requirements to uranium mining , regardless of land ownership;
2. Consider expanding public participation opportunities for EIA to be more robust (i.e., federal NEPA model); and
3. Consider establishing criteria for determining the significance of impacts in the Environmental Impact Analysis process.

General PFC-7: In establishing its public involvement program, Virginia should consider the following items:

1. Coordinate public comment opportunities on specific uranium mining projects among the agencies responsible for primary and ancillary permits (Mine Permit, Air Permit, Storm Water Permit, VPDES Permit, Construction Permit, Water Supply Permits, Well Permits, Sewer/Leach field Permits, etc.);
2. Expand web-based information sharing, comment opportunities, notifications, public outreach and education (i.e., expand/improve use of the "Virginia Regulatory Town Hall" web site);
3. Expand the stakeholders to include those beyond adjacent land holders for uranium mining projects; and
4. Expand public participation opportunities in permitting and operation oversight:
    - 4.1.1. public involvement in permit review EIA scoping,
    - 4.1.2. open access to submitted public documents and data,
    - 4.1.3. providing comment opportunities on draft decision documents and draft permits,
    - 4.1.4. comment and appeals processes for final documents, and
    - 4.1.5. development of Environmental Review Committees for uranium mining projects involving qualified stakeholders, including members of the public.

5.3 Specific Points for Consideration Related to Uranium Mining

The following specific PFC are based on literature review, effective existing programs, and emerging standards recommended by international experts, the following regulatory components are important elements in an effective regulatory framework and should be considered in Virginia if the moratorium were lifted. Although there was some variation in approaches among the resources consulted, the provisions below appear to be supported by the weight of experience

and expert opinion. These general recommendations should be evaluated in conjunction with analysis of actual conditions in Virginia, so that their appropriateness for use in Virginia can be fully ascertained. These PFC address aspects of an effective, comprehensive regulatory program, and are organized into the three general phases in the lifetime of a mining facility.

- Permitting/Licensing Phase (including the baseline description of the environment)
- Operating Phase
- Closure/Reclamation/Decommissioning Phase

Specific Points for Consideration for the Permitting/Licensing Phase:

Specific PFC-1: Environmental Baseline (3.3.1.1)

1. The Environmental Baseline should be of an adequate scope and should be based on a complete and accurate conceptual site model (i.e. a robust mine plan). A complete and accurate conceptual site plan should:

   1.1. Consider developing detailed guidelines establishing minimum requirements and/or decision paths (i.e., logic trees) for determining adequate scoping and development of site water quality, geochemical and hydrologic characterizations.

   1.2. Consider guidance for development of more than one site conceptual model to encompass a reasonable range of possible site conditions.

   1.3. Consider guidance for establishing sample adequacy, representativeness for baseline data.

   1.4. Consider developing guidance addressing the following characterization methods for assessment and/or use on samples collected during the exploration phase:

      1.4.1. whole rock analysis;

      1.4.2. appropriate basis for compositing samples;

      1.4.3. mineralogy;

      1.4.4. drill core descriptions (petrology and mineralogy)Block model or similar model (a computerized estimate of the quantity and characteristics of ore and waste);

      1.4.5. available literature on the ore deposit;

      1.4.6. mineral occurrences (e.g., on fracture surfaces, in groundmass, using hand specimens and thin section) with an emphasis on sulfides and carbonates;

      1.4.7. acid-base accounting;

1.4.8. startup of long-term kinetic testing; possible startup of test pads if sufficient material and access to site are available;

1.4.9. baseline surface and groundwater quality and flows (including springs);

1.4.10. potentiometric surface for groundwater;

1.4.11. hydraulic properties (e.g., hydraulic conductivity, porosity, permeability) of soil, vadose zone, and groundwater aquifers, especially under proposed locations of mine facilities;

1.4.12. examination of characteristics of similar mines in region/area; and

1.4.13. hydrogeochemical models for prediction of water quality.

1.5. The scope for development of the Environmental Baseline data should be based on full life-cycle project planning (construction, operations, reclamation, and long-term post reclamation) which considers all reasonable pathways of contaminant transport, biological and physiochemical processes.

2. The general baseline description of the environment should include general information about land use; transportation; geology and soils; hydrology; ecology; meteorology and climatology; noise; historical and cultural resources; socioeconomics and demographics; and public and occupational health. Specific information needed to develop these components of a baseline description of the environment is listed below.

2.1. The geology and soils component of the description should include a characterization of the overburden and potential waste rock, ores, topsoil including the potential to leach contaminants into the environment. This characterization should include the following:

2.1.1. description of appropriate level of detail, accuracy and precision for material characterizations;

2.1.2. description of appropriate level of conservatism to be applied to compensate for uncertainty in data or modeling/predictions;

2.1.3. acid generating/neutralizing potential;

2.1.4. consideration of the limitations for use of static acid –base accounting methods for predicting field conditions;

2.1.5. additional information on mineralogy, availability of acid-producing and neutralizing material, and kinetic tests;

2.1.6. considerations of the limitations for use of humidity cell tests and duration of testing;

2.1.7. oxidation reduction potential;

2.1.8. mineralogy; and

2.1.9. metals and radionuclides content, mobility.

2.2. The hydrology component of the description should include the following items listed below.

2.2.1. Detailed descriptions of the surface and groundwater hydrology; groundwater quantity, quality, potentiometric surface maps and flow rates and direction for each potentially affected aquifer.

2.2.1.1. Scope of study should encompass full range of proposed activities and potential impacts.

2.2.1.2. Consider guidance or requirements for surface water flow modeling with sediment transport and contaminant fate and transport.

2.2.1.3. Consider guidance or requirements for hydrogeologic testing of aquifers, and aquitards.

2.2.1.4. Consider guidance or requirements for groundwater flow and transport modeling for assessing potential future impacts (water quantity and quality).

2.2.1.4.1. Selection of a computer code based on factors.

2.2.1.4.1.1. Modeling objectives.

2.2.1.4.1.2. Capability of the code to simulate important processes affecting water quality at the mine site, as described by the site conceptual model(s).

2.2.1.4.1.3. Ability of the code to simulate spatial and temporal distribution of key input parameters and boundary conditions.

2.2.1.4.1.4. Ease of use of the code, including availability of pre- or post-processors and graphical interface.

2.2.1.4.2. Consider requirements for jointly considering water volume and chemistry for making predictions of water quality at uranium mine sites.

2.2.1.4.3. Consider developing guidance for assessing numeric uncertainty analysis using possible ranges of input values (i.e. sensitivity analyses).

2.2.1.5. Identify degree of potential impacts and duration (draw down and water quality).

2.2.1.5.1. Up-gradient and down-gradient locations, nearby wells, and surface waters in the vicinity.

2.2.1.5.2. Appropriate degrees of conservatism in design and modeling of hydrologic systems to compensate for modeling uncertainty.

2.2.1.6. Consider guidance or requirements for private well surveys in area (construction, water quality, location, hydrogeologic context).

2.3. The ecology component of the description should include the following:

2.3.1. description of communities;

2.3.2. significant habitats;

2.3.3. significant environmental factors;

2.3.4. naturally induced stresses;

2.3.5. seasonal Variation Threatened and Endangered Species;

2.3.6. community dynamics and diversity;

2.3.7. terrestrial:

2.3.7.1. plant and

2.3.7.2. animal;

2.3.8. aquatic:

2.3.8.1. plant and

2.3.8.2. animal.

2.4. The Meteorological and Climatology component should consider requirements for the following.

2.4.1. Best management practices for meteorological monitoring and air quality monitoring (EPA/NRC Guidance).

2.4.2. Best management practices applied to meteorological and air quality modeling.

2.5. The noise component should consider pre-mining noise sources and levels and modeling to determine noise levels at receptors and proposed permit boundary.

2.6. The Historical and Cultural Resources component should consider requirements for assessing historical and cultural resources on private lands and for all uranium mining projects.

2.7. The Socioeconomics and Demographics component should assess environmental justice issues related to socioeconomic class, smoking and their relationship to occupational hazards from the uranium mining and recovery industry.

2.8. The Public and Occupational Health component should consider the following:

2.8.1. Requirements for permit/license applicants to perform site/project specific risk assessments for public and occupational exposures considering project-specific facility configurations and technology and all pathways, and application of public and occupational dose modeling (i.e., like MILDOS) for uranium mine applications and

2.8.2. Performance of ongoing Department review of literature regarding public health impacts from uranium mining.

3. The Cost Benefit Analysis component should consider development of guidance for the following:

3.1. assessing likelihood of scenarios for benefit or cost;

3.2. assessing likelihood of adverse impacts to water resources;

3.3. requesting determination of break-even commodity price; and

3.4. mechanisms for tracking long-term housing and local agricultural commodities prices to assess potential for cost impacts.

4. The radiological assessment component should include an assessment of the natural conditions of the site and surrounding areas (Assess NRC Regulatory Guide 4.14 as applicable model for adequacy).

4.1. Provide for a gamma radiation survey over all proposed mining, waste storage, and hauling areas prior to the removal of topsoil.

4.2. Provide for a survey of airborne dust and radio-particulates and radon, upwind locations, site boundaries, areas of expected high dust/radon levels, and nearby potential receptors (see meteorological and climatology component above).

4.3. Address radionuclides in water quality sampling program (see hydrology component above).

4.4. Address radionuclides in soil sampling program (see geology and soils component above).

4.5. Address radionuclides in vegetation sampling program (crops, local forage) (see ecology component above).

4.6. Address radionuclides in local animals that may be part of human exposure (cattle, poultry, fish) (see land use and ecology components above).

5. The cumulative impacts component should consider an assessment of the cumulative impacts from all area projects on the environment (NEPA process as example).

6. The development of the environmental baseline should include interaction between the applicant and regulator prior to and during the application process to clarify regulatory information requirements, process, and schedule.

Specific PFC-2: Historical and Cultural Resources Survey (3.3.1.2) (see baseline studies, above).

Specific PFC-3: Mine/Operations Plan (3.3.1.3) - The Mine/Operations Plan should include the elements listed below.

1. Development of guidance/requirements for use of appropriate design events for design of critical structures for periods of operation and post-operation. The Plan should look at the magnitude, duration and return interval (likelihood) of the following:

1.1. seismic/earthquake events;

1.2. precipitation/surface water flow events; and

1.3. wind events.

2. Requirement for applicants to assess the probability of a mine waste/effluent release considering the following factors, weighed equally:

2.1. an extreme storm and/or earthquake event;

2.2. placement of wastes in an above ground impoundment;

2.3. wastes not protected from erosion; and

2.4. wastes allocated next to a stream channel.

2. Development of siting criteria for mine for mining facilities, including consideration of flooding, erosion and hydrologic systems, particularly where ores and/or wastes are stored or handled.

3. Requirement for use of demonstrated Best Management Practices (BMPs) for mine design.

4. Demonstration of the effectiveness of BMPs proposed from other similar or comparable projects.

5. Requirement for appropriate construction QA/QC with designs approved by a Licensed Professional Engineer (P.E.).

6. Requirement for as-build drawings for all engineered structures and facilities approved by a licensed P.E.

7. Development of a description of the nature of the materials to be mined including waste/overburden materials and the estimated annual tonnages of ore and waste materials to be mined (see geology and soils, above).

8. Identification of the types of operations to be conducted, including the mining/processing methods to be used on-site.

9. Estimation of the acreages proposed to be disturbed and/or reclaimed annually.

10. Sequentially including an assessment of hydrologic and water quality impacts from drawdown and mine dewatering.

11. Compilation of all pre-operational data collected per the environmental baseline, above, including descriptive narratives and conclusions.

12. Identification of the proposed location and size of ore and waste stockpiles and water storage/treatment ponds.

13. Development of a robust Environmental Monitoring Plan for all appropriate media including monitoring of waste management system performance for environmental protection.

14. Development of monitoring plans to ensure worker and public health and safety that will include the following assessments.

    14.1. Assessment of NRC, EPA, and MSHA standards for all uranium decay chain isotopes to ensure adequate standards and protection measures are required.

    14.2. Assessment of EPA and MSHA standards for public and occupational radon exposure and review of scientific literature to assess if more stringent requirements are warranted in Virginia.

    14.3. Implementation of OSHA and MSHA noise protection standards.

14.4. Requirement for demonstration of BMPs for control of noise and mitigation to the impacted public.

14.5. Comparison of Commonwealth standards with appropriate federal standards (EPA/MSHA/NRC) to be equal or more stringent.

15. Development of plans for Waste Management and environmental protection that include demonstrated BMP's.

15.1. Use of demonstrated BMPs regarding mine waste handling, surface water control and monitoring systems:

15.1.1. demonstrate the effectiveness of BMPs proposed from other similar or comparable projects; and
15.1.2. establishment of a design period that is appropriate for mine waste reclamation stabilization.

15.2. Consideration of requirements for applications to use modern mine characterization techniques, in conjunction with geochemical and physical modeling, to predict the quality of drainage that will be generated by mine wastes over time.

15.3. Consideration of requirements for applications to employ engineering-design risk model to establish performance standards.

15.4. Consideration of the following requirements:

15.4.1. identify and document effective mitigations from review of similar mining projects when proposing mitigation actions in applications;
15.4.2. assess the likelihood and consequences of mitigation failures;
15.4.3. propose multiple mitigation measures for areas having high likelihood and/or high consequences of failure.

16. Development of plans for interim stabilization for standby or extended periods of shut down.

Specific PFC-4: Reclamation/Closure Plan (3.3.1.4) - Ensure that a Reclamation/Closure Plan is provided with application (see Closure section below for additional details).

Specific PFC-5: Mine Worker Health and Safety Plan (3.3.1.5) - The Mine Worker Health and Safety Plan should include an assessment of MSHA and other state mine safety and emergency response requirements.

Specific PFC-6: Financial Assurance (3.3.1.6) - The Financial Assurance Plan should include the following:

1. Use of third parties for regular (annual/significant permit amendments) financial surety reviews;

2. Assessment of additional mechanisms needed for developing contingency funds for unforeseen and unfunded remediation and reclamation obligations (Prepayment, Surety/Insurance/Parent Company Guarantee/External Sinking Fund + Surety);

3. Assessment of, or requirement for additional insurance of environmental impacts or bond shortfalls;

4. Requirements for surety transfer with ownership transfer;

5. Acceptance of only sureties from bonding companies acceptable to the federal Government;

6. Consideration of robust project life-cycle bonding requirements, including the following:

    6.1. the entire permitted land area;

    6.2. remediation of any contamination;

    6.3. site reuse;

    6.4. contamination of groundwater and surface water;

    6.5. disturbance of natural habitat;

    6.6. instability of the land;

    6.7. proper cleanup of uranium mining and extraction wastes;

    6.8. cost of data collection, risk analysis, reclamation plans, and monitoring programs;

    6.9. hydro-geochemistry studies and plans. The dismantling and removal of all buildings and equipment on the site; and

    6.10. re-vegetation and landscape restoration.

7. Consider mining disaster remediation.

Specific PFC-7: Public Notice and Comment (3.3.2.1) - The plans for Public Notice and Comment should consider the following.

1. A public process that encourages applicants to engage the public directly early in the planning process.

2. Mechanisms for providing consistent public access to licensee/permittee reports with overviews of results to ensure public understanding of the operator's actions and performance.

Specific Points for Consideration for the Operating Phase:

Specific PFC-8: Mine Plan/Sequence (3.3.2.1) - The Mine Plan should include the following.

1. Use of Best Management Practices to prevent or minimize impact to the public and the environment; critical items should require construction and maintenance under the supervision of a Licensed Professional Engineer.

2. Mine planning including rock stability for surface and underground facilities.

3. Consider requirements for regular risk analyses, hazard analyses, and operations analyses and for structured change management systems.

Specific PFC-9: Erosion and sediment control (3.3.2.2).

1. Consider requirements for erosion and sediment control structures to be designed based on demonstrated effective best management practices from other similar projects.

2. Consider establishing specific construction, operation, reclamation and post-reclamation phase design conditions/events for which the erosion and sediment control structures must perform.

3. Consider requirements for routine inspection and maintenance of all erosion and sediment control systems and facilities.

Specific PFC-10: Topsoil salvage and protection (3.3.2.3).

1. Consider establishing a definition for “successful” stabilization.

2. Consider requirements for timely stabilization.

3. Consider requirements for routine inspection and maintenance of all topsoil salvage areas with prompt mitigation of unsuccessful stabilization.

4. Consider minimum requirements for stabilization, which may include a) revegetation, b) fencing, c) signage identifying topsoil salvage areas.

5. Consider requirements for annual inventory of salvaged topsoil.

Specific PFC-11: Temporary storage areas (3.3.2.4).

1. Consider requirements for siting temporary storage areas out of construction and operational phase watercourses.

2. Consider requirements for characterization of temporary storage area materials, which may include a) geochemical and radiological characteristics, b) hydrologic characteristics, and c) seismic and slope stability characteristics for the operational timeframe that temporary storage will occur.

3. Consider requirements for selective handling of waste materials based on their characteristics. This may include a) segregation of wastes, b) temporary encapsulation of wastes, and c) comingling of wastes.

4. Consider requirements for control of surface waters (run-on and runoff) for all temporary storage areas.

5. Consider requirements for temporary waste storage area liners based on characterization data, potential for contaminant migration and potential hazards of waste components.

Specific PFC-12: Waste Management/Permanent waste stockpiles (3.3.2.5).

1. Consider establishing specific construction, operation, reclamation and post-reclamation phase design conditions/events for which the waste management/permanent waste storage facilities must perform. Performance period should balance the potential hazard of release with durability of the design.

2. Consider requirements for characterization for waste materials, which may include a) geochemical and radiological characteristics, b) hydrologic characteristics, and c) seismic and slope stability characteristics for the design timeframe over which storage will occur.

3. Consider requirements for selective handling of waste materials based on their characteristics. This may include a) segregation of wastes, b) encapsulation of wastes, c) comingling of wastes, and/or physical and/or chemical stabilization of wastes.

4. Consider requirements for control of surface waters (run-on and runoff) for all waste management /storage areas.

5. Consider requirements for waste management/storage area liners based on characterization data, potential for contaminant migration and potential hazards of waste components.

Specific PFC-13: Environmental monitoring (3.3.2.6) - Environmental monitoring should include the following.

1. Comprehensive monitoring of all relevant media to assure contaminants are not migrating to unauthorized areas.

2. Periodic assessment of monitoring data to confirm that the assumptions made during permitting remain valid.

Specific PFC-14: Inspection and Enforcement (3.3.2.7) - Inspection and Enforcement should include the following.

1. Regular and unscheduled inspections, compliance and enforcement to ensure operations are following the permit.

2. Development of strong enforcement and penalty authorities.

3. Consideration of promulgating regulations that address mechanisms for mitigating lapses in uranium mining and/or milling management practices for control of potential hazards.

Specific PFC-15: Public and Worker Health and Safety (3.3.2.8).

1. Consider expanding occupational exposure monitoring requirements for miners to encompass personal dosimetry for all underground and surface uranium miners.

2. Consider environmental monitoring requirements for mine conditions at the permit boundary, which may include a) air quality for radioparticulates, radon and direct gamma radiation, b) periodic monitoring/sampling of vegetation adjacent to mine and mill areas for metals and radionuclides, and c) surface water and groundwater quality at the permit boundary.

3. Consider making all baseline and operational monitoring data publically available.

Specific PFC-16: Training and re-training (3.3.2.9).

1. Consider requirements for minimum training standards for mine workers, which may include annual radiation awareness and protection training, b) task-specific training, c) requisite refresher training, d) emergency response training.

2. Consider establishing minimum refresher training requirements, which may include a) frequency and, b) minimum proficiency.

3. Consider establishing training documentation requirements, which may include a) training materials, b) training test records, c) duration of records retention, d) records review and availability.

Specific PFC-17: Public Participation (3.3.2.10) - The Public Participation process should provide for the following.

1. Public involvement in monitoring activities and allow the public to file a complaint and mandate a compliance inspection.

2. Readily available public access to reported environmental data.

3. Consideration of establishment of project-specific independent environmental review committees and an independent state-wide Environmental Quality Committee with broad but qualified stakeholder representation.

Specific PFC-18: Regulatory Process - The regulatory process should provide for review and approval of proposed amendments to the permit/license.

Specific Points for Consideration for the Closure/Reclamation/Decommissioning Phase: The Closure process should provide for the submittal and approval of an up-to-date reclamation plan and contemporaneous reclamation whenever possible.

Specific PFC-19: The Closure plan should establish criteria for uranium mine reclamation standards including the following:

1. Period of performance;

2. Stability requirements; and

3. Discharge requirements:

   3.1. all media (water, soil, air); and

   3.2. metals, radionuclides, radon, gamma radiation.

Specific PFC-20: The Closure plan should consider requirements for reclamation planning to explicitly address proposed end-state land use and any potential restrictions on land use.

Specific PFC-21: The Closure plan should include requirements for using demonstrated BMPs for mine reclamation design.

1. Assessment of well abandonment records and requirements for maintaining and submitting well abandonment data.

2. Demonstration of the effectiveness for long-term isolation of mine wastes.

Specific PFC-22: The Closure plan should measures for the neutralization and encapsulation of waste (3.3.3.1) including the following requirements:

1. Performance based reclamation conditions, and

2. Phased or concurrent reclamation during operations.

Specific PFC-23: The Closure plan should address shaft, adit, and high-wall elimination including requirements for prompt remediation of impacts to any and all media that could lead to off-site exposure.

Specific PFC-24: The Closure plan should include requirements for re-contouring of surface areas (3.3.3.3).

Specific PFC-25: The Closure plan should include requirements for replacing of topsoil (3.3.3.4).

Specific PFC-26: The Closure plan should include requirements for re-vegetation (3.3.3.5).

Specific PFC-27: The Closure plan should include requirements for environmental monitoring for surety release (3.3.3.6). The environmental monitoring components should include the following:

1. A specified period of monitoring to determine the site is stable and no contaminants are moving to unauthorized areas; and

2. A bond release process that has site-specific standards and allows public involvement.

Specific PFC-28: The Closure plan should include provisions for public notice and comment (3.3.3.7). The public notice and comment components of the plan should include:

1. Establishment of a process for active public outreach, education and comment;

2. Consideration of a broad stakeholder group for public comment, not just adjacent land owners; and

3. Including a process that provides for the public to be involved in monitoring activities and allows the public to provide input to Virginia as unanticipated conditions arise.

Specific PFC-29: The Closure plan should include groundwater cleanup/restoration/ISR (3.3.3.8).

5.4 Points for Consideration from the International Community

International PFC-1: Follow the ICRP and NRC ongoing revision processes closely, since the regulatory basis may be changing significantly in the near future. The ICRP recommendations for radon exposure are in the process of revision at this time. The draft recommendations include use of real-time monitors and personal dosimeters in situations with high and variable radon concentrations. Periodic monitoring would be sufficient where radon concentrations are low and stable. (Note that the USNRC is also currently finalizing its own guidance on radon and decay product monitoring in the outdoor environment, for protection of the public).

International PFC-2: Carefully reevaluate agency stakeholder involvement programs. Virginia should consider the following in order to fully implement the practices on which the IAEA focuses.

1. Maximizing public/stakeholder involvement. Identifying stakeholders and then successfully engaging them in a participatory manner is a fundamental building block in the development of a successful project.

2. Requiring thorough impact assessments for uranium mining. Identifying, communicating, predicting and interpreting information to identify potential impacts through the life of a project, followed by determination of measures to manage these impacts.

3. Requiring thorough risk assessments for uranium mining. This requirement allows decision makers to evaluate acceptable levels of risk, where benefits flowing from a particular action or decision outweigh the potential risk; and avoid unacceptable levels of risk, where the likelihood and magnitude of the potential risk outweigh the expected benefits, or where the magnitude of the potential risk, regardless of likelihood, is such that it cannot be mitigated.

4. Implementing licensing policies requiring "Designing for Closure." The term indicates a formal process which leads to a facility designed at initiation to minimize its potential impacts.

5. Implementing licensing policies requiring designs based on Best Practice principles. These would specify that projects fully incorporate certain defined management systems into the operation. Two series of ISO standards are particularly relevant: the ISO 9000 series focuses on quality, while the ISO 14000 series defines a management system based on a commitment to continuous improvement.

6. Implementing in regulation certain Best Practices related to waste management systems. These systems, detailed to a greater extent in our initial report, are site-specific.

7. Specifying in regulation a set of Best Practices related to final site closure.

International PFC-3: Carefully define how an operator develops and implements a comprehensive radiological protection program, with the assistance of U.S. and international experts. Such a program addresses all sources of occupational radiation exposure associated with the process, including radioactive waste. The protection of the public, from the beginning of operations to post closure, is considered in its entirety from the initiation of the design of the facilities. Such measures should be formally reevaluated, then specified in formal license modifications and implemented throughout the design, construction, and operation of uranium extraction facilities.

International PFC-4: Specify in regulations the key precautions to be taken during the extraction of uranium ores, in order to protect the health of the workers. These precautions could include:

1. Sufficient forced ventilation systems in underground mines, modified as work progresses, to ensure that exposure to radon gas and its radioactive daughter products is as low as practicable and will not approach established safety levels;

2. Efficient dust control, both in terms of worker and public exposure potential, because the dust may contain radioactive constituents;

3. Limited radiation exposure of workers in uranium extraction projects so that it is ALARA, and in any event does not approach specified allowable dose limits;

4. The use of currently optimal radiation detection equipment in all facilities. This implies regular re-evaluation, in writing, of equipment in use vs. equipment newly available;

5. Imposition of strict personal hygiene standards for workers handling uranium oxide concentrate;

6. Assessment of air quality, meteorological, and radiological baseline characterization requirements currently employed by the various international regulatory authorities;

7. Development of a detailed set of regulatory requirements that regularly re-assess current technology, ongoing potential changes in the regulatory structure developed by international regulatory authorities, and the need to re-establish a detailed understanding of current air quality, including radon gas and radioactive particulates;

8. Specification of appropriate modeling systems to characterize environmental impacts associated with primary and secondary transport media, both for potential radiological and non-radiological hazards. This includes specification of the U.S. and internationally developed atmospheric transport and surface/groundwater pathway analysis models utilizing local, detailed environmental data, modeling technology and best practices. The

specification should require an operator's regular, written re-evaluation of current best practices; and

9. Periodic application of updated, site-specific data within permitting model verification/validation, to ensure that up-to-date information is available for regulatory evaluations. Consideration of how modeling results should be evaluated and used with respect to permit modifications, providing regulatory staff with the most detailed and accurate information and estimates feasible.

International PFC-5: Request that an IAEA Uranium Production Site Appraisal Team (UPSAT) review its regulatory development process. An UPSAT mission is a peer review by a team of selected international experts having direct experience in the technical areas specific to the topic. The review is a technical exchange of experience and work practices that may be aimed at strengthening the development of a regulatory structure.

International PFC-6: Follow the principles established by the International Commission on Radiological Protection.

1. Justification: The benefit of a planned activity must be greater than the detriment.

2. Optimization: Radiation exposures should be kept as low as reasonable achievable.

3. Limitation: Dose limits must avoid undue risk to individuals.

International PFC-7: Follow the principles from the World Nuclear Association (more detailed discussions of each are provided in Section 4.3.2).

1. Adherence to sustainable development.

2. Health, safety and environmental protection.

3. Compliance systems.

4. Social responsibility.

5. Management of hazardous materials.

6. Quality management systems.

7. Accidents and emergencies.

8. Transport of hazardous materials.

9. A systematic approach to training, focused on necessary end results.

10. Security of sealed radioactive sources and nuclear substances.

11. Decommissioning and site closure.

International PFC-8: Continue current policy of discussions with USNRC staff. These discussions should focus especially on the NRC staff members who are rewriting Regulatory Guide 4.14 at this time, and on NRC staff who are developing current policy concerning the monitoring of radon related to uranium extraction site releases in the outdoor environment, in order to evaluate exposures to members of the public. Interaction with these specific staff will not only be of value in the potential development of a potential VA human health uranium regulatory structure, but will also provide opportunities for discussions concerning the NRC's current and developing thought on radiation human health risk and environmental monitoring. The NRC's sources being considered during the development of this new guidance include key international radiation protection organizations.

International PFC-9: Hire staff with specific skills to complete its expertise set. Regulation of a uranium extraction facility would require the involvement of staff with significant uranium-related experience. These professionals are in short supply. In this context, we recommend that the Departments consider developing the capability to provide or contract for specialized training in uranium operations radiation safety for its staff members. Looking ahead, we also recommend that the Departments consider developing a university assistantship program to support the education of local students in radiation protection, with uranium-extraction specialization. Regardless of decisions made concerning specific uranium extraction projects or regulatory developments, such students will have good job opportunities nationally, and may become important young members of Virginia's regulatory community. Recruiting students from the international community can also provide significant exposure to current emerging thought.

International PFC-10: Enter into discussions with the DOE's Legacy Management (LM) Long Term Surveillance and Maintenance (LTSM) group in Grand Junction, Colorado. This group is responsible for acceptance of former uranium extraction sites into long-term management, and as such is very familiar with the early problems in the industry leading to current remedial action problems. This experience will be valuable during the development of any new/revised human-health regulatory structure. The LTSM group participates in a number of international organizations and conferences, thus providing another source of emerging thought for Virginia's consideration.

International PFC-11: Enter into discussions with the International Atomic Energy Agency concerning the invitation of an expert international group to convene in Richmond to discuss emerging international thought on uranium extraction. An initial meeting might best be convened by Virginia Tech or another interested school, to focus at this early juncture on an open exchange of current thought concerning future regulation and protection. The IAEA is the

best focus for development of such a cooperative discussion, given their active work in this area for decades.

International PFC-12: Actively encourage current and future staff members to participate in national and international conferences on various aspects of uranium extraction and long-term surveillance. Staff should develop papers for presentation at such meetings, since such presentations are effective in the development of professional relationships with experts in the field. These connections will be a valuable source of information during the development of any future regulatory systems.

International PFC 13-18: Canadian example. The Canadian and specifically the uranium mining operations in Saskatchewan provide practical examples of one way of putting the IAEA principals into operation. The environmental review process clearly defines the baseline and the potential impacts on the environment. A series of license conditions define requirements through all phases of mine development, exploration, test mines, construction, operation, closure and abandonment. There are strongly defined public consultation processes throughout the mine life. Processes are in place to ensure that the benefits of mining accrue locally. Strong radiation protection/monitoring systems have been put in place to protect the workers and local community.

Many of the uranium mines in Saskatchewan require test mining for metallurgical and engineering purposes. The bulk samples provide strong technical information on the full scale operations on which to base review and licensing processes.

International PFC-13: Make allowances in their regulations for a test mine and bulk sampling.

Uranium ores contain a range of elements that are acid generating and potentially more harmful to the environment than uranium. If not managed correctly, these impacts may cause significant damage to the environment.

International PFC-14: Carefully manage all potentially harmful aspects of uranium mining on the environment.

In Canada, there are clearly defined roles within the provincial and federal departments. These are clearly established in public documents. The system provides the public with clear lines of responsibilities.

International PFC-15: Establish clearly defined roles for each agency involved in the uranium mining processes, minimizing overlapping jurisdictions between other Commonwealth and federal agencies.

Canada has three levels of environmental reviews: screening, comprehensive, and panel reviews. Public acceptance of the quality of the review is critical, and uranium mines typically go through an enhanced review processes.

International PFC-16: Develop an enhanced level of review for a proposed uranium mine.

In Canada, the CNSC lease renewals or significant changes to the original project trigger new environmental reviews. This additional review provides a strong regulatory system to protect the public.

International PFC-17: Consider whether to develop threshold "triggers" for additional EIA processes on lease renewals.

Public reviews of proposed uranium mines often become a focus for energy policy and moral issues associated with nuclear weapons. Review should focus on the impact of the proposed mine.

International PFC-18: Carefully consider the scope of the EIA, considering the possibility of limiting the topics covered during discussions pertaining to a specific uranium extraction license.

International PFC-19: Consider whether it will operate on a cost recovery basis with regards to licensing and inspections.

International PFC-20: Regulatory control can be achieved in different ways. Consider the pros and cons of a performance-based-system (licensing can either be standard-based or results/performance based.) Additional regulatory control can be achieved by using multiple licenses covering construction, operation, closure, and abandonment.

International PFC-21: Consider the value of requiring license renewal, more than one license during the life of a project.

International PFC-22: Ensure benefits accrue to Virginia. Saskatchewan has evaluated the social benefits and risks associated with uranium mining and milling. The province has taken steps to ensure that social benefits from the project accrue to Saskatchewan.

International PFC-23: Ensure an ongoing dialogue about the environment with the local community and how to establish and maintain such a dialogue. Saskatchewan has established Environmental Quality Committees to ensure an ongoing dialogue between local communities and mines.

6.0 REFERENCES

ARPANSA, 2005. Australian Radiation Protection and Nuclear Safety Agency. Code of Practice and Safety Guide: Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing. Radiation Protection Series Publication No. 9. August. Available at: http://www.arpansa.gov.au/Publications/codes/rps9.cfm.

Baker, 2011. A Preliminary Assessment of Potential Impacts of Uranium Mining in Virginia on Drinking Water Sources. City of Virginia Beach, Baker and Associates.

CNSC, 2000. Canadian Nuclear Safety Commission. General Nuclear Safety and Control Regulations.

Chmura, 2011. The Socioeconomic Impact of Uranium Mining and Milling in the Chatham Labor Shed. Economics and Analytics. Virginia.

Clifton and Associates, 2009. Toward a Results-Based Regulatory System Saskatchewan Ministry of Environment Regina, Saskatchewan. Ministry of Environment File R4143.6 February. Available at: http://www.environment.gov.sk.ca/Regulations.

Earthworks, 2004. Predicting Water Quality at Hardrock Mines: Methods and Models, Uncertainties, and State-of-the-Art. Maest, A.S., Kuipers, J.R., Travers, C.L., and Atkins, D.A.

Earthworks, 2006. Comparison of Predicted and Actual Water Quality at Hardrock Mines: The reliability of predictions in Environmental Impact Statements. Kuipers, J.R.

EPA, 1976. U.S. Environmental Protection Agency. Resource Conservation and Recovery Act (RCRA).

Heiser, S. IAEA.org, 2009. Prospects and Challenges For Uranium Production. International Atomic Energy Agency.

IAEA, 1998. International Atomic Energy Agency. Guidebook on Good Practice in the Management of Uranium Mining and Mill Operations and the Preparation for Their Closure. IAEA-TECDOC-1059, Vienna.

IAEA, 2002. International Atomic Energy Agency. Management of Radioactive Waste from the Mining and Milling of Ores. International Atomic Energy Agency. Safety Series No. WS-G-1.2, IAEA, Vienna.

IAEA, 2004. International Atomic Energy Agency. The Long Term Stabilization of Uranium Mill Tailings. International Atomic Energy Agency. IAEA-TECDOS-1403, Vienna.

IAEA, 2004. International Atomic Energy Agency. Occupational Radiation Protection in the Mining and Processing of Raw Materials. International Atomic Energy Agency, Safety Guide No. RS-G-1.6O, IAEA, Vienna.

IAEA, 2005. International Atomic Energy Agency. Regulations for the Safe Transport of Radioactive Material. International Atomic Energy Agency, Safety Requirements, Safety Standards No. TS-R-1.

IAEA, 2010. International Atomic Energy Agency. Best Practice in Environmental Management of Uranium Mining. International Atomic Energy Agency, Nuclear Energy Series, No. NF-T-1.2, IAEA, Vienna.

IAEA, 2012. International Atomic Energy Agency. Uranium Production Site Appraisal Team (UPSAT). International Atomic Energy Agency.

IAEA, 2011. International Atomic Energy Agency. Environet Network, 2011. The New Uranium Mining Boom, Supporting the Remediation of Uranium Mining and Milling Sites, H. Fernandes, P. Carson, in: The New Uranium Mining Boom, edited by Merkel, B. Merkel, Schipek, M. Schipek. Springer.

ICRP, 1977. International Commission on Radiological Protection. Recommendations of the International Commission on Radiological Protection, ICRP Publication 26, Ann. ICRP 1(3).

ICRP, 1991. International Commission on Radiological Protection. Recommendations of the International Commission on Radiological Protection. ICRP Publication 60, Ann. ICRP 21 (1–3).

ICRP, 1993. International Commission on Radiological Protection. Protection Against Radon-222 at Home and at Work. ICRP Publication 65. Ann. ICRP 23(2).

ICRP, 2007. International Commission on Radiological Protection. The 2007 Recommendations of the International Commission on Radiological Protection. ICRP Publication 103, Ann. ICRP 37(2-4).

ICRP, 2007. Recommendations of the International Commission on Radiological Protection. ICRP Publication 103, Ann. ICRP 37(2-4).

ICRP, 2008. International Commission on Radiological Protection. Scope of Radiological Protection Control Measures. ICRP Publication 104.

ICRP, 2009a. International Commission on Radiological Protection Statement on Radon. ICRP Ref 00/902/09.

ICRP, 2009b. International Commission on Radiological Protection. Environmental Protection: Transfer Parameters for Reference Animals and Plants. ICRP Publication 114, Ann. ICRP 39(6).

ICRP, 2010. International Commission on Radiological Protection. Conversion Coefficients for Radiological Protection Quantities for External Radiation Exposures. ICRP Publication 116, Ann. ICRP 40(2-5).

ICRP, 2011a. International Commission on Radiological Protection. Radiological Protection against Radon Exposure. Draft Report for Consultation. ICRP ref 4829-9671-6554. December 6.

ICRP, 2011b. International Commission on Radiological Protection. Statement on Tissue Reactions. ICRP ref 4826-3093-1464. April 21.

Moran, 2011. Site-Specific Assessment of the Proposed Uranium Mining and Milling Project at Coles Hill, Pittsylvania County, Virginia. Roanoke River Basin Association. November.

NAS, 2011. National Academy of Sciences. Uranium Mining in Virginia: Scientific, Technical, Environmental, Human Health and Safety, and Regulatory Aspects of Uranium Mining and Processing in Virginia. December.

NRC, 2012. Nuclear Regulatory Commission. Recommendations for Policy and Technical Direction to Revise Radiation Protection Regulations and Guidance. SECY-12-0064. April 25.

NRDC, 2012. National Resource Defense Council. Nuclear Fuel's Dirty Beginnings: Environmental Damage and Public Health Risks From Uranium Mining in the American West. March.

Parsons G. F. and Barsi, R, 2001. Uranium Mining in Northern Saskatchewan, Part 3. Uranium Mining in Northern Saskatchewan: A Public-Private Transition (Part3): Hosted on the International Development Research Center (IDRC) web site: http://web.irdrc.ca/emplois/ev-28036-201-1-DO_TOPIC.html

RTI, 2011. Supporting the Remediation of Uranium Mining and Milling Sites. IAEA Environet Network. H. Fernandes, P. Carson, in: The New Uranium Mining Boom, edited by B. Merkel, M. Schipek, Springer.

RTI, 2011. Proposed Uranium Mine and Mill, Coles Hill Virginia: An Assessment of Possible Socioeconomic Impacts. December.

Senes Consultants Limited, 1984. Assessment of Risk from Uranium Mining in Virginia. Report prepared for the Coal and Energy Commission, Commonwealth of Virginia. September.

Slezak, Jan and Guy, Shaun, 2008. Implementation of the Sustainable Best Practice in Uranium Mining and Processing. IAEA Technical Meeting on Uranium Exploration and Mining Methods, 17 – 11. Amman, Jordan, Nuclear Fuel Cycle and Materials Section, Uranium Production Cycle. IAEA. Available at: http://www.iaea.org/OurWork/ST/NE/NEFW/nfcms_rawmaterials_tmJordan.html.

UN, 1987. Best Practice in Environmental Management of Uranium Mining (IAEA Report NF-T-1.2, Vienna, 2010)

URAM, 2009. An International Symposium on Uranium Raw Material for the Nuclear Fuel Cycle. Organization for Economic Co-operation and Development, the Nuclear Energy Agency (OECD/NEA), the Nuclear Energy Institute (NEI) and the World Nuclear Association.

WNA, 2008. World Nuclear Association. Sustaining Global Best Practices in Uranium Mining and Processing – Principles for Managing Radiation, Health and Safety, Waste and the Environment. World Nuclear Association, London.

WNA, 2011. World Nuclear Association. Uranium, from Mine to Mill. World Nuclear Association, London. Available at: http://www.world-nuclear.org/uploadedFiles/Pocket%20Guide%202009%20Uranium.pdf.

FIGURES

Figure 3.1 General US Regulatory Structure for Uranium Mining and Milling

GENERAL U.S. REGULATORY FRAMEWORK (Operations / Reclamation)

MINING

Emissions	Agency
AIR	**EPA/State[1]**
Fugitive Dust	
PM_{10}, $PM_{2.5}$	
Air Permit	
Monitoring, Reporting	
Air Pollutants	**EPA/State[1]**
NOx, SOx, VOC, etc.	
Air Permit	
Emissions Inventory, Reporting	
Radon	**EPA/State[1]**
Underground mine (40 C FR 61, subpart B)	**+MSHA**
Exposure modeling, Monitoring	
Surface Mine	**MSHA**
Monitoring, Reporting	
WATER	
Surface Water	**State[3]/Federal[2]**
Sediment Control	
Storm Water Pollution Prevention Plan (SWPPP)	
Point Discharge and Effluent (NPDES)	
Hydrologic Control Plan (Mine Plan)	
Hydrologic Restoration Plan (Reclamation Plan)	
Monitoring, Reporting	
Groundwater	**EPA/State[1]**
Well Construction Standards	
Groundwater Protection Standards-Quality	
Groundwater Protection Standards-Quantity	
Underground Injection and Control (UIC)	
Monitoring/Reporting	

Wastes	Agency
NORM/TENORM	**State**
(ore in outcrop / Mine spoils)	
Mine Permit	
Reclaimed on site	
Hazardous Wastes (RCRA)	**EPA/State[1]**
(Spent oils, batteries, etc.)	
Licensed Haz. Waste Landfill	
Municipal Wastes	**State**
(i.e., domestic trash)	
Licensed Landfill	

Products	Agency
Ore	**State**
(Ores To Mill or Processing Plant)	

MILLING

Products	Agency
Source Material	**NRC/Agreement State**
Uranium	
(U_3O_8 Yellowcake)	
Vanadium	
(V_2O_5 Vanadium Oxide)	
Transport to Enrichment Facility	**DOT/State**

Wastes	Agency
Byproduct Material	**NRC/Agreement State**
Tailings	
Spent process reagents	
Contaminated equipment	
Contaminated PPE	
Other Wastes	
Licensed Disposal Cell	
(Long-Term Custodian)	
Hazardous Wastes (RCRA)	**EPA/State[1]**
(Spent oils, batteries, etc.)	
Licensed Haz. Waste Landfill	
Municipal Wastes	**State**
(i.e., domestic trash)	
Licensed Municipal Waste Landfill	

Emissions	Agency
AIR	**EPA/State[1]/NRC**
Fugitive Dust	
PM_{10}, $PM_{2.5}$	**EPA**
Air Permit	
Monitoring, Reporting	
Radioparticulates	**NRC**
Radioactive Materials License	
Exposure Modeling, Monitoring, Reporting	
Air Pollutants	**EPA/State[1]**
NOx, SOx, VOC, etc.	
Air Permit	
Monitoring, Reporting	
Radon	
From Mill/Processing Plant/Tailings	**NRC/Agreement State**
Radioactive Materials License	
Exposure Modeling, Monitoring, Reporting	
Tailings (40 CFR Part 61, Subpart W)	**EPA/State[1]**
Monitoring, Reporting	
WATER	**NRC/Agreement State**
Surface Water	
Storm Water Containment /Diversions	**(plus EPA/State[1])**
Radioactive Materials License	
Surface Water Stability	
Geomorphic Stability	
Monitoring, Reporting	
Groundwater	**NRC/Agreement State**
Radioactive Materials License	
Groundwater Protection Standards-Quality	
Alternate Contaminant Levels	
Groundwater Protection Standards-Quality	
Monitoring, Reporting	

OCCUPATIONAL HEALTH & SAFETY	**State/MSHA**
PUBLIC HEALTH & SAFETY	**State**
ENVIRONMENTAL PROTECTION	**State/EPA[3]**

[1] If State has been delegated authority by E
[2] If Federal Land or Minerals
[3] Via Clean Air Act, Clean Water Act, etc.

OCCUPATIONAL HEALTH & SAFETY NRC/Agreement State/MSHA

PUBLIC HEALTH & SAFETY NRC/Agreement State

ENVIRONMENTAL PROTECTION NRC/Agreement State

TABLES

Table 3-1 Comparison of Uranium Mining Regulatory Programs

Regulated Area	EPA	MSHA	WY	UT	CO	Canada see Appendix A
1. Mining						
a. Permitting/Licensing (3.3.1)						
i. Environmental Baseline (3.3.1.1)			X	X	X	
ii. Historical and Cultural Resources (3.3.1.2)			X		X	
iii. Mine Operations Plan (3.3.1.3)		X	X	X	X	
iv. Reclamation/Closure Plan (3.3.1.4)			X	X	X	
v. Mine Worker Health and Safety Plan (3.3.1.5)		X	X	X	X	
vi. Financial Assurance (3.3.1.6)			X	X	X	
vii. Public Notice and Comment (3.3.1.7)			X	X	X	
b. Operations (3.3.2)						
i. Mine Sequence (3.3.2.1)			X	X	X	
ii. Erosion/Sediment Control (3.3.2.2)			X	X	X	
iii. Topsoil Salvage and Protection (3.3.2.3)			X	X	X	
iv. Temporary Storage Areas (3.3.2.4)			X	X	X	
v. Waste Management/Permanent Waste Stockpiles (3.3.2.5)	X		X	X	X	
vi. Environmental Monitoring (3.3.2.6)		X	X	X	X	
vii. Inspection and Enforcement (3.3.2.7)		X	X	X	X	
viii. Public and Occupational Health and Safety (3.3.2.8)	X	X	X	X	X	
ix. Training (3.3.2.9)		X	X			
x. Public Participation (3.3.2.10)			X	X		
c. Closure (3.3.3)						
i. Neutralization/Encapsulation of Waste (3.3.3.1)			X	X	X	
ii. Shaft, Adit, and High-wall Elimination (3.3.3.2)		X	X	X	X	
iii. Re-contouring Surface Areas (3.3.3.3)			X	X	X	
iv. Replacing Topsoil (3.3.3.4)			X	X	X	
v. Re-vegetation (3.3.3.5)			X	X	X	
vi. Environmental Monitoring for Surety Release (3.3.3.6)			X	X	X	
vii. Public Notice and Comment (3.3.3.7)				X	X	
viii. Groundwater Cleanup/Restoration/ISR (3.3.3.8)						

Table 4-1 Comparison of ICRP 103 Dose Limits to 10CFR20 Dose Limits

	ICRP 103 Dose Limit	Current 10CFR20 Dose Limit (units as written in 10CFR20)
Occupational Exposure		
Effective dose	20 mSv/y (2 rem/y) averaged over 5 years with no more than 50 mSv (5 rem) in any one year	5 rem/y (0.05 Sv/y)
Dose to the lens of the eye	150 mSv/y (15 rem/y) [recommendation changed in 2011 to 20 mSv/y (2 rem/y)	
Skin dose	500 mSv/y (50 rem/y)	50 rem/y 0.5 Sv/y)
Dose to the hands and feet	500 mSv/y (50 rem/y)	50 rem/y (0.5 Sv/y)
Dose to other organs	No equivalent	50 rem/y (0.5 Sv/y)
Dose to the fetus – limit for pregnant women who formally declare their pregnancy	1 mSv (0.1 rem)for the remainder of the pregnancy (after declaration)	0.5 rem (0.005 Sv) for the period of gestation (requires determination of dose prior to declaration)
Members of the Public (during operation)		
Effective Dose	1 mSv/y (0.1 rem/y)	0.1 rem/y (1 mSv/y) with provision for doses up to 0.5 rem/y under specified conditions and with prior approval.
Lens of the eye	15 mSv/y (1.5 rem/y)	No equivalent
Skin	50 mSv/y (5 rem/y)	No equivalent

Table 4-2 ICRP Recommendations Relevant to DEQ Uranium Regulations

Issue	Relevance to potential VA Uranium Regulations
Reduction in the occupational dose limit from 50 mSv/y (5 rem/y) to 20 mSv/y (2 rem/y) with a maximum of 50 mSv (5 rem) in any year and a total of no more than 100 mSv (10 rem) in a 5-year period.	The NRC is studying the potential impact of reducing the dose limit. Radiation doses in the uranium recovery industry are currently generally below 0.5 rem per year.
Reduction in the dose limit to the lens of the eye from 150 mSv/y (15 rem) per year to 20 mSv/y (2 rem/y) averaged over 5 years with no more than 50 mSv (5 rem) in any single year.	If the dose limit to the lens of the eye is reduced to 2 rem per year based on new data that suggests a much lower threshold for induction of cataracts than previously assumed, the lens of the eye would be the limiting factor for occupational doses.
Dose limit to the fetus - 1.0 mSv (0.1 rem) from the time the pregnancy is formally declared	The current NRC dose limit to the fetus is 0.5 rem for the period of gestation. Concern has been raised as to whether a woman would choose not to declare her pregnancy in order to maintain a position where exposures in excess of the limit are possible.
Distinguishing between planned exposures and existing exposures with different dose limits for members of the public	Current regulations do not distinguish between existing exposures (e.g., contaminated land from previous NORM activities) and planned exposures that can be controlled in advance.
Draft radon dose levels for occupational exposure.	Exposure to radon concentrations at levels greater than the reference level for dwellings - 300 Bq/m^3 (8.1 pCi/L) - that are under the control of the employer, would be considered occupational doses, particularly in the uranium recovery industry.
Dose limits to members of the public – 1.0 mSv per year (100 mrem/y)	No change
Change to SI units and other terminology	Would impact VA regulations

APPENDIX A
LITERATURE REVIEW FINDINGS, COMMENTS AND RECOMMENDATIONS

Summary of Uranium Studies for the Commonwealth of Virginia with Findings, Comments and Recommendations

Studies Assessed:

1. **Chmura Study** - The Socioeconomic Impact of Uranium Mining and Milling in the Chatham Labor Shed, Virginia.
2. **RTI Study** - Proposed Uranium Mine and Mill, Coles Hill Virginia: An Assessment of Possible Socioeconomic Impacts.
3. **Roanoke River Basin Assoc./Michael-Moran Assoc. Study** - Site-Specific Assessment Of The Proposed Uranium Mining And Milling Project At Coles Hill, Pittsylvania County, VA.
4. **National Academy of Sciences Study** - Uranium Mining in Virginia: Scientific, Technical, Environmental, Human Health and Safety, and Regulatory Aspects of Uranium Mining and Processing in Virginia.
5. **Baker Study** - A preliminary Assessment of Potential Impacts of Uranium Mining in Virginia on Drinking Water Sources.
6. **SENES Study** - Assessment Of Risk From Uranium Mining In Virginia.
7. **NRDC Study** - Nuclear Fuel's Dirty Beginnings, Environmental Damage and Public Health Risks From Uranium Mining in the American West.

Study: Chmura Study

Title: The Socioeconomic Impact of Uranium Mining and Milling in the Chatham Labor Shed, Virginia

Authors: Chmura Economics & Analytics (2011)

Chmura Study - Summary

Chmura Economics & Analytics (Chmura) was charged by the Virginia Coal and Energy Commission with producing a study to consider the socioeconomic impact from a potential mining and milling operation in the Commonwealth. The report provided the facts and context to understand the magnitude of economic benefits and the socioeconomic costs from a uranium mine and mill in Virginia. Chmura's analysis provided a framework for Virginia legislators to assess the health and environmental risks and the economic rewards.

Chmura defined and analyzed four scenarios with various levels of environmental contamination. Scenario 2 was the "baseline" scenario and the main focus of the report.

- **Scenario 1**: Negligible environmental impact. The qualities of air, water, noise, and soil are not materially altered from today's existing conditions.

- **Scenario 2**: (BASELINE) Moderate environmental impact in terms of the qualities of air, water, noise, and soil—all contamination remains within limits set by current federal standards.
- **Scenario 3**: Significant environmental impact in terms of the qualities of air, noise, or soil (but not water). At least in one of these three areas, (air, soil, or noise, but not water) contamination exceeds the limits set by current federal standards.
- **Scenario 4**: Severe environmental impact in terms of the qualities of air, water, noise, and soil. Contamination of both water and at least one other area (air, soil, or noise) exceeds the limits set by current federal standards.

Chmura Study Section 1 – Summary of Key Findings

Executive Summary

- *In the opinion of Chmura, the mining and milling operations would bring substantial and much needed economic benefits to Pittsylvania County.*
- *Net benefits come after a broad array of potential negative socioeconomic costs, such as public health and the environment, and negative "stigma" effects on some sectors, such as tourism and agriculture, are subtracted.*
- *The figures are based on the assumption that the Coles Hill site will be continuously operated and ultimately decommissioned within established federal guidelines. It is unlikely that changing this assumption to the more accurate "federal or state guidelines" would have any impact on the conclusions made by Chmura.*
- *Based on the extensive federal regulations within which VUI must operate, some advances in technology, and other reasons the operation will be of economic benefit.*
- *The most significant driver of the socioeconomic costs is not the reclamation and remediation price tag to clean-up the environment, but rather the potential negative stigma effects impacting agriculture, tourism, and possibly other industries.*
- *The estimate of added cost to the Commonwealth of Virginia of $2.5 million per year to monitor the industry may need to be re-evaluated and defined.*
- *The baseline scenario used, as a basis for Chmura to make its judgments should only be accepted after the probability of potential risks are more closely assessed.*
- *A vast majority of residents were skeptical of state or federal authorities to safeguard the environment or public health via an enhanced regulatory environment.*
- *Several steps could be taken to mitigate some of this skepticism by obtaining an "Impact-Benefit Agreement" between VUI and Pittsylvania County, the establishment of a permanent Environmental Quality Committee, and the utilization of "adaptive management practices by VUI.*

Chmura Study Section 3.3 - Summary of Key Findings

Government Service and Regulation

1. *Chmura made no determination of the likelihood for the four scenarios used to evaluate the cost benefits.*

Recommendation Chmura Section 3.3-1: The Departments should created weighted averages for the likelihood of each scenario when making cost-benefit analyses.

2. *Chmura made no determination as to the likelihood of the risks associated with potential water contamination.*

Recommendation Chmura Section 3.3-2: The Departments should further delineate the likelihood of risks associated with potential water contamination.

3. *Chmura recommended that the probability distribution of water related risks deserves additional study and consideration.*

Recommendation Chmura Section 3.3-3: The Departments should consider further defining water-related risks associated with uranium mining and milling activities.

Chmura Section 3.4 - Summary of Key Findings

Public Health and Environment

1. *Scientific studies concerning long-term exposure to heavy metals and mildly radioactive substances are incomplete and inconclusive.*

Comment Chmura 3.4-1: We question the veracity of this statement. There are a substantial number of epidemiological and other scientific data and studies on this topic and there are widely accepted methods for conservatively modeling potential health risks to such exposures. This is a principal focus of the Virginia Department of Health Uranium Study.

Recommendation Chmura 3.4-1: The Departments should consider further evaluating the existing literature with regard to long-term exposure to heavy metals and mildly radioactive substances in order to more fully assess the potential risks associated with uranium mining and milling.

Chmura Section 5.0

Economic Development Impact

Chmura Section 5.3.2 – Summary of Key Findings

Estimated Revenues and Cost of Mining and Milling Operations

1. *Aside from the production level, the total revenue of the milling and mining operations will also depend largely on the price of yellowcake. This economic impact study assumes that the price of yellowcake will be $60 per pound under the baseline scenario. Chmura judges this*

price to be a reasonable estimate of the average long-term price that VUI will realize for its sales of yellowcake.

Comment Chmura Section 5.3.2-1: Even though the economic impact study is based on the assumptions that both the uranium price will be $60 per pound, and that the mining operations will continue for 35 years, it is possible that the operation may be discontinued if the uranium price falls below the break-even point, which is defined as the price point where operational revenues equal operational costs.

Recommendation Chmura Section 5.3.2-1: The Departments should consider requiring permit applicants to develop a project cost-benefit analysis that defines the break-even price for mining and/or milling.

Chmura Section 5.4 - Summary of Key Findings

Spending and Employment Impact of Reclamation

1. *Reclamation efforts for tailings impoundments can start in the middle of the mining and milling operation.*

Comment Chmura 5.4-1: Yes. There are regulations that require licensees to place interim covers over completed tailings cells and limit the exposed acreage of tailings at any given time. EPA regulations at 40 CFR Part 61.252 state: "After December 15, 1989, no new tailings impoundment can be built unless it is designed, constructed and operated to meet one of the two following work practices: (1) Phased disposal in lined tailings impoundments that are no more than 40 acres in area and meet the requirements of 40 CFR 192.32(a) as determined by the Nuclear Regulatory Commission. The owner or operator shall have no more than two impoundments, including existing impoundments, in operation at any one time. (2) Continuous disposal of tailings such that tailings are dewatered and immediately disposed with no more than 10 acres uncovered at any time and operated in accordance with §192.32(a) as determined by the Nuclear Regulatory Commission."

Recommendation Chmura 5.4-1: The Departments should consider requiring fazed or concurrent reclamation and decommissioning of mining and milling activities as appropriate to minimize potential waste and effluent emissions.

Chmura Section 5.5. - Summary of Key Findings

Spending and Employment Impact Summary

1. *During the life of the mine (and mill), the cumulative economic impacts (including direct, indirect, and induced) are estimated to be $3.8 billion, with 19,788 jobs in the Chatham*

Labor Shed. The annual average impact is estimated to be $102.3 million that can support 535 jobs in the labor shed during the life of the mine (and mill).

Comment Chmura Section 5.6.2: There are no direct recommendations for the DEQ and DMME related to this finding.

Chmura Section 5.6.2 – Summary of Key Findings

Stigma and Environmental Contamination Risks on Real Estate Values

1. *The public generally associates this industry with environmental degradation, water contamination, and increased health risks.*

Recommendation Chmura 5.6.2-1: The Department and the Industry should consider creating public outreach programs and solicit public input to engage and educate the public.

2. *Properties within 2 miles of the mining and milling operations have the greatest potential to be affected, and those impacts will likely be sustained over the operation life of the mine and mill.*

Recommendation Chmura 5.6.2-2: Community members, not just adjacent landowners should be contacted early in the planning process and should be closely involved/advised in the public comment process.

3. *Should the qualities of water, air, and soil near any mining and milling operation remain unaffected during the early years of operation, the majority of the stigma effects on most of the properties within five miles would disappear.*

Comment Chmura 5.6.2-3: There are no direct recommendations for the DEQ and DMME related to this finding.

4. *If no accidents occur and the mine and milling sites are property maintained and reclaimed afterwards, any negative effect on residential property value is likely to be short-lived.*

Comment Chmura 5.6.2-4: There are no direct recommendations for the DEQ and DMME related to this finding.

5. *Chmura noted that some landfill operators monitor long-term housing trends in their area and provide a formula for property owners within a 2-mile radius to seek compensatory payment from the company if they sell their house below its fair market value due to the presence of the landfill.*

Recommendation Chmura 5.6.2-5: The Department should consider establishing requirements for operators to monitor or assess long-term housing value trends in the project area during the project life cycle.

Chmura Section 5.8.4 – Summary of Key Findings

Stigma and Environmental Contamination Risks to the Agricultural Sector

1. *A concern of stakeholders is that uranium mining and milling operations will negatively impact the agricultural sector and depress the sales of locally produced foodstuffs and farm related items. These threats to the agricultural sector are limited and related to the public health risks associated with sustained exposures to low-level radiation.*

Comment Chmura Section 5.8.4: Continuous monitoring of operations should alleviate any risk of long-term exposure. Public outreach by both licensee and regulator is important.

Recommendation Chmura Section 5.8.4-1: The Department should consider establishing requirements for operators to monitor or assess long-term agricultural produce value trends in the project area during the project life cycle.

2. *Studies have shown that Uranium mill tailings can spread radionuclides to forage grasses and other vegetation. Chmura neglects to expand on how this might occur.*

Comment Chmura Section 5.8.4-2: Monitoring of meteorological conditions (i.e., wind speed and direction) as well as air concentrations of radioparticulates is standard practice at uranium processing facilities. Monitoring data documents the presence or absence of contaminants that could impact vegetation and soils downwind from the facilities. Public outreach by both licensee and regulator is important.

Recommendation Chmura Section 5.8.4-2: The Department should consider requirements for best management practices for meteorological monitoring, air quality monitoring as well as waste and effluent management and control.

3. *The limited research that exists regarding the exposure to humans of uranium in the food chain concludes that animals and vegetables exposed to uranium tailing pose only "minimal" risk to human health.*

Recommendation Chmura Section 5.8.4-3: The Departments should continuously assess the scientific literature regarding potential human and ecological health risks associated with exposure to uranium mine and mill related hazards.

4. *Public perception and popular stereotypes are malleable and evolve over time, suggesting outreach by industry groups and governmental agencies can mitigate any potential stigma effects. The public trust in the industry can grow over time and the information provided by the uranium industry with regard to public safety and environmental responsibility can be received as credible and accurate.*

Comment Chmura Section 5.8.4-4: Public outreach by both licensee and regulator is important.

Recommendation Chmura Section 5.8.4-4: The Departments should consider mechanisms for providing consistent public access to licensee/permittee reports with overviews of results to ensure public understanding of the actions and performance of the operator.

5. *Monitoring the water quality of private wells for radionuclides, a source of drinking water for humans and animals, and other toxic substances should be included in any regulatory regime.*

Recommendation Chmura Section 5.8.4-5: The Departments should consider developing or enhancing requirements for the following:

- Applicants to document their efforts to identify locations of, acquire access to and survey private wells and septic systems.
- Applicants to expend reasonable efforts to collect data on private wells from either public data sources or perform detailed inventories of local wells and septic systems, including survey of well locations and construction, hydrogeologic context, use, and associated water quality.

Chmura Section 5.9 - Summary of Key Findings

Spending and Employment Impact of the Cessation of Mining and Milling

1. *Regulations would need to be developed to establish protective measures necessary to ensure public health and safety while the plant was idled and VUI was unready or unwilling to implement full remediation and reclamation efforts.*

Comment Chmura Section 5.9-1: There are federal regulations at 10 CFR Part 40.42 that require timely decommissioning of unused or idle uranium recovery facilities. Financial assurance requirements also would ensure reclamation in the absence of the licensee (bankruptcy). Wyoming DEQ/LQD has regulations that address temporary idling of mining and milling operations called Interim Mine Stabilization. They address stabilization measures, monitoring and bonding along with specified renewal periods and criteria for approval.

Recommendation Chmura Section 5.9-1: The Departments should consider expanding existing or developing new requirements for interim mine and/or mill stabilization requirements.

The Departments should consider establishing annual surety reviews for mining/milling permits/licenses to ensure that adequate financial resources are available for a third party to remediate existing impacts and reclaim the site should a permittee/licensee default on its obligations.

Chmura Section 6 – Summary of Key Findings

Government Service and Regulation

Chmura Section 6.1 – Summary of Key Findings

Government Cost for Regulation

1. *Chmura assumes that 1) The Commonwealth of Virginia will choose to become an "Agreement State" and 2) will remain an "Agreement State" for the purposes of regulating uranium mining.*

Comment Chmura Section 6.1: The commonwealth of Virginia does not currently have authority to regulate uranium milling or the associated Byproduct Material. In addition, there are no federal laws establishing a regulatory program for uranium mining on non-federal lands.

Chmura Section 6.2.4 – Summary of Key Findings

Increased Usage of Water

1. *The Coles hill site is expected to use approximately 300,000 to 390,000 gallons of water per day during normal operations, which is roughly between two-thirds to four-fifths of the amount currently consumed by the Town of Chatham.*

Recommendation Chmura Section 6.2.4-1: The Departments should assess their requirements for applicants to demonstrate the surface and groundwater resource impacts associated with mining and milling projects including water consumption, aquifer drawdown and radius of influence, and modification of surface water systems.

Chmura Section 6.4 - Summary of Key Findings

Cost of Contingency Planning and Disaster Preparedness

1. *Chmura assumed two scenarios as having the highest probability of occurrence: 1) an underground mining accident that leaves miners trapped underground; and 2) a transportation accident that spills yellowcake onto a Virginia roadway.*

Comment Chmura 6.4-1: MSHA requires mine safety plans that address safe mining practices and emergency response. NRC requires transportation analyses that assess transportation risk. In addition, NRC requires emergency response plans addressing such accidents.

Recommendation Chmura 6.4-1: The Department should assess the MSHA and NRC requirements for mine safety and emergency response and consider if other requirements are necessary and appropriate for the Commonwealth's programs.

Chmura Section 6.5 - Summary of Key Findings

Cost to Upstream and Downstream Localities

1. *The baseline scenario assumes that the environmental impact is moderate and the contamination to the water (ground and surface), air, soil, or excess noise is assumed to be within federal limits. Given these assumptions, Chmura estimates there will be no costs to upstream or downstream localities. However, in alternate scenarios that assume greater environmental degradation, surrounding communities (particularly downstream) could face some negative economic impact from environmental contamination related to the uranium industry in the Coles Hill area.*

Recommendation Chmura Section 6.5-1: The Departments should create weighted averages of the likelihood for each scenario before determining the cost to upstream and downstream localities.

Chmura Section 6.6.1 – Summary of Key Findings

Responsibility of Industry versus Government

1. *One of the common criticisms of the uranium mining industry is that the industry has historically underestimated the costs and likelihood of environmental contamination.*

Comment Chmura 6.6.1-1: The mining industry as a whole has underestimated these costs. Modern regulatory and operator best management practices are likely to mitigate many of these costs.

Recommendation Chmura 6.6.1-1: For assessing amounts the Departments should consider:

- Establishing requirements for third party reviews of permittee/licensee surety estimates.
- Establishing requirements for permittee/licensees to demonstrate design and operations using best management practices.

2. *Should large-scale environmental contamination occur, the finances of VUI and its partners will likely be insufficient to fully offset the costs of remediation. In this case Chmura assumed that the federal or state government would provide monies to fund the remaining remediation efforts.*

Comment Chmura 6.6.1-2: The insurance industry may provide a mechanism for providing additional assurance that permittees/licensees have the financial means to fulfill all their obligations in the event of large-scale failure. However, insurance is often void if the operators have been negligent in their operations. Therefore, strong requirements for design, construction quality control, monitoring, and maintenance are important to mitigate the potential for large-scale environmental impacts.

Recommendation Chmura 6.6.1-2: The Departments should assess their existing requirements for mine and mill design, construction quality control, monitoring, and maintenance for applicability to uranium mining and/or milling.

Chmura Section 6.7 - Summary of Key Findings

Source of Funding to Offset above Government Cost

1. *From the study: "For example, money from the federally established "Abandoned Mine Land (AML) Trust Fund" (on the federal, state, and tribal authorities) is used to fund cleanup efforts at abandoned mines—predominantly coal, gold, and uranium mines. The AML was established as part of the Surface Mining Control and Reclamation Act of 1977 and receives funds from a special tax levied on active coal mines. The funds are available to 'certified states' and the Act was reauthorized in 2006 by Congress."*

Comment Chmura Section 6.7-1: This statement is inaccurate. The fund was set up to fund reclamation of abandoned coal mines. A state does not need to be a certified state in order to receive AML funds. They do have to be certified to use the funds for abandoned sites other than coal.

2. *A combination of fees, financial sureties, and taxes have been put in place at the federal and state government levels to ensure mineral extracting industries provide adequate funds for any clean-up, remediation, and mine closure efforts.*

Recommendation Chmura Section 6.7-2: See Recommendation Chmura 6.6.1-1

3. *To provide a hedge from responsibility of funding unforeseen reclamation costs, Virginia may consider some innovative or alternative taxing schemes to raise additional revenue from the industry as a precaution against any unforeseen remediation or regulation liabilities that may fall on Virginia to fund.*

Recommendation Chmura Section 6.7-3: The Department should assess if additional mechanisms are needed for developing contingency funds for unforeseen and unfunded remediation and reclamation obligations.

Chmura Section 6.7.1 - Summary of Key Findings

Fines

1. *Current Virginia law does not allow for civil penalties to be brought against Virginia's mining industry.*

Comment Chmura Section 6.7.1-1: Federal law does allow civil penalties to be brought against uranium milling licensees. Under authority of Section 234 of the Atomic Energy Act, NRC describes its civil penalties process at 10 CFR Part 2.205.

Recommendation Chmura Section 6.7.1-1: The Departments should assess their enforcement and penalty authorities to ensure adequate opportunity exists for appropriate penalties to be levied on mining and milling operators who adversely impact public health, safety and the environment through compliance violations or negligence.

Chmura Section 6.7.3 – Summary of Key Findings

Bonding Estimates

1. *Bonding estimates should be included in the up-front cost planning, namely in the form of insurance bonding.*

Comment Chmura Section 6.7.3-1: The bonding/surety companies point out that a reclamation performance bond is NOT an insurance bond. The risk associated with a reclamation performance bond is based on the surety company's assessment of the mining company's ability to complete reclamation. An insurance policy is based on other risks such as the likelihood that a hurricane may cause a release of contaminates. NRC regulations require that uranium mills provide an estimate of the costs of decontamination, decommissioning, and reclamation for their facilities and provide annual updates to their financial sureties. Licensees must provide financial assurance for decommissioning costs before they begin operations that could result in contamination that needs to be cleaned up.

Recommendation Chmura Section 6.7.3-1: The regulating authority should consider using a host of available methods to secure funding for decommissioning and reclamation:

- **Prepayment:** a deposit by the licensee at the start of operation in a separate account, such as an escrow or trust fund.
- **Surety, insurance, or parent company guarantee:** a guarantee of payment of decommissioning costs by a third party, which can be used in the event that the licensee defaults on its obligation to decommission the site.
- **External sinking fund combined with a surety method:** Where an external sinking fund is used by a materials licensee, it must be combined with another financial instrument to assure that the full cost of decommissioning is available at the start of operations. As the value of the external fund increases, the value of the other instrument may be decreased.

- **Statement of intent:** available for government licensees only, this method documents the government licensee's intent to fund decommissioning through legislative appropriation.

2. *"The burden of responsibility over long-term maintenance could be a major consideration in a state's determination of whether to accept custody of tailings sites via a decision to become a full "agreement" state for the purposes of regulating and managing the mill portion of the operation."*

Comment Chmura Section 6.7.3-2: A state does not have to be an agreement state to accept the site, nor does being an agreement state require it to take the site for long-term care. With the transfer of the site to the state or federal government, funds are also provided by the operator to cover the cost of long-term surveillance, monitoring and maintenance. The decision to accept long-term stewardship of a uranium mill tailings site can be made in consultation with the NRC and U.S. Department of Energy toward the end of the uranium recovery project life cycle.

3. *Appropriately priced performance bonds should provide reasonable assurances of funding available to remediate the site under the baseline scenario.*

Recommendation Chmura Section 6.7.3-3: (See Recommendation Chmura 6.6.1-1)

4. *Virginia may want to use the Treasury Department as a first screen for suitable bonding companies if specific bonding legislation is written by the Virginia legislature.*

Recommendation Chmura Section 6.7.3-4: Virginia should only use bonding companies acceptable to the federal government and not just as a first screen.

5. *Bonding should be provided that takes into consideration the following issues (from IAEA publication):*
    - *The entire permitted land area must be covered*
    - *Remediation of any contamination*
    - *Site reuse*
    - *Public exposure to radon*
    - *Contamination of groundwater and surface water*
    - *Disturbance of natural habitat*
    - *Instability of the land*
    - *Misuse of radioactive wastes as building materials*
    - *Proper cleanup of uranium mining and extraction wastes*
    - *Cost of data collection, risk analysis, reclamation plans, and monitoring programs*
    - *Hydrogeochemistry studies and plans*
    - *The dismantling and removal of all buildings and equipment on the site*
    - *Revegetation and landscape restoration*
    - *Miner health and safety*
    - *Mining disaster remediation*

Comment Chmura Section 6.7.3-5: The list seems to go beyond what is normally covered by a reclamation performance bond and includes items that would be covered under an environmental liability policy. These would include: Public exposure to radon, misuse of radioactive materials, and miner health and safety.

Recommendation Chmura Section 6.7.3-5: The regulating authority should consider bonding against:

- *The entire permitted land area must be covered*
- *Remediation of any contamination*
- *Site reuse*
- *Contamination of groundwater and surface water*
- *Disturbance of natural habitat*
- *Instability of the land*
- *Proper cleanup of uranium mining and extraction wastes*
- *Cost of data collection, risk analysis, reclamation plans, and monitoring programs*
- *Hydrogeochemistry studies and plans*
- *The dismantling and removal of all buildings and equipment on the site*
- *Revegetation and landscape restoration*
- *Mining disaster remediation*

Chmura Section 7 – Summary of Key Findings

Public Health and Environment

1. *Uranium mining and milling operations unambiguously increase the exposure of the public and the environment to mildly radioactive substances, toxic chemicals, heavy metals and other carcinogenic materials.*

Comment Chmura Section 7-1: Even under the best of circumstances, some impacts to the environment are inevitable. We do not agree with the presumption that public exposure is significantly increased. The risk is increased but a fully compliant operation would be fully protective of public health, safety and the environment. Even facilities that have inadvertent releases may not result in any significant public exposure if promptly detected and mitigated.

2. *It would be naïve to think that all health and environmental risks can be removed by employing the latest technologies or advanced design techniques.*

Comment Chmura Section 7-2: Even under the best of circumstances, risk is increased by undertaking any development of natural resources. The diligent application of best management

practices by both industry and the regulatory agencies can reduce the risks and potential for adverse impacts to acceptable levels.

Chmura Section 7.1.1 – Summary of Key Findings

Sources of Risk to Public Health and the Environment

1. *The waste rock by-product of uranium milling is TENORM, which is radioactive, carcinogenic, and may also contain toxic materials such as some heavy metals. A number of heavy metals may occur in association with uranium deposits and will ultimately be present in the mill tailings, such as arsenic.*

Comment Chmura Section 7.1.1-1: TENROM is developed as a waste product of mining, not milling, milling waste is Byproduct Material as defined by the Atomic Energy Act. Mine waste may have radiological and toxological characteristics, as mentioned.

Recommendation Chmura Section 7.1.1-1: The Department should consider requirements for best practices in the handling and reclamation of uranium mine wastes.

Chmura Section 7.1.2 – Summary of Key Findings

1. *The relatively wet environment of southern Virginia suggests that rain runoff may be one of the most important pathways to control in order to limit the spread of radionuclides.*

Recommendation Chmura Section 7.1.2-1: The Departments should consider development of rigorous surface water control systems and monitoring requirements for applicants to ensure appropriate management of surface water and control of mining and milling related hazards.

Chmura Section 7.3.1 – Summary of Key Findings

Impact of Noise, Light, and Trucks

1. *The mining industry is inherently noisy; NIOSH reported that hearing loss was the second most reported injury among miners. Seventy dB was selected as the basis tolerable by most individuals and is the standard by which noise is measured. Noise does not pose a significant impact on the local population or the environment either during or after the mining. Simple and straightforward practices can assure noise levels are kept to an acceptable level, such as use and maintenance of good quality equipment, construction of earthen berms, planting of trees, use of sound proofing walls around unavoidable noisy equipment.*

Recommendation Chmura Section 7.3.1-1: The Departments should assess federal noise standards for occupation health protection and determine if more stringent requirements are

appropriate. Assessment of Occupational Safety and Health Administration (OSHA) and MSHA regulations regarding safety equipment requirements for miners should be considered.

The Departments should consider requirements for best management practices related to control of noise impacts to the public.

Chmura Section 7.3.4 – Key Findings

Issues Relating to the Watershed

1. *Chmura is aware of only one hydrogeological study of the Coles hill site, which was limited and recommended a more thorough and comprehensive study be conducted.*

Recommendation Chmura Section 7.3.4-1: Any plan to mine and mill uranium at Coles Hill should consider negative water implications arising from run-off of moisture (from rain, snow, fog, dew, etc.) from mine waste, mill tailings, and stockpiled ore that will be located on site. Additional consideration should be made for the dewatering of underground works through constant pumping of water to the surface for processing. Lastly, contaminated water should be isolated from leaching into the groundwater that is utilized by the surrounding communities which ultimately forms part of the greater Roanoke River basin. The risks to both public health and the environment stem in large part from the potential exposure of nearby surface and groundwater sources to water from the Coles Hill site. The Coles Hill site may contain unsafe levels of radionuclides, heavy metals, and other toxins.

Chmura Section 7.4 – Summary of Key Findings

Environmental Justice

1. *Meaningful involvement means community residents in the potential impact area having an appropriate opportunity to participate in decisions about a proposed activity that will affect their environment and/or health; the public's contribution can influence the regulatory agency's decision; the concerns of all participants involved will be considered in the decision making process; and the decision makers seek out and facilitate the involvement of those in the potential impact area.*

Comment Chmura Section 7.4: Engaging "stakeholders" early in the process will better define their concerns and identify means for mitigating them.

Recommendation Chmura Section 7.4-1: Uranium mining and/or milling project "Stakeholders" should be engaged early in the planning process and should be closely involved/advised in the public comment process.

Chmura Section 8 – Summary of Key Findings

Chmura Section 8.2 - Summary of Key Findings

Public Confidence in the Company

1. *The International Atomic Energy Agency recommends two best practices that can help alleviate some of the concerns that ownership of the mine and mill will eventually be transferred to unknown investors or corporate entities.*

    a. *Impact-Benefit Agreement which creates a legally binding mechanism to address three issues:*
        - *Environmental protection and compensation*
        - *Employment, training and business development opportunities*
        - *Benefits sharing*

Comment Chmura Section 8.2-1a: Financial Assurance requirements in the U.S. exist to ensure that appropriate decommissioning/reclamation will occur if a licensee has financial difficulties. Also, licenses require that any change in operational ownership would be reviewed and approved by the regulatory agency.

Recommendation Chmura Section 8.2-1a: The Departments should consider establishing strong surety requirements and ensure that they are transferable to any domestic or international owners.

    b. *The creation of a permanent Environmental Quality Committee that provides a regular forum for local communities, regulatory agencies, and industry official to discuss and evaluate performance of the mining and milling operations as it relates to the environment. The EQC provides an effective means for community participation in monitoring the uranium mining industry, influencing decision making about the industry and providing two-way communication.*

Comment Chmura Section 8.2-1b: The NRC also encourages the use of local groups such as Citizens Advisory Boards to involve the local community in licensee activities.

Recommendation Chmura Section 8.2-1b: The Departments should consider establishing independent Environmental Review Committees for individual projects as well as an independent Environmental Quality Committee to periodically assess state-wide environmental protection performance by industry.

    c. *IAEA recommends that "adaptive management" practices can help mitigate these risks and increase stakeholder confidence.*

Comment Chmura Section 8.2-1c: An applicant/operator's commitment and culture of responsible operation is critical for a safe and successful operation. Adaptive management (*continuous updating and reassessment of business practices and mining techniques and technologies in light of environmental and socioeconomic performance, and technological change; it also includes the updating of environmental, weather, and engineering-design risk models*) is difficult for regulatory agencies to mandate. Typically, agencies require operators to meet specific performance criteria (containment, limits on effluent amounts and concentrations, safety practices, etc.). It is not always productive or effective for the agencies, public or operator to specify how standards are achieved as long as there is a reasonable assurance that the proposed action can and will be operated safely. This reasonable assurance can be developed based on robust technical submittals by the permittee/licensee.

Recommendation Chmura Section 8.2-1c: The Departments should assess how engineering-design risk models may best be used by permittees/licensees to achieve rigorous performance standards for the protection of public health, safety and the environment.

The Departments should consider empowering lead agencies to mandate detailed applications and rigorous design, construction, operation, maintenance and reclamation designs and monitoring programs.

Chmura Section 8.3 – Summary of Key Findings

Public Confidence in the Ability of Government to Uphold Proper Regulations

1. *If there is skepticism that VUI will be able to operate a uranium mine and mill in such a way as to ensure the safety of public health and the environment, there is an equal if not greater amount of skepticism that governmental agencies at either the federal or state level will be able to ensure public health and environment via regulation and monitoring. Chmura found a broad spectrum of stakeholders that were skeptical of the efficacy of additional regulations to balance the risks posed to public health and the environment by the uranium industry. One concern that was expressed time and time again was that the existing safeguards, standards, and regulations that are designed to protect public health, worker safety, and the environment will be "watered down" by an overly cozy relationship between the uranium industry and those charged to both monitor it and protect the broader public and environment. Similarly, problems at the Nuclear Regulatory Commission (NRC) are well known, and many environmental groups and other skeptics have indicated that these problems could further undermine credible efforts to regulate the industry.*

Comment Chmura Section 8.3-1: Public skepticism regarding efficacy of regulatory requirements and oversight can be managed in part by clear and frequent communication with the public. A great deal of skepticism is often born from a lack of understanding about regulatory frameworks, process, and requirements. Though there ample examples of failures on the part of

both industry and the regulatory community, it is often forgotten that the vast majority of modern regulatory programs and projects developed under modern standards are effective in protecting public health, safety and the environment.

The Departments have initiated a process for scoping these issues and the Commonwealth's Coal and Energy Commission and the Uranium Workgroup has and continues to engage the public.

Recommendation Chmura Section 8.3-1: The Departments should assess their public outreach and communications policies and programs for adequacy in providing ample public access to educational materials regarding uranium mining and milling processes as well as the regulatory process for overseeing these industries.

Study: RTI Study

Title: Proposed Uranium Mine and Mill, Coles Hill Virginia: An Assessment of Possible Socioeconomic Impacts

Authors: Danville Regional Foundation and RTI International (2012)

RTI Uranium Study – Summary

RTI International was commissioned by the Danville Regional Foundation (DRF) to conduct a comprehensive, independent assessment of the possible impacts of a uranium mine and mill at Coles Hill. The report has both a Non-technical Summary and an Executive Summary. Both were reviewed as part of this effort. Section 5 of the Executive Summary contains many recommendations that are applicable to the regulation of uranium mining and milling in Virginia.

RTI Study - Summary of Key Findings

Non-technical Summary

1. *Some measurable environmental contamination would occur, especially within a mile or so of the site; proper facility design and regulatory oversight and proactive best practices at the mine and mill would limit environmental and human health impacts.*

Comment RTI Non-technical Summary-1: The issue is more complex than the finding appears. Most regulatory programs require that there be no off-site impacts. The point of compliance for many media is at the permit boundary. Many programs allow environmental degradation up to established standards such that the beneficial use of the media is not impacted (maintaining class of use). For example, drinking water has standards for numerous constituents. A permitted activity may be allowed to have a measurable impact on those constituents as long as those constituents remain suitable for drinking water. An example is if a site's existing water quality is half of the existing standard, the concentration of the constituent may be allowed to increase as long as it remains below that standard. So the statement in the summary of findings while true, fails to explain the limits of the contamination.

2. *Groundwater levels near the mine would decline because of groundwater pumping at the mine. Solid waste materials from the mill (tailings) would remain radioactive for thousands of years and would need to be managed so they remain contained and isolated from contact with water and to prevent radon emissions.*

Comment RTI Non-technical Summary-2: Water levels will decline during mining as the water table is depressed to allow mining. What the summary fails to mention is neither the amount of decline nor the fact that when mining ceases, the water table will begin to rise.

Recommendation RTI Non-technical Summary-2: The permitting process should identify which aquifers will be impacted, the degree of the impact (both physical and chemical), and duration.

Potential Environmental Impacts

1. *Mining and milling would result in releases of uranium and other contaminants into the surrounding area, even if the mine and mill meet or exceed regulatory requirements.*

Comment RTI Study Potential Environmental Impacts-1: See discussion of Summary of Key Findings No. 2.

Impacts on State and Local Governments

1. *Overall, between 10 and 20 additional state employees would be needed, costing between $2 million and $5 million per year.*

Comment RTI Study Impacts on State and Local Governments-1: Based on personal experience in state government, 20 additional state employees is very high and 10 or less is more realistic to supplement staff in existing regulatory programs for mining. It is acknowledged that these new staff may have to have additional training and experience in areas that current staff may not have.

RTI Study Chapter ES.4 – Summary of Key Findings Chmura Section 5.6.2 – Summary of Key Findings

Stigma and Environmental Contamination Risks on Real Estate Values

1. *The public generally associates this industry with environmental degradation, water contamination, and increased health risks.*

Characterization of the Mine and Mill and Possible Environmental Releases

Comment RTI Study Chapter ES.4-1: The report contains the statement on page ES-12, "*As required by the NRC, the tailings will be mixed with cement and stored in at least six impoundments. The resulting paste tailings process results in the stabilization and solidification of the tailings and will result in dramatically reducing the potential of contaminants transported from the site.*" While the latter sentence is valid, the first is false as it implies the NRC requires cement to be added to tailings disposed in surface cells and this is not true. The NRC requires steps to be taken to prevent contaminants transported from the site but does not require cement to be added nor dictate the number of impoundments.

Comment RTI Study Chapter ES.4-2: On page ES-13 there is a table of the estimated range of constituent discharge rates to surface water. It provides estimates on a Low-Impact Scenario and a High-Impact Scenario. While the table may be an accurate estimate, it should be noted that the scenarios provided are based on the discharges meeting EPA's Effluent Limitations for Mine Drainage of New Uranium Mines (which the report does state). To the casual reader however, it appears the surface water quality is being more severely impacted by the High-Impact Scenario when in reality the level of impact is the same - just more water is being discharged.

Comment RTI Study Chapter ES.4-3: Page ES-13 the report discusses estimated radon emissions from overburden storage areas. Note that in the open the level of radon emissions is quickly diminished by dilution and dispersion.

RTI Study Chapter ES.5 – Summary of Key Findings

Human and Ecological Health

RTI Study - Surface Water

1. *Any mine and mill facilities handling potential contaminants would clearly need to be located at elevations well above the area of potential flooding. Furthermore, storm water management facilities would need to be designed to minimize runoff and erosion across the facility, particularly in areas where ore, ore byproducts, and wastes are handled. The analysis of flood potential for site is an important component of an effective permitting program.*

Recommendation RTI Study Surface Water-1: The Departments should consider establishing facility siting requirements that include an analysis of potential flooding. Facilities siting should be required to be located above potential high water or provide adequate engineered designed protection. The requirements should also include designs to minimize runoff and erosion across the facility, particularly in areas where ore, ore byproducts, and wastes are handled or stockpiled.

RTI Study - Groundwater

1. *Groundwater levels in the area around the mine would lower as a result of the dewatering, which could impact nearby wells, springs, and surface water bodies. Wells and springs in the affected area could decrease in capacity or go dry. Groundwater flow to surface water could decrease, or surface water could flow back into the groundwater system in areas of lowered groundwater elevations, thus decreasing the surface water flows.*

Recommendation RTI Study – Groundwater-1a: The Departments should consider requirements for hydrogeologic testing to estimate the potential extent of groundwater lowering necessary to dewater the mine and rate of groundwater recovery.

Recommendation RTI Study – Groundwater-1b: The Departments should consider requirements for modeling groundwater systems to determine potential impact.

RTI Study - Constituents of Concern

1. *Preliminary information suggests that concentrations of heavy metals at the site may be limited, which would mitigate concerns about some potential contaminants from ore and overburden sources. However, this determination should be verified through more comprehensive sampling and analysis of rock and leachate samples from the site.*

Recommendation RTI Study - Constituents of Concern-1: The Departments should consider requirements for comprehensive sampling and testing of overburden, host rock, and ore, including leachate tests to characterize potential mobilization of contaminants and acid producing material.

RTI Study - Tailings Management

1. *Water in contact with uranium tailings (the primary waste material from the milling process) contains elevated radioactivity and concentrations of several metals well above regulatory thresholds (e.g., arsenic, cadmium, chromium). This information underscores the requirement for proper management and long-term isolation of tailings materials because of the associated metals concentrations in addition to the elevated radiation levels.*

Recommendation RTI Study - Tailings Management-1: The Departments should consider requirements for applicants to demonstrate long-term isolation of mine waste effluents and mill wastes from the environment.

The Departments should consider requirements for applicants to develop and implement robust management plans for monitoring and maintenance of the mine waste and mill tailings until and potentially beyond when the facilities are fully reclaimed and/or transferred to either the Commonwealth or the federal government.

RTI Study - Testing for Acid Mine Drainage

1. *Specific leachate testing of the ore and other potentially stockpiled materials (overburden, sub-ore) would be necessary to confirm whether acid (or alkaline) mine drainage would be an issue at this site.*

Recommendation RTI Study - Testing for Acid Mine Drainage-1: The Departments should consider requirements for characterization of the acid generating potential, net neutralizing potential and the potential mobility of radionuclides and metals form wastes and ores.

The Departments should consider requirements for development of waste rock and ore handling management plans. These plans should contain methods for materials characterization that would be used to segregate materials based on their radiological and mineralogical characteristics so that they can be appropriately managed or used for future waste isolation.

RTI Study - Need for Baseline Characterization

1. *Many of the chemicals of potential concern are present naturally in the environment. It can be challenging to distinguish between natural and anthropogenic concentrations of these*

chemicals. Therefore, characterization of baseline conditions prior to facility construction would be important to understand future environmental concentrations and potential impacts due to operations.

Recommendation RTI Study - Need for Baseline Characterization-1: The Departments should consider requirements for characterization of baseline conditions prior to permit issuance. The baseline studies should include but not necessarily be limited to naturally occurring constituent and radionuclides identified in State drinking water standards and NRC regulations identified in 10 CFR Part 40, Appendix A, Criterion 5. This is important to enable an understanding of potential future environmental concentrations and potential impacts. It will also help to distinguish measured contaminant levels in the future from natural levels.

RTI Study - Airborne Particulate Emissions and Deposition

1. *A comprehensive human health risk assessment would be needed to provide quantitative estimates of the potential risks associated with these emissions.*

Recommendation RTI Study - Airborne Particulate Emissions and Deposition-1: The Departments should consider requirements for permit/license applicants to develop comprehensive human health risk assessments to provide quantitative estimates of the potential risks associated with airborne particulate (radiological and non-radiological) emissions.

RTI Study - Potential for Sediment Erosion to Contaminate Streams

1. *Estimates of erosion rates and associated mass transfer to local waterbodies under as-built conditions would be needed to quantify potential contaminant loads that may be transferred via sediment erosion.*

Recommendation RTI Study - Potential for Sediment Erosion to Contaminate Streams-1: The Departments should consider requirements for permit/license applicants to perform surface water flow modeling of proposed disturbed area to predict sediment transport and deposition. Based on the results, the Commonwealth would have the ability to request more detailed fate and transport analysis of contaminants of concern, as warranted.

RTI Study - Paste Tailings Backfill Has Both Advantages and Risks

1. *The report recommended that isolation of subsurface paste tailings from groundwater is necessary.*

Recommendation RTI Study - Paste Tailings Backfill Has Both Advantages and Risks-1: Should the Commonwealth elect to assume regulatory authority over uranium milling and Byproduct Material, it should consider requirements for characterization and demonstration of the short-term and long-term solubility/leachability of tailings (stabilized with paste technology or otherwise) if placed in the subsurface outside a conventional double-lined disposal cell with leak detection and, if necessary, model the fate and transport of any constituent of concern. The results would determine if the subsurface tailings disposal would need further isolation from groundwater.

RTI Study - Proper Tailings Management Is Critical

10. *The report did not make specific recommendations for this topic but did point out that double lined systems with leak detection systems as used for municipal landfills have been effective but proper engineering, construction, and operational maintenance is crucial.*

Recommendation RTI Study - Proper Tailings Management Is Critical-1: Should the Commonwealth elect to assume regulatory authority over uranium milling and Byproduct Material, it should consider requirements for tailings disposal cell minimum design standards. Consideration of these minimum design standards should include designs signed by a Licensed Professional Engineer and a double lined system with a leak detection system.

The Commonwealth should also consider requirements for rigorous construction QA/QC with an as-built certification by a Licensed Professional Engineer. The requirements should also include a maintenance plan with reports signed by a Licensed Professional Engineer.

RTI Study - Key Mitigating Factors

1. *Comprehensive baseline characterization of environmental media and ecosystems before the mine is built;*
2. *Comprehensive and ongoing monitoring during operations of emissions and concentrations in media at the mine and in the mine vicinity, including, air, water, soil, agricultural products, flora, and fauna;*
3. *Use of effective technologies to reduce emissions;*
4. *Sustained focus on pollution prevention and reduction;*
5. *Collaboration and transparency between the mining company, regulators and citizens throughout the planning, operation and closure stages; and*
6. *Expedient and effective reclamation*

Comment RTI Study Key Mitigating Factors-1: There are all part of a best practices approach.

Recommendation RTI Study Key Mitigating Factors-1: The Departments should consider requirements for and demonstration of best management practices in design, construction, operation and reclamation in uranium mining and/or milling project applications.

Study: Roanoke River Basin Associates/Michael-Moran Associates Study (Moran Study)

Title: Site-Specific Assessment Of The Proposed Uranium Mining And Milling Project At Coles Hill, Pittsylvania County, VA

Authors: Michael-Moran Associates (2011)

Moran Study - Summary

The Roanoke River Basin associate commissioned a study by Michael-Moran Associates, LLC to provide a site-specific assessment of the Coles Hill uranium project site. The paper focused on water–related issues and drew on original data and reports and more recent, publicly available, Virginia Uranium documents.

Moran Study – Summary of Key Findings

Finding Moran-1:

Virginia Uranium reports fail to present the operational and technical detail necessary for the public, investors and regulators to realistically evaluate future environmental contamination, increased water resource competition, and unforeseen public and investor liabilities.

Comment Moran-1: It is our understanding that the reports assessed by Michael-Moran Associates were developed for specific purposes and not intended as comprehensive permit applications or characterizations of the site or to *"..present the operational and technical detail necessary for the public, investors and regulators to realistically evaluate future environmental contamination, increased water resource competition, and unforeseen public and investor liabilities"* The public and regulatory agencies should not relay on these documents for any purpose other than for that which they were intended.

Recommendation Moran-1: The Departments should assess proposed projects based on formal and complete applications from the applicants as well as input from stakeholders and the public. Pre-judgment of a project based on partial information is not recommended.

Finding Moran-2:

Predictions made about the expected, largely benign water quality at numerous other uranium mining and processing facilities by some of these same consultants have proven to be overly optimistic and incorrect.

Elsewhere in the report, it is stated:

While the Marline Report (1983) argues that most of these contaminants would be reduced to environmentally-insignificant concentrations by attenuation on various types of clays and other sediments, this argument has proven to be overly-optimistic at dozens of other formerly-operating

uranium mine and mill sites. In fact, the same sorts of column tests, described in Volume 1A of the Marline Report (1983), pages 68 through 73 (and performed by some of the same Marline consultants) have also failed to realistically predict the actual concentrations, significantly underestimating long-term contaminant concentrations and migration for other uranium projects.

Recommendation Moran-2: The Departments should consider available site and material characterization data when assessing potential adverse impacts and project feasibility for protection of public health safety and the environment or for required operational mitigation and monitoring.

The Departments should consider use of third party expert assessment of critical applicant water quality and modeling predictions if it does not have the internal expertise or wishes to provide additional basis for its decision making.

The Departments should consider appropriate degrees of conservatism in design or modeling assumptions to compensate for uncertainty in model predictions.

Finding Moran-3:

*.....the public has no information on which to evaluate the **long-term** possibility of generating acid drainage from the waste rock, tailings, or pit / mine walls*

Comment Moran-3: These data will likely not be available to the regulatory agencies or the public until a formal application is submitted. Such an application will not be developed until there is an approved regulatory framework and program under which it can be regulated.

Recommendation Moran-3: The Departments should consider requirements for mine and mill waste characterizations that address material acid generating potential and net neutralizing potential.

Finding Moran-4:

The permeability of the bedrock units is mostly via faults and fractures, but the crystalline bedrock generally yielded little water in the pump test wells. However, none of these test wells was drilled more than 200 feet deep, and the proposed mine pit was to be 850 feet deep. Thus, the available data may greatly underestimate the volumes of water produced from the deeper bedrock zones, especially after they are fractured due to blasting.

Recommendation Moran-4: The Departments should consider requirements that specify hydrogeologic characterizations adequately encompass the full hydrologic regime in which mine and/or mill activities or impacts may occur.

Finding Moran-5:

….none of the publicly available documents provide technical information (i.e. abandonment logs) substantiating that these boreholes were correctly abandoned, or that they have been correctly maintained since the early 1980s.

Comment Moran-5: It should be noted that the abandonment of exploration boreholes or wells are dependent on the geologic setting and there are not known conditions unique to uranium mines or ills form other mines or mills that would indicate that different abandonment techniques would be necessary. However, even approved State abandonment methods should be assessed on a case-by-case basis for the individual hydrogeologic context in which the penetration is abandoned.

Recommendation Moran-5: The Departments should consider assessment of existing well and borehole abandonment methods and requirements for adequacy by comparing those methods with other state, federal and international best practices.

The Departments should consider requirements for maintaining and submitting detailed well and borehole abandonment records.

Finding Moran-6:

Baseline data are only truly meaningful if the number of samples analyzed from each site is sufficient to allow a statistical analysis of the variability by sampling site, region and water-bearing unit. That is, simply having one or two samples from a site is not adequate to define baseline conditions.

Recommendation Moran-6: The Departments should consider development for minimum requirements for adequate baseline data sample populations.

Study: NAS Study

Title: "Uranium Mining in Virginia: Scientific, Technical, Environmental, Human Health and Safety, and Regulatory Aspects of Uranium Mining and Processing in Virginia"

Author: National Academy of Sciences/ The National Academies Press (2011)

NAS Study – Summary

The National Academy of Sciences Report addresses a broad range of topics and issues. Below, the individual Findings and Key Concepts from each chapter are summarized and comments and recommendations are provided that are relevant to the Commonwealths existing regulatory framework and that would apply to the full life-cycle of uranium mining and milling, including best practices.

NAS Study – Summary of Key Findings

Chapter 2 –Virginia Physical and Social Context

Finding NAS Ch 2-1:
Virginia has a diverse natural and cultural heritage. To protect Virginia's valued resources, a detailed assessment of both the site and its surrounding area (including natural, historical, and social characteristics) would be needed.

Comment NAS Ch 2-1: Should the Commonwealth seek authority for regulation or uranium milling and Byproduct Material, it would have to adopt requirements consistent with and equal to or more stringent than those identified in 10 CFR Part 51 (Environmental Protection Regulations For Domestic Licensing And Related Regulatory Functions), which set out the NRC requirements for implementing the National environmental Policy Act of 1969, as amended (NEPA). These requirements include historical and cultural surveys of lands to be affected by the licensed activities.

Recommendation NAS Ch 2-1: Should the Commonwealth lift the moratorium on uranium mining and/or seek authority for regulation or uranium milling and Byproduct Material, it should consider modification of Statutes regarding historical and cultural surveys for non-State projects on private lands.

Finding NAS Ch 2-2:
Virginia is subject to extreme natural events. From the body of the report: *The potential for adverse health effects increases if there are uncontrolled releases as a result of extreme events (e.g., floods,*

fire, earthquakes) or human error. The potential for adverse health effects related to releases of radionuclides is directly related to the population density near the mine or processing facility.

Comment NAS Ch 2-2: The potential for uncontrolled release of mine and/or mill wastes are due to either engineering failure and/or monitoring failure, regardless of the severity of the extreme event. Engineering design criteria typically reflect a balance between practicability and potential impacts of failure and likelihood of extreme event occurrence.

NRC regulations and guidance recognize the importance of designing for extreme events, including both hydrologic (storms and floods) as well as seismic (earthquakes). NRC regulations require that uranium mill tailings impoundments, which are invariably co-located with the associated processing facilities, may not be located near a capable fault that could cause a maximum credible earthquake larger than that which the impoundment could reasonably be expected to withstand. (10 CFR Part 40, Appendix A, Criterion 4; site and design criteria). The term "maximum credible earthquake" means that earthquake which would cause the maximum vibratory ground motion based upon an evaluation of earthquake potential considering the regional and sites-specific local geology and seismology and specific characteristics of local subsurface material.

Similarly, NRC Guidance recognizes that the most disruptive natural phenomena affecting tailings stabilization are likely to be wind erosion and water erosion. They also recognize that wind and water erosion can be mitigated by a cover of reasonable thickness and that the design of the protective cover will normally be controlled by the precipitation or flood events (NRC, 2002. NUREG-1623). NUREG-1623, states:

"The NRC staff has reviewed design flood computations using both statistical data and deterministic data. In general, use of statistical data to produce flood estimates has been found to be less appropriate than deterministic computations."

In addition, NRC states in NUREG-1623:

"An event that is commonly used for design purposes is the Probable Maximum Flood (PMF), which is based on the occurrence of the Probable Maximum Precipitation (PMP) over appropriate parts of a watershed. The PMF is defined (U.S. Army Corps of Engineers, 1966) as the hypothetical flood (peak discharge, volume, and hydrograph shape) that is considered to be the most severe reasonably possible, based on comprehensive hydrometeorological application of the PUP and other hydrologic factors favorable for maximum flood runoff, such as sequential storms and snowmelt. The PMP is the estimated depth of rainfall for a given duration, drainage area, and time of year for which there is virtually no risk of exceedance."

Recommendations NAS Ch 2-2: The Departments should assess design criteria to mitigate potential risks and hazards associated with extreme natural events when evaluating any particular site's suitability for uranium mining and processing operations.

The Departments should consider establishing design criteria that takes into account the magnitude and likelihood (return interval) of extreme events commensurate with the operational life span of the project facilities.

The Departments should establish a requirement for robust monitoring of all effluent and waste management systems for uranium mining, and if applicable, uranium milling projects.

NAS Ch 3 – Uranium Occurrences, Resources and Markets

Finding NAS Ch 3-1:
Because of their geological characteristics, ***none of the known uranium occurrences in Virginia would be suitable for the in situ leaching / in situ recovery (ISL/ISR) uranium mining/processing technique.***

Comment NAS Ch 3-1: Given the lack of known uranium occurrences in Virginia would be suitable for ISR uranium mining/processing technique, it is not clear if development of statutes, regulations and guidance for this particular mining and uranium recovery method at this time is practical. Not developing statutes, regulation and guidance for this particular mining and uranium recovery method would limit the scope and simplify the development of these materials and would afford the public additional opportunity to be engaged in the regulatory process in the future should such mining/milling methods be sought.

Recommendation NAS Ch 3-1: The Departments should consider if development of statutes, regulations and guidance for regulation of ISR is warranted at this time.

NAS Ch 4 – Uranium Mining, Processing and Reclamation

Finding NAS Ch 4-1:
Mine design—whether open pit or underground—requires detailed engineering planning that would include pit and rock stability considerations, as well as ventilation design to account for the presence of radon and other respiratory hazards.

Comment NAS Ch 4-1: The Department of Mines, Minerals and Energy (DMME) and MSHA already have extensive regulatory frameworks in place for conventional mining that include detailed engineering planning that include pit and rock stability considerations, as well as ventilation design to account for the presence of radon and other respiratory hazards.

Recommendation NAS Ch 4-1: The Departments should assess the engineering planning requirements for surface and subsurface mining to ensure they adequately address mine planning, including pit and rock stability considerations.

Also, see response for Finding Ch 5-1.

Finding NAS Ch 4-2:
Uranium mining and processing adds another dimension of risk because of the ***potential for exposure to elevated concentrations of radionuclides****.*

Recommendation NAS Ch 4-2: Should the Commonwealth lift the moratorium on uranium mining and/or seek authority for regulation or uranium milling and Byproduct Material, the Departments should amend their Statutes to specifically address radionuclides and associated potential hazards to public, environmental and occupational receptors.

Finding NAS Ch 4-3:
A complete life cycle analysis *is an essential component of planning for the exploitation of a uranium deposit—from exploration, through engineering and design, to start-up, operations, reclamation, and finally to decommissioning leading to final closure and post-closure monitoring. Each of these steps requires wide ranging stakeholder interaction and communications.*

Comment NAS Ch 4-3: Unless an economical ore deposit is known and exploration drilling is intended to further develop a known resource or reserve, it is difficult to incorporate exploration drilling into the life cycle design of project before the scope of the potential project is known or if it is even feasible.

The mining and mineral processing industry (base metals, precious metals, industrial minerals, coal, oil and gas, and uranium) has recently, to varying degrees throughout the U.S., applied the concept of "planning for closure" to new projects, in which the end-state land use and reclamation objectives are integrated into the planning and design of facilities up-front and not as an afterthought once operations have commenced.

Most State and Federal agencies require reclamation and closure plans for mining and milling permit/license applications. These reclamation and closure plans typically reflect consideration of life-cycle activities. Further, for Federal actions (and actions licensed by the Commonwealth should it adopt regulations governing uranium milling), the NEPA process requires assessment of reasonable alternatives to proposed actions that would mitigate potential impacts of all or parts of those actions. This process not only requires applicants to assess their projects from a life-cycle perspective but also provides opportunities for meaningful public and other agency involvement on the project life-cycle planning.

Public involvement is an integral part of all significant federal actions (i.e., uranium mill licensing). In addition, the concept of sustainability in mining and natural resource development is integrally tied to the concept of "social licensing", in which public

Recommendation NAS Ch 4-3: The Departments should consider explicit requirements for life cycle planning in permit and license applications.

NAS Ch 5 – Potential Human Health Impacts

Finding NAS Ch 5-1:
In 1987, the National Institute for Occupational Safety and Health (NIOSH) in the Centers for Disease Control and Prevention recognized that current occupational standards for radon exposure in the United States do not provide adequate protection for workers at risk of lung cancer from protracted radon decay exposure, recommending that the occupational exposure limit for radon decay products should be reduced substantially. To date, this recommendation by NIOSH has not been incorporated into an enforceable standard by the U.S. Department of Labor's Mine Safety and Health Administration or Occupational Safety and Health Administration.

Comment NAS Ch 5-1: The occupation exposure limit for Radon is set forth in 10 CFR Part 20, Appendix B, Table 1. Appendix B, Table 1 lists activities (μCi) and concentrations (μCi/ml) of radionuclides necessary to keep worker radiation doses below the occupational exposure limits of 5 rem whole body or 50 rem to an organ or tissue. Values are listed for both ingestion and inhalation. Inhalation is the dominant pathway for exposure for most occupational (but not all) settings. Column 2 lists the inhalation annual limit of intake (ALI), which is the annual intake of a given radionuclide that would result in a committed effective dose equivalent of 5 rem or a committed does equivalent of 50 rems to an organ or tissue. For Rn-222 with its daughters present the current NRC ALI is 4 working level months (WLM). A WLM is the exposure to 1 Working Level (1.3 x 105 MeV of alpha energy) for one month at a radon air activity concentration of roughly 100 pC/l. Column 3 lists the inhalation derived air concentration (DAC), which are limits intended to control chronic occupational exposures. The DAC for Rn-222 with its daughters present is 0.33 working levels (WL) or at 100% equilibrium 30 pCi/L (10 CFR 20, 2003 edition). The DAC value is based on a 2000-hour work year.

The DAC and the ALI are related. The DAC (in μCi/ml) = ALI(in μCi)/2.4E9 ml , or put another way the DAC is the concentration of radionuclide in air, which if breathed for a work-year (2000 hrs) would result in the intake of one ALI. In terms of Rn-222 this would mean that in an environment with 30 pCi/L (DAC) for 2000-hours per year, one would accumulate 4 WLM (ALI) of exposure, which would produce a 5 rem whole body or 50 rem lung dose. For comparison purposes, if exposed to the average environmental radon concentration (~0.3 pCi/L) one would accumulate 0.2 WLM of exposure per year. (*Radon in the Workplace, The OSHA Ionizing Radiation Regulations*. Robert K. Lewis PA DEP, Bureau of Radiation Protection, Radon Division. Harrisburg, PA USA).

Note that NRC occupational dose limits are 1/10th of the 10 CFR Part 20, Appendix B levels with a maximum allowable annual dose of 500 mrem (0.5 rem). It should also be noted that application of the ALARA principles in workplace exposures typically keep radon exposures significantly (one to two orders of magnitude) ***below*** the statutory does limits identified in 10 CFR Part 20 Appendix B. Modern occupational radiation protection plans for mining and milling include individual radiation exposure monitoring as well as routine work-space monitoring to ensure exposures and doses remain well below regulatory limits. Further, individual doses are carefully monitored, documented and reported to both workers and regulatory agencies.

Recommendation NAS Ch 5-1: The issue of occupational radon exposure and other inhalation hazards is also being addressed in greater detail through the Virginia Department of Health Uranium Study contract. The Department should consider the epidemiological and scientific literature on occupational radon exposure, dose and incidence of adverse health effects and determine if setting occupational radon dose limits more stringent than the Federal limits is appropriate.

Finding NAS Ch 5-2:
Workers are also at risk from exposure to other radionuclides, including uranium itself, which undergo radioactive decay by alpha, beta, or gamma emission. In particular, radium-226 and its decay products (e.g., 214Bi and 214Pb) present an alpha and gamma radiation hazard to uranium miners and processors.

Recommendation NAS Ch 5-2: The Departments should consider assessing NRC, EPA and MSHA standards for all uranium decay chain isotopes to ensure adequate standards and protection measures are required.

Finding NAS Ch 5-3:
*The potential for adverse health effects increases if there are **uncontrolled releases as a result of extreme events** (e.g., floods, fire, earthquakes) or human error. The potential for adverse health effects related to releases of radionuclides is directly related to the population density near the mine or processing facility.*

Comment NAS Ch 5-3: See Comment and Recommendation to Finding Ch 2-2

Finding NAS Ch 5-4:
Because thorium–230 and radium-226 are present in mine tailings, these radionuclides and their decay products can—if not controlled adequately—contaminate the local environment under certain conditions, in particular by seeping into water sources and thereby increasing radionuclide concentrations.

Comment NAS Ch 5-4: Isolation of mill tailings and other byproduct material from potential human and ecological exposure is the prime function of existing NRC statutes, regulations and guidance. Minimum design standards for double-lined leak detection systems are well established and have been effective when applied with proper construction, quality assurance measures, inspection and maintenance. Should the Commonwealth choose to seek regulatory authority over uranium milling and Byproduct Material, it would be required to adopt standards consistent with and equal to or more stringent than the NRC design standard s.

Recommendation NAS Ch 5-4: The Department, should it be authorized to regulate uranium milling, should assess the NRC radiation protection and waste isolation design standards for adequacy and determine if more stringent standards are warranted. Detailed designs should be signed by a Licensed Professional Engineer. Further, detailed QA/QC plans for facilities construction phase with an as-built certification by a Licensed Professional Engineer should be required. The requirements should also include a detailed maintenance plan with routine inspections and maintenance reports signed by a Licensed Professional Engineer.

Finding NAS Ch 5-5:
A large proportion of the epidemiologic studies performed in the United States, exploring adverse health effects from potential off-site radionuclide releases from uranium mining and processing facilities, have lacked the ability to evaluate causal relationships (e.g., to test study hypotheses) because of their ecologic study design.

Comment NAS Ch 5-5: This comment is being assessed within the VDH Uranium Study.

Finding NAS Ch 5-6:
The decay products of uranium (e.g., 230Th, 226Ra) provide a constant source of radiation in uranium tailings for thousands of years, substantially outlasting the current U.S. regulations for oversight of processing facility tailings.

Comment NAS Ch 5-6: This is true. The combination of conservative design standards: long-term surveillance funds provided by the licensee and long-term stewardship by the US Department of Energy for all byproduct material disposal constitutes the state-of-practice waste management for uranium recovery.

Finding NAS Ch 5-7:
Radionuclides are not the only uranium mining- and processing-associated occupational exposures with potential adverse human health effects—two other notable inhalation risks are posed by silica dust and diesel exhaust.

Comment NAS Ch 5-7: The Federal Coal Mine Health and Safety Act of 1969 and the rules and regulations under Code of Federal Regulations, Title 30 entitled Mineral Resources, provide

regulations addressing air quality and occupational exposure of miners. Title 30 Part 56 and Part 57, Subpart D provide regulatory exposure limits for airborne contaminants, monitoring requirements, related miner training, and record keeping. The regulation specifically refers to silica, volatile chemicals, radiation, radon gas, and diesel particulates.

The Virginia Administrative Code Chapter 40, entitled Safety and Health Regulation for Mineral Mining, Part V Sections 720 through 760, provides regulatory standards for air quality and physical agents for surface and underground mineral mining operations. These regulations specifically cite the silica and dust and airborne contaminants given a "C" designation. "C" threshold limit values are adopted by the American Conference of Governmental Industrial Hygienists which are provided in the publication entitled, TLV's Threshold Limit Values for Chemical Substances in Workroom Air Adopted by ACGIH for 1973. This is the same reference cited in MSHA regulations.

Recommendation NAS Ch 5-7: The Departments should consider establishing statues, regulations and guidance for underground and surface uranium mining operations and milling that are consistent with or more stringent than those currently implemented by MSHA and Virginia DMME.

Finding NAS Ch 5-8:
Because manual workers and lower socioeconomic status (SES) groups in the United States generally have higher rates of smoking, work-related lung cancer in uranium miners and processors may be related to socioeconomic status such that those with lower SES could comprise a particularly vulnerable subset of the population.

Comment NAS Ch 5-8: Smoking is a known risk factor for cancers and has been correlated with higher incidences of cancer in uranium workers.

Recommendation NAS Ch 5-8: The Commonwealth should consider assessing environmental justice issues related to socioeconomic class, smoking and their relationship to occupational hazards from the uranium mining and recovery industry.

Finding NAS Ch 5-9:
*Although uranium mining-specific **injury data** for the United States were not available for review, work-related **physical trauma** risk (including electrical injury) is particularly high in the mining sector overall and this could be anticipated to also apply to uranium mining. In addition, **hearing loss** has been a major problem in the mining sector generally.*

Comment NAS Ch 5-9: As stated, this issue is not unique to uranium mining or processing. Therefore, there are no unique recommendations for the Departments regarding the potential regulatory framework associated with regulating uranium mining or milling.

Finding NAS Ch 5-10:
A number of other exposures associated with uranium mining or processing, including waste management, also could carry the potential for adverse human health effects. Many of these exposures have not been adequately evaluated in animal or human studies.

Comment NAS Ch 5-10: This is within the scope of the Virginia Department of Health Uranium Study and will be address therein.

Finding NAS Ch 5-11:
*Assessing the **potential risks of multiple combined exposures** from uranium mining and processing activities is not possible in practical terms, even though the example of multiple potential lung carcinogen exposures in uranium mining and processing underscores that this is more than a theoretical concern.*

Comment NAS Ch 5-11: Assessment of public exposure to radionuclides from uranium mining activities is typically related solely to radon emissions from venting of underground workings (10 CFR Part 61, Subpart B). Modeling of public exposure from airborne radon emissions from underground mine vents in advance of operations (permitting) and routine monitoring of underground mine vent emissions are required. Assessment of public exposure to radionuclides from milling activities encompasses all pathways (inhalation of airborne radionuclides, ingestion of vegetables, meats and dairy products as well as local groundwater in assessing public dose.

Recommendation NAS Ch 5-11: Where uranium mining and milling operations are co-located (i.e., mines and mill are adjacent or have potential to affect same population), the Department should consider assessing public exposures from all activities including mining that could result in radiological dose.

The Departments should consider assessing the dose limits identified in 40 CFR Part 61 for adequacy related to public exposure and protection from radon**.**

NAS Ch 6 – Long-Term Impacts
The committee recognizes that mining, processing, and reclamation, by nature, can cause long-term impacts to habitats (in the order of decades to centuries), hydrologic alterations, and adverse changes to water quality. Virginia has extensive experience with mining and its impacts, and thus, the primary focus of this chapter is on the specific environment impacts of uranium mining.

Finding NAS Ch 6-1:
Uranium mining, processing, and reclamation in Virginia have the potential to impact surface water quality and quantity, groundwater quality and quantity, soils, air quality, and biota. The impact of these activities in Virginia will depend on site-specific conditions, the rigor of the monitoring program established to provide early warning of contaminant migration, and the efforts to mitigate and control potential impacts. If uranium mining, processing, and reclamation are designed, constructed, operated, and monitored according to modern international best practices (see Chapter 8), the committee anticipates that the near- to moderate term environmental effects specific to uranium mining and processing should be substantially reduced.

Recommendation NAS Ch 6-1: Should the Commonwealth lift the moratorium on uranium mining and/or undertake regulation of uranium milling and Byproduct Material, the Departments should consider promulgating requirements for implementing best practices in all aspects of uranium mining and milling.

Finding NAS Ch 6-2:
Significant potential environmental risks are associated with extreme natural events and failures in management practices. The empowerment of all regulatory and mine- and processing-site staff to report and address deficiencies can potentially reduce such occurrences or minimize their impacts.

Comment NAS Ch 6-2: (See comment Ch 2-2.)

Waste and effluent management system failures that met the current permitting requirements are failures of both engineering and regulatory processes. Potential deficiencies or lapses in management practices, can be mitigated by internal, 3rd party and regulatory reviews and audits as well as rigorous and routine staff training. Annual ALARA audits are required by most radioactive materials licenses. These audits are reviews of compliance with existing license and permit conditions related to public, occupational and environmental protection from exposure to radionuclides. In addition, annual reviews of Standard Operation Procedures (SOPs) by the Radiation Safety Officer (RSO) and other senior operations managers are typically required. These audits and reviews afford opportunities for regular improvements on management practices. Though not always required, many companies retain third parties to develop ALARA audits.

Recommendation NAS Ch 6-2: (See Recommendation Ch 2-2.)

Should the Commonwealth lift the moratorium on uranium mining and/or undertake regulation of uranium milling and Byproduct Material, the Departments should consider promulgating requirements that address mechanisms for mitigating lapses in uranium mining and/or milling management practices for control of potential hazards.

Finding NAS Ch 6-3:
Thoughtful environmental monitoring design *can also lead to early detection of contamination caused by management failures, thereby lessening the extent of any offsite remediation that might be required.*

Comment NAS Ch 6-3: Environmental compliance monitoring should always be designed to provide prompt detection of effluents in excess of regulatory standards.

Finding NAS Ch 6-4:
Models and comprehensive site characterization are important for estimating the environmental effects of a specific uranium mine and processing facility. A thorough site characterization, supplemented by air quality and hydrological modeling, is essential for estimating the potential environmental impacts of uranium mining and processing under site-specific conditions and mitigation practices.

Comment NAS Ch 6-4: Requiring site models and site characterization is a common element of all uranium mining and milling regulatory frameworks. However, no one characterization methodology and/or model is necessarily appropriate for all sites as every site is different and usually has site-specific characteristics that warrant greater or lesser focus on specific areas. In some cases, site-specific characteristics only become evident as a result of initial characterization efforts, resulting in a multi-phased investigation. Appropriate models are then selected based on the site-specific conditions.

Recommendation NAS Ch 6-4: The Department should ensure that statutes, regulation and guidance require comprehensive site characterization and appropriate site modeling to support demonstration that proposed operations, waste management and reclamation activities can be protective of public health, safety and the environment.

The Department should ensure that regulation and guidance require appropriate site-specific hydrologic and air quality modeling of permitted and licensed activities for potential environmental and public exposure effects from routine operations and reasonable non-routine events.

Finding NAS Ch 6-5:
Ongoing water and air quality monitoring are necessary to confirm model predictions and provide the basis for updating and revising these models as additional site-specific data become available.

Comment NAS Ch 6-5: Water and air quality monitoring are typically required for demonstration of continued compliance with regulatory requirements for protection of public

health, safety and the environment. Periodically reassessing site models using site operational data is an appropriate practice for model validation.

Recommendation NAS Ch 6-5: Should the Commonwealth lift the moratorium on uranium mining and/or undertake regulation of uranium milling and Byproduct Material, the Departments should consider developing regulations and/or guidance for periodically applying site compliance monitoring data to models used in permitting.

NAS Ch 7 – Federal and State Regulation and Oversight

Finding NAS Ch 7-1:
At present, there are gaps in legal and regulatory coverage for activities involved in uranium mining, processing, reclamation, and long-term stewardship. While there are several options for addressing these gaps, the committee notes that Canada and the state of Colorado have enacted laws and promulgated regulations based on best practices that require modern mining and processing methods, and empower regulatory agencies with strong information-gathering, enforcement, and inspection authorities.

Comment NAS Ch 7-1: Canada has different laws and legal definitions for the types of materials involved in uranium mining and milling than the U.S., allowing a different regulatory framework for management of the related hazards. The U.S. regulatory framework has developed with its own waste and material definitions, which in some cases dictates which agencies have primacy over regulation of their associated hazards.

Adoption of effective best practices, regardless of their origins, is beneficial to industry and the public welfare. Understanding what is involved in developing a strong state regulatory is the primary objective of this study. Strong regulatory oversight and enforcement is typically not a statutory or regulation issue, as most regulatory frameworks provide for broad regulatory authority and enforcement powers, but rather it is often a function of agency practices, funding and resources.

Recommendation NAS Ch 7-1: Should the Commonwealth lift the moratorium on uranium mining and/or undertake regulation of uranium milling and Byproduct Material, the Departments should identify best practices for uranium mining, processing, reclamation and long-term stewardship.

In addition, the Departments should develop regulations and guidance that ensure detailed design, monitoring, inspection, audit, and reporting requirements.

The Commonwealth should consider cost recovery funding by permittees, licensees and taxes that remain dedicated to the agencies responsible for regulation and oversight of those activities and not solely funded by legislative budgets and funds from the general treasury.

Finding NAS Ch 7-5:
Because almost all uranium mining and processing to date has taken place in parts of the United States that have a negative water balance (dry climates with low rainfall), federal agencies have limited experience applying laws and regulations in positive water balance (wet climates with medium to high rainfall) situations.

Comment NAS Ch 7-5: Federal agencies do have experience with positive water balance environments, not only through management and reclamation of uranium mill sites reclaimed under the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA), Title I (i.e., Canonsburg, Pennsylvania) but also through past federal regulation of the LLRW facility in Barnwell South Carolina as well as numerous RCRA facilities regulated by EPA.

The meteorological differences between the arid west and the more humid east with higher occurrences of hurricanes and high intensity storm events are well understood and can be appropriately modeled. Engineering design requirements to accommodate extreme events (i.e., probable maximum precipitation event and maximum probable flood event) are also well established and are based on site specific data conditions and equations that accommodate the large amounts of rain and associated high surface flows. The issue for the regulatory framework is the selection of appropriate storm events as design criteria for operations versus reclamation and how much conservatism to include in the design. However, the issue is quite detailed and is more suited to specific regulation and guidance than Statutory or regulatory framework.

Recommendation NAS Ch 7-5: (See Recommendation Ch 2-2)

The regulatory framework should provide clear direction for the Departments to establish specific design requirements for operations, reclamation and post closure periods that are based on the meteorological conditions of the proposed action.

Finding NAS Ch 7-6:
Under the current regulatory structure, opportunities for meaningful public involvement are fragmented and limited.

Comment NAS Ch 7-6: Fragmentation of public comment process is a direct function of the different agencies engaged in regulation of different aspects of uranium mining and milling projects. Each agency has their own respective mandate and obligation to engage the public on the matters and materials before them. In is not always possible to integrate and coordinate public comment processes as proponent materials and decision events between agencies.

However, the fact the more than one agency is engaged means there can frequently be more than one public process, which affords the public multiple opportunities to comment on focused aspects of projects rather than limited opportunities on the whole of what is usually a large and complex project.

Similarly, the time to gain permit approval, the certainty of gaining approval, and the costs of assembling and processing an application may all vary between agencies. For example, a mining permit may take two years to complete the approval process where an air quality permit may only take a year. These factors make it impracticable or undesirable for an applicant to submit an application for all required permits at the same time.

Meaningful public involvement is interpreted to mean that the public has reasonable access to the same materials as the regulatory agencies (except proprietary information), has the opportunity to review them and has opportunity to engage the agencies and the proponent in discussion regarding the scope and approach of the proposed action.

Recommendation NAS Ch 7-6: To address the issue of fragmented public comment opportunities, the Departments should consider coordinating public comment opportunities between agencies when possible. See also Recommendation NAS Ch 7-7.

To address the issue of limited meaningful public involvement, the Departments should consider holding additional informational public meetings to more fully describe projects, the decision making process and increase opportunities to take comments. Similarly, the Departments should assess other mechanisms for ongoing public comment opportunities (i.e., assessing their web sites for automated public comment opportunities for specific projects).

Finding NAS Ch 7-7:
The current regulatory structure requires that members of the public who are interested in prospective uranium mining and processing in Virginia be aware of and respond to rule-making by several different state and federal agencies. The "Virginia Regulatory Town Hall" could provide an on-line means of coordinating information and opinion exchanges about upcoming state-level regulatory changes pertinent to mining, but at present the Regulatory Town Hall does not offer transparent cross-agency coordination by topic.

Recommendation NAS Ch 7-7: The Departments should consider enhancing the "Virginia Regulatory Town Hall" as an integrated tool for public information and comment.

Finding NAS Ch 7-8:
The Division of Mineral Mining's explicit opportunities for public participation in licensing mining facilities currently are limited to adjacent landowners. The U.S. NRC has a more robust approach to public participation in licensing a uranium processing facility, but there are no guarantees that pre-

licensing public meetings or hearings will be held in the vicinity of the proposed facility, except in the event that an EIS (rather than simply an environmental assessment) is undertaken.

Comment NAS Ch 7-8: The ability of an agency to hold pre-licensing public meetings is problematic and dependent on the level of information available to the agency upon which to base the description of an action not yet proposed for which no application has yet been received.

Recommendation NAS Ch 7-8: The Departments should consider enhancing public participation opportunities to a broader group of individuals with standing related to permitting mining projects.

The Departments should consider establishing a basis for when pre-licensing/pre-permitting public input should be sought.

Finding NAS Ch 7-9:
There is no evidence at present that members of the public would be included in deliberations about post-closure plans.

Comment NAS Ch 7-9: Post-closure or end-state land use is typically described in the reclamation plans of mine and mill applications. The public would be afforded the opportunity to comment on this aspect of the reclamation plan during and EIA/EIS.

Recommendation NAS Ch 7-9: The Departments should consider specifically requiring mine and mill reclamation plans discuss end-state land use.

The Departments should consider expanding the scope of EIA to more closely resemble NEPA EA and EIS.

The Departments should consider establishing a public comment process on EIA the includes full public scoping public comment on draft EIA as well as comment response processes demonstrating how public comment was addressed in the final EIA.

NAS Ch 8 – Best Practices

Finding NAS Ch 8-1:
Uranium mining and processing has planning, construction, production, closure, and long-term stewardship phases, and best practice requires a complete life cycle approach during the project planning phase. Planning should take into account all aspects of the process—including the eventual closure, site remediation, and return of the impacted area to as close to natural condition as possible—prior to initiation of a project.

Comment NAS Ch 8-1: The mining and mineral processing industry (base metals, precious metals, industrial minerals, coal, oil and gas, and uranium) has recently, to varying degrees throughout the U.S., applied the concept of "planning for closure" to new projects, in which the end-state land use and reclamation objectives are integrated into the planning and design of facilities up-front and not as an afterthought once operations have commenced. Most State and Federal agencies require reclamation and closure plans for mining and milling permit/license applications. These reclamation and closure plans typically reflect consideration of life-cycle activities. Further, for Federal actions (and actions licensed by the Commonwealth should it adopt regulations governing uranium milling), the NEPA process requires assessment of reasonable alternatives to proposed actions that would mitigate potential impacts of all or parts of those actions. This process not only requires applicants to assess their projects from a life-cycle perspective but also provides opportunities for meaningful public and other agency involvement on the project life-cycle planning.

Recommendation NAS Ch 8-1: The Departments should consider explicit requirements for life cycle planning in permit and license applications.

Finding NAS Ch 8-2:

Good operating practice is for site and waste remediation to be carried out on a continual basis during ore recovery, thereby reducing the time and costs for final decommissioning, remediation, and reclamation.

Comment NAS Ch 8-2: Concurrent reclamation during operations is becoming standard practice in the mining and mineral recovery industries as this is cost effective means of reducing short-term, intermediate and long-term environmental impacts and liabilities. Remediation of site impacts to water is required promptly by most state and Federal Regulations. Remediation of soils during operations (e.g., clean up of surface soils during active mining to reclamation standards) is frequently impractical and or little value as the areas are likely to continue to receive material during operations.

Recommendation NAS Ch 8-2: The Departments should consider developing requirements for reasonable concurrent reclamation during operations for the purposes of minimizing potential public and environmental exposures and adverse health impacts.

The Departments should ensure that requirements for prompt remediation of environmental impacts to any and all media that could lead to off-site exposures of adverse impacts are included in regulations and guidance.

Finding NAS Ch 8-3:

Regular and structured risk analyses, hazard analyses, and operation analyses should take place within a structured change management system, and the results of all such assessments should be openly available and communicated to the public.

Comment NAS Ch 8-3: Regulatory frameworks, associated regulations and guidance are typically performance based, requiring the operators to meet specific performance standards but infrequently dictate how operators achieve those standards. Prescriptive regulation can have the benefit of ensuring specific processes are in-place but can have the disadvantage of limiting alternative methods of achieving compliance.

Recommendation NAS Ch 8-3: The Departments should consider prescriptive requirements for regular risk analyses, hazard analyses and operations analyses and for structured change management systems by mining and/or milling applicants.

Finding NAS Ch 8-4:
Development of a mining and/or processing project should use the expertise and experience of professionals familiar with internationally accepted best practices, to form an integrated and cross-disciplinary collaboration that encompasses all components of the project, including legal, environmental, health, monitoring, safety, and engineering elements.

Recommendation NAS Ch 8-4:
The Departments should consider development of requirements that proposed uranium mining and/or processing facilities address best practices.

Finding NAS Ch 8-5:
Meaningful and timely public participation should occur throughout the life cycle of a project, so that the public is both informed about—and can comment upon—any decisions made that could impact their community. All stages of permitting should be transparent, with independent advisory reviews.

Comment NAS Ch 8-5: Most agencies publically notice significant permit and/or license changes for mining and/or milling projects for public comment. NRC meetings with Licensees are publically noticed and the public may attend in person or via phone.

Recommendation NAS Ch 8-5: The Departments should consider enhancing the public notice and public open meeting requirements in their statutes for permitting and ongoing administration of permits mining and milling permits and licenses.

Finding NAS Ch 8-6:

Development of a comprehensive Environmental Impact Statement for any proposed uranium mining and processing facility would be an essential element for public participation and the transparent sharing of information.

Recommendation NAS Ch 8-6: The Departments should consider enhancing the requirement for EIA to more closely resemble the NEPA process and EA/EIS to improve completeness of assessments and public participation in the assessment process.

Finding NAS Ch 8-7:
A number of detailed specific best practice documents (e.g., guidelines produced by the World Nuclear Association, International Atomic Energy Agency, and International Radiation Protection Association) exist that describe accepted international best practices for uranium mining and processing projects. Although these documents are by their nature generic, they provide a basis from which specific requirements for any uranium mining and processing projects in Virginia could be developed.

Recommendation NAS Ch 8-7: The Departments should consider requirements for project applicants to demonstrate application of best practices for mining and milling projects.

Finding NAS Ch 8-8:
Some of the worker and public health risks could be mitigated or better controlled if uranium mining, processing and reclamation are all conducted according to best practices, which at a minimum for workers would include the use of personal dosimetry—including for radon decay products—and a national radiation dose registry for radiation- and radon-related hazards; and exposure limits lowered to at least NIOSH-recommended levels for radon, diesel gas and particulates, occupational noise, and silica hazards.

Comment NAS Ch 8-8: (see recommendation NAS Ch 8-7, above)

Finding NAS Ch 8-9:
A well-designed and executed monitoring plan, available to the public, is essential for gauging performance, determining and demonstrating compliance, triggering corrective actions, fostering transparency and enhancing site-specific understanding. The monitoring strategy, encompassing baseline monitoring, operational monitoring, and decommissioning and post-closure monitoring, should be subject to annual updates and independent reviews to incorporate new knowledge or enhanced understanding gained from analysis of the monitoring data.

Comment NAS Ch 8-9: The NRC requires licensees document annual review of all standard operating procedures, including personnel, public and environmental monitoring procedures. In addition, NRC requires annual ALARA (as low as reasonably achievable) audits, which address

monitoring programs as well as monitoring data to verify potential exposures and releases are being kept ALARA.

Recommendation NAS Ch 8-9: The Departments should consider making monitoring plans for baseline, operations, reclamation and post closure portions of the project life cycle available to the public, possibly through their web sites.

The Departments should consider establishing independent advisory review panels of qualified individuals. These panels could be empowered to periodically review mine and mill monitoring plans.
The Departments should assess their existing environmental, occupational health and public health monitoring requirements and ensure specific requirements for monitoring during all appropriate phases of project life cycles are required.

Recommendation NAS Ch 8-10: Because the impacts of uranium mining and processing projects are localized, modern best practice is for project implementation and operations to provide benefits and opportunities to the local region and local communities.

Comment NAS Ch 8-10: It seems beyond the scope of the Departments to detail specific requirements that projects ensure benefits and opportunities to the local region and local communities. The degree to which a given project affords such benefits and opportunities would be revealed in a cost-benefit analysis as part of a robust EIA. (see Recommendation NAS CH 7-9)

Finding NAS Ch 8-11:
Regulatory programs are inherently reactive, and as a result the standards contained in regulatory programs represent only a starting point for establishing a protective and proactive program for protecting worker and public health, environmental resources, and ecosystems. The concept of ALARA (as low as reasonably achievable) is one way of enhancing regulatory standards.

Comment NAS Ch 8-11: We disagree with the premise of this statement. Regulatory programs are inherently proactive efforts of government to preclude adverse impacts and to promote responsible project design, construction, operation and closure. Simply because they must sometimes react to project failures does not mean they are inherently reactive.

Finding NAS Ch 8-12:
*Ensure that life cycle costs as well as long-term stewardship needs are reflected in the type of, and amount of, the **financial surety**.*

Recommendation NAS Ch 8-12: The Departments should consider development of requirements that ensure adequate life-cycle surety amounts and instruments.

Finding NAS Ch 8-13:
Ensure that inspection and enforcement tools are, transparent, practical, sufficient, available, independent, and sustainable.

- *"**Transparency**" requires that the enforcement tools are clear and comprehensible to the regulated community, the public, and the regulator;*
- *"**Practical**" requires that the enforcement tools are easily implemented;*
- *"**Sufficient**" means that the enforcement tools are effective in producing deterrence;*
- *"**Available**" means that regulatory agencies should have available adequate funding and other resources to function in an environment of continuous improvement to enable them to take full advantage of international uranium mining and processing innovations;*
- *"**Independent**" means that the regulatory agency would provide independent verification of compliance and not be overly influenced by the industry that they are regulating, even if the funding for the regulatory agency is derived from a fee placed on the industry; and*
- *"**Sustainable**" requires that enforcement actions be supported by strong scientific and other evidence that will meet legal standards.*

Recommendation NAS NAS Ch 8-13: The Departments should ensure robust inspection and enforcement requirements are integral components of any future statutory changes addressing uranium mining and milling.

Finding NAS Ch 8-14:
At present, the laws applicable in Virginia do not require that an environmental impact assessment is undertaken before hard rock mining operations commence. Modern best international practice requires an environmental impact assessment prior to the commencement of any mining activities.

Comment NAS Ch 8-14: See recommendation NAS Ch 7-9.

Study: Baker Study
Title: **"**A preliminary Assessment of Potential Impacts of Uranium Mining in Virginia on Drinking Water Sources"
Authors: City of Virginia Beach/Baker (2011)

Baker Study – Summary

The Michael Baker group was commissioned by the City of Virginia Beach, Virginia, to perform a preliminary assessment to determine whether a catastrophic failure of a tailings containment cell at the potential Coles Hill Uranium Project could cause contamination of downstream drinking water sources located within the Bannister and Roanoke rivers.

Phase I of the assessment utilized published data related to uranium mining across the United States as site-specific information for the Coles Hill Project was not available to the investigators. The assessment used one-dimensional numerical modeling, but did not extend to areas beyond the Kerr Reservoir.

Phase II of the assessment used two-dimensional modeling to estimate possible concentrations and residence times of radium, uranium and thorium in Kerr Reservoir and Lake Gaston should a catastrophic failure of the Coles Hill tailings facility occur. This assessment utilized available site-specific information and actual hydrologic conditions during periods of both wet and dry weather.

Comment Baker Study Summary: The models used in the study are generally acceptable. However, the one-dimensional model used in Phase I does not accurately predict the total flow of sediments and contaminants that would impacting the river/reservoir system in the event of a catastrophic release. It should be noted that the Baker study did not address the likelihood of such a failure for a modern tailings disposal.

Baker Study – Summary of Key Findings

Assumptions of the study:

1. The tailings impoundment will be completely above grade due to the presence of shallow ground water in the area;
2. Although the plan is to dispose of a portion of the tailings into the mine, the assumption was made that the tailings impoundment would be filled to capacity; and
3. The tailings impoundment will be located near the Bannister River such that a catastrophic failure would cause the contents of the tailings impoundment to flow into the river.

Klienfelder Comments on Baker Study

Klienfelder, a contractor for Virginia Uranium, provided comments on the Baker Study, as follows:

Many of the assumptions used in the Baker study are not reasonable given the actual conditions:

- *The assumption that the impoundment will be located adjacent to rivers is in violation of NRC regulations, which require tailings impoundments to be located away from rivers and as far upstream as possible.*
- *The assumption that the design of the impoundment would be similar to historical sites that failed is faulty since impoundments designed and constructed under current NRC regulations and current engineering design and construction practices are less likely to fail.*
- *The assumption that all tailings will be stored above grade is faulty since if an operator offers an alternative to the "prime option" of below grade storage, the alternative option must provide an equivalent isolation of tailings.*
- *The failure mode was not identified, which can be important for both the timing of a release and the total quantity of tailings released.*
- *The two most likely failure modes (structural failure and erosion due to overtopping) are addressed in current NRC design requirements.*
- *The Baker assumption that NRC and EPA standards are "suggestions" is faulty as these standards have the force of law.*

Limitations

The Baker Report is extremely limited as it does not address all potential circumstances nor use data representative of the ore deposit being considered.

- *The Baker Study did not examine the entire pathway of potential contamination from the tailings impoundment to the consumer's water tap.*
- *Additional flow components that were not considered in the model include segments of flow between Kerr Reservoir, the water treatment plants of Virginia Beach, and the consumers of the water in Virginia Beach.*
- *The Wyoming sandstone roll front data used in the model does not accurately reflect the material that will be generated at Coles Hill.*
- *Other potential contaminants should have been considered in the study such as sewage, petroleum products, animal waste and industrial materials which all could be increased by an extremely rare storm event.*
- *The Baker Study did not take into consideration other options that Virginia Beach has in the event of a release, such as*
  - *Multiple sources of other water are available;*
  - *Treatment plants have the ability to remove radioactive contaminants;*
  - *Continuous monitoring of their water quality.*
- *NRC regulations require the use of a 1000-year PMF for design, which is more conservative than the Baker Study assumption of a 200-year PMF.*
- *The Baker study does not address the probability of a tailings release, and assumes the certainty that a release will happen, regardless of its statistical plausibility,*

Comment: NRC requires slope stability analyses for tailings facility designs that includes resistance to failure under storm conditions and earthquake loading conditions for both operational and long-term conditions. The magnitudes of these earthquake loads are based on the probability of an earthquake occurring over a given period. Different levels of conservatism (different earth quake loads) can be determined by changing the desired return interval (longer return interval equates to a larger earthquake load). However, the return interval for these events should reasonably relate to the period of concern (i.e., period of operations vs. long-term reclamation).

Recommendation Baker Study w/ Klienfelder Comments: The Departments should consider requirements for uranium milling applicants to assess the probability of a tailings release site considering the following factors, which are all weighed equally:

- An extreme storm and/or earthquake event occurs;
- Tailings are placed in an above ground impoundment;
- Tailings are not protected from erosion; and
- The impoundment is located next to a stream channel.

Study: SENES Study
Title: Assessment Of Risk From Uranium Mining In Virginia.
Authors: The Coal and Energy Commission Commonwealth of Virginia/SENES Consultants Limited (1984)

SENES Study – Summary

SENES prepared a 1984 assessment for the Coal and Energy Commission, Commonwealth of Virginia. The report discusses potential radiological risks linked to the mining of uranium in Virginia. The SENES report's principal focus is radiological environmental transport and human health risk modeling work that was performed by proponents of the development of what is now identified as the Coles Hill uranium deposit. Marline and Union Carbide ("Marline") published the results of that work in 1983, as a 9-volume set. SENES was requested to evaluate and summarize the radiological risk analysis contained in that report.

SENES also provided discussions of the process of radioactive materials risk assessment, including comparisons to other commonly encountered human health and accident risks, and developed some considerations relevant to development of uranium radiation protection standards.

Because the SENES report does not provide certain details concerning the Marline study, a more detailed summary of that study, prepared by Dravo Engineers (Dravo, 1984) for Marline/UMETCO in 1984, was also reviewed while preparing this current discussion. This process of risk assessment modeling, combining available data with accepted environmental transport models, is commonly used to develop estimates of the potential impacts of a proposed operation, in this case hard-rock mining and milling of the Coles Hill uranium deposit. The Marline study, as reported by both SENES and Dravo, utilized a reasonably well-developed pre-licensing set of data and estimates. The authors did not have access to complete sets of information concerning potential releases to air, water and subsurface, or the extended meteorological data and other information required to perform a more thorough evaluation of risks. Marline did, however, have limited sets of much of the required information, and used acceptable methods to estimate other required data. SENES did not perform its own risk assessment modeling, relying instead on the Marline work to develop its own conclusions.

SENES Study – Summary of Key Findings

Environmental transport and risk assessment modeling

1. *SENES, after presenting material on uranium mining, milling and tailings management, discusses the radioactive materials pathway analysis process. This process, applied to a potential facility, typically uses:*
   a) *Available meteorological data from a nearby first order weather station (in this case from Danville, Virginia),*

b) Estimates of the quantities of radioactive isotopes likely to be released during eventual facility operations (in this case based on Coles Hill deposit ore samples and limited water leaching studies),

c) Accepted models to estimate dispersion of the released materials via air, water and associated environmental pathways to humans, and,

d) Currently accepted dose conversion factors to estimate human health risk based on radionuclide intake, principally via ingestion and inhalation.

Comment SENES Study Summary of Key Findings: Marline used two computer codes, both appropriate for the time and topic, to simulate transport and dose/risk to humans from the facility via air (MILDOS), and surface water (PABLM). Modeling the transport via groundwater is generally too complex to be attempted for a hypothetical facility, where insufficient detailed information exists concerning complex subsurface water pathways to humans. Marline did, however, have information from 60-110 wells of various types in the area, plus an understanding of the subsurface environment, based on boreholes previously emplaced to define the uranium deposit. Marline utilized data available from the uranium resource studies, and engineering pre-design work, to develop estimates of drinking water radionuclide concentrations and risks to nearby residents.

Finding SENSE-1:

2. *To simplify the estimates of risk associated with releases to groundwater (primarily from the planned open pit mine and the mill's tailings repository), Marline assumed direct transfer of seepage water to nearby streams, then to the Banister River.*

Comment SENES-1: This is a conservative approach, resulting in dose estimates higher than would be the case for releases attenuated during transfer through the groundwater environment. This set of information and assumptions resulted in the conclusion that potential groundwater pathways to humans from mine/mill/tailings facilities would not be significant, in terms of risk from released radioactive materials, compared to risks associated with releases to air and surface water.

As presented in more detail in the Dravo report, much of the Marline work was essentially a first-cut analysis leading to what might be identified as pre-licensing technical and environmental reports. The data collection and analysis requirements are outlined in USNRC regulations and guidance, USEPA regulations and policy, and State government mine-permitting requirements (where State regulations exist). However, the time frames associated with Marline's data collection for some of the environmental parameters (meteorological data, integrated radon and gamma monitoring and radon flux measurements, as examples) were shorter than the 12-month collection periods recommended in USNRC guidance (USNRC Regulatory Guide 4.14). This resulted in a "hybrid" set of reports from Marline, more detailed in some areas (plant pre-design

discussions, for example) and less so in others (site-specific meteorological data, e.g.), still suitable for the intended purpose of preliminary risk assessment.

Dose Risk

Finding SENSE-2:

1. *The dominant route of human exposure from Coles Hill mining operations would be associated with particulate and radon radionuclide releases to the atmosphere, primarily from the large open pit mine, including particulates from ore crushing operations at the mill. The report concluded that releases from the mine would contribute the largest portion of the dose and risk to nearby humans. Exposures were estimated to decrease rapidly with distance from the facility, and would drop "markedly" upon project closeout.*

   Dose and risk were calculated for radionuclides released to water, and as particulates and radon gas released to air. Direct radiation doses to nearby residents were also estimated, using MILDOS estimates of radionuclide deposition and build-up over time, on ground surfaces. Radioactive material doses and risks were estimated to the following:

   - *The nearest resident*
   - *The most highly exposed resident*
   - *An individual with the highest potential for exposure via drinking water*
   - *Other potentially exposed individuals*
   - *The regional population, were all found to be very low when compared to USNRC and USEPA regulatory standards and guidance. Use of modern vacuum dryer technology would reduce this dose to some extent, if the same assessment were to be performed today*

Comment SENSE-2: At the time that the Marline report was prepared, final drying of the concentrated yellowcake uranium product was typically performed using systems that exhausted air to the external environment through filters. These systems allowed some particulate radioactive material to enter the outdoor environment, with the potential for human exposure. Modern vacuum dryers instead recirculate air internally, such that particulate releases of yellowcake dust are essentially zero. Other sources of radioactive particulates are still present in a modern facility, primarily releases from the mining operation itself, the mill's crusher systems, and to a lesser extent from the developing tailings impoundment area.

Recommendation SENSE-2: The Departments should consider requirements for permit/license applicants to perform site/project specific risk assessments for public and occupational exposures considering project-specific facility configurations and technology.

Comment SENNSE-3: Some short-term data on existing radon concentrations in air and gamma exposure rates were collected to support the Marline report. The results show low to moderate radon concentrations, with some higher values near the ore deposit. Gamma exposure rates, however, increase very significantly near the uranium deposit, with values reported by Marline ranging up to 150 uR/hour, 10-15 times the levels for Virginia in general. Regulatory policy on allowable exposures associated with operation of a uranium production facility anticipates such situations: allowable radiation dose, per such policy, is calculated as the dose in excess of background levels.

Recommendation SENSE-3: Should the Commonwealth elect to assume regulatory authority over uranium milling and Byproduct Material, it should assess the NRC requirements for detailed radiological characterization of pre-existing/baseline conditions for adequacy.

Considerations relevant to development of uranium mining radiation protection standards

SENES concluded its report on the Marline study with some general observations that may be useful in the context of the possible development of uranium mining regulations by the Commonwealth of Virginia, *"Based on this risk assessment, the following suggestions should be considered in the establishment of radiation protections standards for uranium mining in Virginia:*

- *All sources and pathways should be considered in assessing potential exposures.*
- *The prime standard should be a maximum annual whole body dose consistent with a level of risk considered to be acceptable in Virginia.*
- *Secondary criteria (such as concentrations in air and water) and procedures for determining compliance need to be developed by State authorities.*
- *Efforts should be made to ensure that all doses are kept as far below the maximum dose limit as reasonable achievable, social and economic factors taken into account (ALARA)."*

Recommendation SENSE-4: The Departments should consider establishing requirements for uranium mine permit applicants to perform public and occupational dose modeling (i.e., like MILDOS) for uranium mine applications and include proposed monitoring plans for air, water and other media, similar to those required by NRC.

Other observations

Comment SENES Study – Other Observations -1: We note that uranium mining and milling on a scale as large as the potential Coles Hill operation have never been undertaken in the wet climate of the eastern U.S. Smaller examples, including the reclaimed tailings site in Canonsburg, Pennsylvania (remediated under the Uranium Mill Tailings Remedial Action Project beginning in

1983), may provide some useful observations concerning the unique aspects of mining, milling and tailings management in a wet environment.

Comment SENES Study – Other Observations-2: A few general observations concerning uranium mining operations in a wet environment, taken from the Marline report, the associated Dravo and SENES reviews, and from our own experience are as follows:

- Dust releases from the mine and mill, found in the Marline study to dominate the relatively small calculated doses associated with operations, are anticipated to be lower than for the western, dry climate operations that provide most of the historical information on uranium mine/mill impacts. Dust releases from the dry surfaces of tailings impoundments, the largest component of human health risk associated with western operations, should be smaller for wet climate facilities such as the Coles Hill operation. This is especially likely given our past experience with old facilities, pointing toward a great deal of emphasis on dust control in new designs. More specifically, the Dravo summary of the Marline report notes that planned Coles Hill deposit tailings management would involve partial dewatering of the tailings, which would then be placed, using dust control methods, in a gradually expanding impoundment with each increment covered by waste rock. This process is quite different from methods used in the past in western operations, where large surface area tailings piles were exposed to high winds, often causing very significant dust releases. It is not clear that the Marline tailings management system would result in large reductions in radon gas releases, however, and exposure to radon would be a significant component of mine/mill/tailings radionuclide exposures at Coles Hill.
- Control of rainfall in a wet environment will be critical to potential impacts associated with leachate and storm runoff. For example, very large quantities of water will accumulate in the mine pit during storm events. Careful planning to handle such water, plus the routine infiltration of rainfall on the growing tailings impoundment, will be important to the success of an eastern uranium mining operations.
- Finally, the fact of higher population density near an eastern site such as Coles Hill significantly changes all aspects of environmental monitoring and protection. As the Federal regulatory system adapts in the near future to the renewed interest in uranium mining, with increasing emphasis on protection of the public from exposure to radon and its progeny, for example, the need for a very detailed understanding of background radon, gamma and air particulate exposures has become clear. USNRC guidance on background radiation studies, for example, is changing rapidly even as this review is being written, and development of a Virginia regulatory system should incorporate recognition of the increased level of detail likely to be required as a result.

Study: NRDC Study
Title: Nuclear Fuels Dirty Beginnings, Environmental Damage and Public Health Risks From Uranium Mining in the American West
Authors: National Resources Defense Council (2012)

NRDC Study – Summary of Key Findings

The National Resources Defense Council (NRDC) as stated on Page 2 of the report, examines "*whether conventional controls on both conventional hard-rock mining and milling, and alternative solution-mining techniques for uranium recovery, are sufficient to prevent a new round of harms to the natural resources and communities of this region*." Below, the individual Findings and Key Concepts from each chapter are summarized and comments and recommendations are provided that are relevant to the Commonwealth's existing regulatory framework and that would apply to the full life-cycle of uranium mining and milling, including best practices.

NRDC Chapter 2 –Conventional Uranium Recovery: Environmental and Health Impacts

Finding NRDC Ch 2-2:
C*onventional mining and milling practices for military and civilian purposes left an extensive environmental legacy of radioactive and heavy metals pollution in the western United State and Canada.*

Comment NRDC Ch 2-2: Conventional uranium mining and milling began in response to demand for military weapons. Much of this activity occurred in the 1940s and 1950s. The facilities were not regulated under the current regulatory environment and some of the facilities created long-term environmental problems.

Recommendations NRDC Ch 2-2: The Departments should consider establishing appropriate best management practice requirements for uranium mining and if applicable, milling projects. The Commonwealth should consider promulgating uranium mining, and if applicable, uranium milling rules and regulations.

The Departments should establish a requirement for robust monitoring of all effluent and waste management systems for uranium mining, and if applicable, uranium milling projects.

NRDC Ch 3 – In-Situ Leach Mining: The Environmental Impacts and the Failure of the NRC Environmental Review Process

Finding NRDC Ch 3:
As yet, there has been no comprehensive review of ISL industry practices or assessment of potential options for lessening or remediating its environmental harm. The long-overdue interagency

assessment is necessary to ensure that the uranium mining industry does not repeat the mistakes of the past. Furthermore, NRDC believes that the NRC should provide:
(1) A complete listing of all mines where baseline and relevant pollution standards— called maximum contaminant level (MCL) standards—were not met.
(2) A complete listing of all mines—regulated either by the NRC or by an Agreement State—where alternative concentration limits (ACLs), or any otherwise-named variance or relaxation of original standards, was used.
(3) Thorough analysis of the post-closure monitoring of all ISL mines in all states, including an assessment of the current state of contamination and ongoing restoration.
(4) Thorough analysis of the short- and long-term environmental impacts that have resulted from the applications of the current regulatory regime, performed in conjunction with other federal and state regulators.

Comment NRDC Ch 3: ISL mines are required to reclaim the ground water to baseline; if baseline cannot be achieved then reclamation to class of use of the aquifer is accepted. If the aquifer cannot be restored to baseline or class of use, then the operator can submit an alternate concentration limit (ACL) application. The NRDC asserts that to date, no ISL operations have restored a mined aquifer to baseline conditions. Aquifers have been considered restored in Wyoming to class of use of the aquifer. This means that the water quality of the aquifer meets the class of use of the aquifer, based on all of the constituents, but not all constituents were returned to baseline conditions.

Recommendation NRDC Ch 3: The Commonwealth should consider specific rules and regulations for uranium mining facilities and in-situ uranium facilities. When considering these regulations, determination of restoration criteria should be established.

NRDC Ch 4 – The Regulatory Predicament

Finding NRDC Ch 4:
The regulatory system for uranium ISL mining is inadequate.

Comment NRDC Ch 4: The NRC does not have specific regulations for ISR mining. The NRC uses applicable requirements from current regulations and guidance documents to regulate ISR. Without specific regulations, both the industry and the NRC are trying to function within a regulatory regime set up for other types of facilities. The State of Wyoming promulgated rules and regulations for in-situ uranium mines in 2005. Previous to 2005, Wyoming had guidance for in-site mines but had to use the non-coal mining rules and regulations to regulate these facilities.

Recommendation NRDC Ch 4: The Commonwealth should consider specific rules and regulations for uranium mining facilities. Additionally, the commonwealth should consider

specific rules and regulations for in-situ uranium milling facilities should the Commonwealth become an agreement state with NRC.

NRDC Ch 5 – Effect of Multiple Resource Extraction in One Area

Finding NRDC Ch 5:
The environmental impacts of uranium recovery must be assessed in conjunction with other historical, ongoing, and reasonably foreseeable effects of natural resource extraction in the areas of proposed mining. The NRC's GEIS on ISL uranium recovery provided an opportunity to address the cumulative impact for all methods of resource extraction activities. On this crucial issue the NRC failed.

Comment NRDC Ch 5: The NRC has a Generic EIS (GEIS) for in situ uranium recovery facilities. This GEIS discusses environmental issues associated with this facilities located in the western United States. The GEIS is used in assessing issue common to ISR in addition to the site-specific review.

Recommendation NRDC Ch 5: The Department should consider requirements for identification of cumulative impacts of mining and milling of uranium and of other natural resource extraction on the natural environment.

NRDC Ch 6 – Conclusions and Policy Recommendations

Finding NRDC Ch 6:
Considering uranium recovery's poor environmental record, the federal government has an obligation to impose a more protective regulatory framework on all types of uranium recovery before more environmental damage is done. Therefore, NRDC recommends a moratorium on any new ISL uranium mining licenses until such time as follows:
(1) The federal government adopts key elements of Colorado's 2008 Land & Water Stewardship Act, which requires substantially more stringent protections than currently exist in law;
(2) EPA standards and NRC regulations are updated to reflect the best available data on what is required to protect the environment from the contamination inflicted by all types of uranium recovery; and
(3) the White House Council on Environmental Quality (CEQ) has undertaken a full interagency review of the cumulative and connected impacts of all current Federal programs and proposed agency actions to facilitate and regulate extraction of mineral and fossil-energy resources in the arid West, including but not limited to the NRC's program to license new uranium recovery operations.

Comment NRDC Ch 6: Colorado HB 08-1161 identified as the Land and Water Stewardship Act of 2008 required that all uranium mining operations be Designated Mining Operations, that

in-situ mine applicants provide a baseline site characterization and plan for monitoring, certify that they have no operations that are violating permits under the Colorado Mined Land Reclamation Act or similar laws of other states or the Federal government, and that groundwater must be reclaimed to baseline conditions or water quality standards of the Water Quality Control Commission. The WQCC of the Colorado Department of Public Health and the Environment has the responsibility of adopting quality standards for surface water and ground water in Colorado.

Recommendation NRDC Ch 6: The Department of Environmental Quality should consider setting water quality classification standards for use of ground water. Additionally, the Commonwealth should consider requiring the permitting of all private use wells. This permitting may include lithologic logs, well completion reports, and water quality sample. The Commonwealth should determine the requirements for ground water restoration at uranium mines.

APPENDIX B
THE CANADIAN REGULATORY BASE: FEDERAL REGULATORY MANDATED LEGISLATION

THE CANADIAN REGULATORY BASE

(The Canadian Regulatory Base: Federal Regulatory Mandated Legislation)

FEDERAL REGULATORY MANDATED LEGISLATION

Canadian Nuclear Safety Commission

Acts

- Nuclear Safety and Control Act
- Nuclear Liability Act
- International Atomic Agency (IAEA) on Nuclear Safeguards Verification

Regulations

- General Nuclear Safety and Control Regulations
- Radiation Protection Regulations
- Packaging and Transportation of Nuclear Substance Regulation (pending amendments)
- Nuclear Non-perforation Import and Export Control Regulations (pending amendments)
- CNC Cost Recovery Fees Regulation
- Uranium Mines and Mills Regulations
- Canadian Nuclear Safety Commission Rules of Procedure
- Canadian Nuclear Safety Commission By-laws
- Saskatchewan Uranium Mines and Mills Exclusion Regulations

Regulatory Documents

RD/GD-993:	Public Information and Disclosure
RD/GD 336	Guidance for Accounting and Reporting of Nuclear Material
RD/GD-370:	Management of Uranium Mine Waste Rock and Mill Tailings
G-4:	Measuring Airborne Radon Progeny at Uranium Mines and Mills
G-129:	Keeping Radiation Exposures and Doses "As Low As Reasonably Achievable" (ALARA)
G-147:	Radio-bio-assay Protocols for Responding to Abnormal Intakes of Radionuclides
G-206:	Financial Guarantees for the Decommissioning of Licensed Activities
G-218:	Preparing Codes of Practice to Control Radiation Doses at Uranium Mines and Mills
G-219:	Decommissioning Planning for Licensed Activities
G-221:	A Guide to Ventilation Requirements for Uranium Mines and Mills
G-225:	Emergency Planning at Class 1 Nuclear Facilities and Uranium Mines and Mills
G-228:	Developing and Using Action Level
G-274:	Security Plans for Category I, II and II Nuclear Material
G-296:	Developing Environmental Protection, Policies, Programs and Procedures at Class 1 Nuclear Facilities and, Uranium Mines and Mills

G-313:	Radiation Safety Training Programs for Workers Involved in licensed Activities with Nuclear Substances and Radiation Devices, and with Class II Nuclear Facilities and Prescribed Equipment
G-320	Assessing the Long Term Safety of Radioactive Waste Management
S-106 Rev 1:	Technical and Quality Assurance Requirements for Dosimetry Services
S-296:	Environmental Protection Policies, Programs and Procedures at Class 1 Nuclear Facilities and Uranium Mines and Mills
P-211:	Compliance
P-223:	Protection of Environment
P-242:	Considering Cost Benefit Information
P-290:	Managing Radioactive Wastes
P-325:	Nuclear Emergency Management

Discussion Papers

DIS-12-01	Protection Groundwater at Nuclear Facilities in Canada

Agreements

CNSC-Saskatchewan Administrative Agreement for the Regulation of Health, Safety and Environment at Saskatchewan Uranium Mines and Mills

Significant Licenses

- A license to prepare a site and construct mine-mill
- A license to operate mine-mill
- A license to decommission a mine-mill
- A license to abandon mine-mill
- License to transport category I, II or III material
- License to transport while in transit
- Certification of packages and special form radioactive material

Canadian Environmental Assessment Agency (CEAA)

The CEAA is an arm's length government agency that ensures environmental regulations and processes are administrated correctly. An environmental review and recommendations must be signed off by the Canadian Minister of Environment.

Acts

- Canadian Environmental Assessment Act

Regulations

- Comprehensive Study List Regulations
- Establishing Timelines for Comprehensive Study Regulations
- Inclusion List Regulations

- Regulation Respecting the Coordination by Federal Authorities of Environmental Assessment Procedures and Requirements

Agreements

- Canada-Saskatchewan Agreement on Environmental Assessment Cooperation (1999)

Proposed Changes to CEAA

From the Budget press release 2012 and current in the house for review.

"There will be new tools to reduce duplication of federal and provincial environmental assessment processes:

- *The Minister must, upon request, allow a provincial process to substitute for a federal environmental assessment, but not federal decision-making, if satisfied that the substantive requirements of the CEA Act 2012 will be met.*
- *The Governor in Council may exclude a project from application of the Act if it determines that a province will undertake an equivalent assessment. For this to occur, all the conditions for substitution must be met and the province must, at the end of its process, determine whether the project is likely to cause significant adverse environmental effects and ensure the implementation of mitigation measures.*
- *New provisions enable regional environmental assessments in cooperation with provincial governments."*

Environment Canada

Acts

- Canadian Environmental Protection Act (includes former Clean Air Act)
- Environmental Enforcement Act
- Migratory Birds Convention Act
- Species at Risk Act

Regulations

- There are about 80 regulations under CEPA, none are specific to mining and milling but influence treatment of materials used at mines mills

Agreement

- Canada-Saskatchewan Administrative Agreement for the Canadian Environmental Protection Act
- Other Federal Regulations

Guidelines

- Guideline for the Assessment of Alternatives for Mine Waste Disposal

Fisheries and Ocean`s Canada

Acts

- Fisheries Act

Regulations

- Metal mining Effluent Regulations

Licenses:

- Publishing of tailings facility
- Letters of advice for water crossing

Agreements

- Agreement on Habitat Compensation between DFO and proponent

Natural Resources Canada

Act

Explosives Act

Regulations

Explosive Regulations

Licenses

- Licenses for Manufacturing Explosives
- Licenses for Storage Explosives
- License for Transportation Explosives
- Authorization for Explosives

Agreements

- *Mandated by a Cabinet Directive on Improving the Performance of the Regulatory System for Major Resource Projects* and the Associated Memorandum of Understanding (MOU)
- Major Project Agreement between Proponents and Federal Deputy Ministers
    - Environmental Assessment Work Plan
    - Aboriginal Consultation and Engagement Work Plan
    - Permitting, Authorization and Approval Work Plan
    - Follow-up and Monitoring Work Plan

Other Federal Regulations

- Canadian Electrical Code
- Canadian Investment Act

Other Federal Regulations

- Canadian Electrical Code
- Canadian Investment Act

Engineering Codes and ISO standards

- ISO 14000

SASKATCHEWAN GOVERNMENT REGULATORY BASE

Saskatchewan Environment Ministry

Acts

- Clean Air Act
- Environmental Assessment Act
- Environment Management and Protection Act (2002)
- The Fisheries Act
- Forest Resources Act
- Forest Resources Management Act
- Provincial Lands Act
- Natural Resources Act
- Water Appeal Board Act
- Wildlife Act
- The Natural Resources Reclaimed Industrial Site Act

Regulations

- Clean Air Regulation
- Environmental Spill Control Regulation
- Hazardous Substances and Waste Dangerous Goods Regulations
- The Used Oil Collection Regulations
- The Scrap tire Management Regulation
- The Water Regulations, 2002
- The Waste Electronic Equipment Regulation
- The Fisheries Regulations
- The Forest Resources Regulations
- The Forest Resources Management Regulations
- Provincial Land Regulations
- Wildlife Habitat Protection Regulations
- The Resource Protection and Development Services Regulations
- Reclamation Industrial Site Regulation

Regulatory Documents

- EPB 381: Guideline For Northern Mine Decommissioning and Reclamation

Agreements

- Canada-Saskatchewan Agreement on Environmental Assessment Cooperation (1999)
- Canada-Saskatchewan Administrative Agreement for the Canadian Environmental Protection Act

Others

- Surface Rights Lease administered by Saskatchewan First Nations and Metris Affairs
- Nature Conservancy Data

Saskatchewan Labour Relations and Work Place Safety Ministry

Act

- The Occupational Health and Safety Act (1993)
- The Radiation Health and Safety Act
- The Worker`s Compensation Act
- The Boiler and Pressure Vessel Act
- The Electrical Inspection Act
- Electrical Licensing Act
- The Gas Inspection Act
- The Gas Licensing Act
- The Passenger and Freight Elevator Act

Regulations

- The Mine Safety Regulations
- The Worker`s Compensation General Regulations, 1985
- Regulations Respecting Design, Construction, Installation and Use of boilers and Pressure Vessels
- Regulations Respecting Examinations and Certificates of Engineers and firemen
- Regulations Respecting the Welding of Boilers, Pressure Vessels and Pressure Piping
- The Electrical Inspection Regulations
- The Use of Electricity in Mine Regulations
- The Passenger and Freight Elevator Regulations

Other

- Workman`s Compensation Board

Saskatchewan Energy and Resources

Act

- The Crown Mines Act

Regulations

- The Mineral Disposition Regulations

Other

- Lake Bottom sediment data for setting norm setting in radioactivity

Tourism, Parks, Culture and Sports

Act

- The Heritage Property Act

Regulations

- The Heritage Property Regulations

Other

- Heritage Resources Review and Assessment

Saskatchewan Watershed Authority

Act

- The Saskatchewan Watershed Authority Act

Regulations

- The Saskatchewan Watershed Authority Regulations

SaskWater

Act

- The Conservation and Development Water Act

Regulations

- The Conservation and Development Water Regulations

First Nations and Metis Affairs:

Other

- Northern Revenue Sharing Trust:
- Surface lease requirements

Transportation and Highways

Regulations

- Professional Engineers and Geologists of Saskatchewan

APPENDIX C
JOINT PANEL RECOMMENDATIONS (THE CANADIAN REGULATORY BASE)

Joint Panel Recommendations (The Canadian Regulatory Base)

In Saskatchewan, a joint panel (Federal-Provincial Panel on Uranium Mining Developments in Northern Saskatchewan, 1998) was established to make the in part the determination if a projects were acceptable or not, and provide for public consultation. This panel and its recommendation set the standards for future EA.

1. Education is a key component. Without a continuation of initiatives such as the Multi-Party Training Plan, northerners will not be able to share in the opportunities offered by the uranium mining industry.

2. Employment and business opportunities must be made available to northerners. This is most effectively accomplished by including appropriate objectives in the Human Resources Agreements that are attached to the surface leases for the mines.

3. Protection of northern communities and the people in them is as important as protection of the biota. Qualified professionals should be engaged to monitor and study the impacts of uranium mining on the quality of life in northern communities. Any detrimental impacts should be mitigated.

4. Scientific research can suggest approaches that will improve the profitability of the industry, while at the same time providing greater environmental protection. Governments, in cooperation with the industry, should promote such research at the Saskatchewan Research Council and the universities.

5. Centralized milling of the ore from several mines at one location will cause less environmental damage, in total, than milling at a series of sites near the mines. Collective milling of several ores should, therefore, be encouraged.

6. In-pit tailings disposal facilities provide better environmental protection than do aboveground facilities. We recommend, therefore, that in the future all tailings should be placed in mined-out pits.

7. All mine rock wastes that have the potential to be acid-generating should be protected from oxygen exposure. This can be achieved by using them for fill when underground mines are decommissioned or by placement in mined-out pits. Underwater disposal in existing lakes should be an option that is considered only if no suitable mined-out pits are available.

8. Perpetual monitoring of decommissioned tailings management facilities and potential acid-generating waste rock depositories will be necessary. A self-sustaining fund should be designated for the cost of monitoring and any mitigation required.

9. Cumulative effects monitoring is necessary on a regional scale to assess the potential spread of contaminants from these mines. It is important that adequate funding continues to be provided to the Cumulative Effects Monitoring Working Group (CEMWG).

10. The Environmental Quality Committees provide northerners with vehicles through which they can participate in the development of this industry. Providing northern people with a better understanding of this industry and empowering them to participate in its future developments is the best way to protect the northern environment. Governments and the industry should continue to support the EQCs.

11. The Province should complete a comprehensive study of the cumulative demands that will be placed on northern roads in the future and prepare, in cooperation with the users, to maintain them at acceptable standards.

Mine workers, particularly those in underground developments, depend on mine regulators to ensure safe workplaces. It is, therefore, essential that legislation and regulations provide adequate protection for both contract and non-contract workers; that mine sites be inspected frequently; and that due care be exercised to ensure that safe work practices are being followed

APPENDIX D
PROJECT AGREEMENT FOR THE MIDWEST URANIUM MINING AND MILLING PROJECT IN SASKATCHEWAN

MIDWEST AGREEMENT (THE CANADIAN REGULATORY BASE: MIDWEST AGREEMENT)

PROJECT AGREEMENT FOR THE MIDWEST URANIUM MINING AND MILLING PROJECT IN SASKATCHEWAN

PREAMBLE
WHEREAS the Government of Canada is committed to improving the federal environmental assessment (EA) and regulatory review processes for major resource projects to enable a more effective assessment and mitigation of potential environmental effects, while protecting the health and safety of Canadians and promoting innovation and competitiveness within the Canadian resource industry sectors;

AND WHEREAS the Government of Canada is committed to undertaking a process of early, effective and meaningful engagement and consultation with Canada's Aboriginal peoples concerning contemplated Crown conduct with respect to, among other things, major resource projects that may adversely affect established or potential Aboriginal and treaty rights under section 35 of the Constitution Act, 1982;

AND WHEREAS the Government of Canada has created the Major Projects Management Office (MPMO) for the purpose of overseeing and tracking the federal review and Aboriginal engagement and consultation for major resource projects;

AND WHEREAS AREVA Resources Canada Incorporated (the Proponent) has submitted a Project Description in support of its proposal to develop a new uranium mine at the Midwest site and transport the mined ore for milling at their McClean Lake operation in northern Saskatchewan;

AND WHEREAS the Canadian Nuclear Safety Commission (CNSC), Fisheries and Oceans Canada (DFO), Natural Resources Canada (NRCan) and Transport Canada (TC) have regulatory and statutory duties in relation to the development proposal;

AND WHEREAS the Minister of the Environment (the Minister) has determined that the EA in relation to the development proposal should proceed by way of a comprehensive study pursuant to the Canadian Environmental Assessment Act (CEAA);

AND WHEREAS the CNSC is a quasi-judicial administrative tribunal exclusively responsible for measures taken under the Nuclear Safety and Control Act (NSCA) and as such, CNSC will ensure that the complete range of evidence required to make fully-informed decisions within its mandate is presented to the Commission;

AND WHEREAS nothing in this Project Agreement (the Agreement) fetters the powers, statutory authorities and functions of federal departments/agencies, the CNSC, and their respective Ministers;

AND WHEREAS the Governments of Canada and Saskatchewan have agreed to coordinate the federal and provincial EAs to the extent possible pursuant to the Canada-Saskatchewan Agreement on Environmental Assessment Cooperation;

AND WHEREAS the Canadian Environmental Assessment Agency (CEA Agency) has agreed to delegate the federal environmental assessment coordinator responsibilities to the CNSC in accordance with subsection 12.4(3)(b) of the CEAA;

AND WHEREAS the CEA Agency has notified Saskatchewan that the CNSC will be Canada's contact pursuant to section 20(3) of the Canada-Saskatchewan Agreement on Environmental Assessment Cooperation;

NOW THEREFORE the signatories (the Parties) to this Agreement commit to work together to facilitate an effective, accountable, transparent, timely and predictable federal review in relation to the development proposal and to contribute to the discharging of any duty to consult with Aboriginal groups.

1.0 PURPOSE

As the EA for this Project commenced prior to the commencement of the MPMO Initiative, this Agreement describes the main remaining activities of the federal review process and outlines the key roles and responsibilities of the Parties. For further clarity, the Agreement shall be read together with the Annexes, which form part of this Agreement. The federal review includes the EA, regulatory review(s), and Aboriginal engagement and consultation activities.

2.0 PROJECT DESCRIPTION

The development proposal consists of the mining and milling of a uranium deposit in northern Saskatchewan. The Project includes: mining uranium ore at the Midwest development by open pit mining methods; hauling ore along a road linking the Midwest development with the existing McClean Lake Operation; and milling uranium ore at the JEB mill.

The Project for the purposes of the federal review may be different from the development proposal, as described in section 4.0.

3.0 ROLES AND RESPONSIBILITIES

Based on the information provided by the Proponent, the following federal departments and agencies have identified an interest in the Project, and will participate in the federal review as follows:

- CNSC has regulatory and statutory responsibilities under the NSCA and, pursuant to the CEAA, is a responsible authority (RA). The CNSC will act as the EA Manager and as the Crown Consultation Coordinator (CCC) for the EA in relation to the Project, and will coordinate the federal input into the provincial EA, to the extent possible;

- DFO has regulatory and statutory responsibilities under the Fisheries Act and, pursuant to the CEAA, is an RA. DFO may be in possession of specialist or expert information or knowledge with respect to the Project and, on request, shall make available that information or knowledge to the RAs;

- TC has regulatory and statutory responsibilities under the Navigable Waters Protection Act (NWPA) and, pursuant to the CEAA, is an RA. TC requires a Navigation Impact Assessment (NIA) to be completed as a component of the EA. To complete the NIA and make its EA decision, TC requires all the information described in the NWPA application form. In order to meet the timelines in this Agreement this information must be submitted no later than the time of submission of the revised Environmental Impact Statement (EIS). TC may be in possession of specialist or expert

information or knowledge with respect to the Project and, on request, shall make available that information or knowledge to the RAs;

- NRCan has regulatory and statutory responsibilities under the Explosives Act and, pursuant to the CEAA, is an RA. NRCan may be in possession of specialist or expert information or knowledge with respect to the Project and, on request, shall make available that information or knowledge to the RAs;

- Indian and Northern Affairs Canada (INAC) has advisory responsibilities to support the Government of Canada's Aboriginal engagement and consultation activities in relation to the Project;

- Environment Canada (EC) and Health Canada (HC) are federal authorities (FAs) pursuant to the CEAA and are in possession of specialist or expert information or knowledge with respect to the Project (expert FA) and, on request, shall make available that information or knowledge to the RAs;

- The CEA Agency has administrative and advisory responsibilities pursuant to the CEAA in support of the EA;

- The MPMO has administrative and advisory responsibilities under the Cabinet Directive on Improving the Performance of the Regulatory System for Major Resource Projects and the associated Memorandum of Understanding (MOU) (June 2007). The MPMO will provide oversight and advice throughout the entire federal review in relation to the Project, to ensure adherence to the service standards and the roles and responsibilities of all Parties.

For further information regarding the roles and responsibilities of the Parties, please see the applicable Annexes.

4.0 FEDERAL REVIEW PROCESS

As agreed to by the RAs, the scope of the Project includes:
The physical works and activities associated with the construction, operation and decommissioning (including closure and reclamation) of:

- The Midwest mine, including all associated facilities and ancillary works;
- The dewatering of Mink Arm;
- Waste rock management facilities located at the Midwest site;
- Dedicated haul road;
- The waste management system that is proposed for transporting waste water from the Midwest site to the water treatment plant located at the JEB Mill on the McClean Lake site;
- The modifications at the JEB Mill at McClean Lake to accommodate the Midwest ore;
- The modifications at JEB Tailings Management Facility, located at McClean Lake, to accommodate the Midwest ore; and,
- All physical works and undertakings associated with the fish habitat compensation plan (FHCP).

The RAs will work with the expert FAs to jointly meet their responsibilities under the CEAA. The Minister has determined that the type of EA required is a comprehensive study.
The CNSC and the Government of Saskatchewan, Ministry of Environment (SK MOE) will coordinate their respective review processes, to ensure that joint steps are undertaken wherever that can appropriately be done pursuant to the Canada-Saskatchewan Agreement on EA Cooperation.

Annex I shows a Gantt chart of the federal review process. Annex II shows the key milestones and service standards for the EA as well as Aboriginal engagement and consultation. Annex IX depicts the Canada-Saskatchewan Cooperative EA Process.
Through the EA process, RAs will confirm any regulatory decisions required in relation to the Project. If no regulatory decisions are required for a department or agency, it will end its participation in the EA as an RA, but may, upon request from an RA, continue to participate as an expert FA should it be in possession of specialist or expert information or knowledge with respect to the Project.

5.0 ABORIGINAL ENGAGEMENT AND CONSULTATION

The Parties are committed to a "Whole of Government" approach to Aboriginal engagement and consultation in the context of major resource projects to ensure that Aboriginal groups are sufficiently consulted, and where appropriate, accommodated, when the Government of Canada contemplates actions that may adversely affect established or potential Aboriginal and treaty rights. To the extent possible, and with the CNSC responsible for coordination, the Parties will work together toward a coordinated approach for Aboriginal engagement and consultation that is integrated with the federal review.

The proposed Aboriginal engagement and consultation roles and responsibilities are identified in Annex III.

6.0 TIMELINES

The target timelines for the EA and regulatory review processes are detailed in the Gantt chart in Annex I, and are as follows:

1. Estimated completion of the EA – 15 months from the filing of the revised draft EIS by the Proponent to the posting of EA course of action decisions;
2. If appropriate, issuance of Fisheries Act authorizations – 3 months from the EA course of action decisions posted on the Canadian Environmental Assessment Registry (CEAR) assuming submission of all applications no later than the time of submission of the revised EIS;
3. If appropriate, issuance of NWPA approvals – 3 months from the EA course of action decisions posted on the CEAR assuming submission of all applications no later than the time of submission of the revised EIS. Submission of draft Treasury Board Submission documents for an NWPA section 23 exemption are contingent on the issuance of all NWPA s.5 approvals;
4. If appropriate, issuance of Explosives Act license – 3 months from the EA course of action decisions posted on the CEAR assuming submission of an application no later than the time of submission of the revised EIS, or within 30 days of submission of a complete application if the application is received after the EA course of action decisions;
5. If appropriate, issue an Order in Council (OIC) exemption under section 23 of the NWPA – within 11.5 months from the EA course of action decisions posted on the CEAR; and
6. If appropriate, issuance of NSCA authorizations - 12 months from the EA course of action decisions posted on the CEAR, assuming submission of all applications no later than the time of the EA course of action decisions posted on the CEAR.

The above timelines have been established on the basis of a number of assumptions, such as activities of participants to the review that are not signatories to this Agreement. Should events unfold in a manner that is different from what has been assumed, the timelines will necessarily be different. The MPMO Tracker will provide for transparent and publicly accessible monitoring of the progress of the federal review.

7.0 FOLLOW-UP AND MONITORING

The RAs have responsibilities under the CEAA in relation to ensuring the implementation of mitigation measures and the design and implementation of a follow-up program. The RAs will work with the expert FAs, the Proponent and the province, to satisfy those responsibilities. Expert FAs will provide any assistance requested by the RAs in ensuring the implementation of a mitigation measure or aspect of the follow-up program on which the expert FA and RAs have agreed.

8.0 ADMINISTRATION

Tracking Progress

The milestones, timelines and service standards set out in this Agreement, subject to any amendments, will provide the basis against which the MPMO will monitor the progress of the federal review and report on this progress in the MPMO Tracker.
The following are examples of situations where the MPMO may pause the timelines of the federal review:

1. the federal review is delayed at the request of the Proponent and/or another jurisdiction;
2. the Minister of the Environment or the RAs have indicated that the Proponent is required to provide additional information necessary for the completion of the federal review, or that the information provided is insufficient;
3. the federal review cannot proceed as a result of circumstances related to Aboriginal engagement and consultation; or
4. litigation or other court action prevents the completion or continuation of the federal review.

Issues Resolution

The Parties will use their best efforts to resolve any differences of opinion in the interpretation or application of this Agreement in an effective and timely manner.
Issues relating to the federal review for the Project will be resolved through direct discussions and collaboration between the involved Parties, supported by the MPMO.
Should issues remain outstanding, they will be referred to the appropriate senior level committee established through the MPMO Initiative.

Post-Project Evaluation

The Parties will participate in an informal evaluation of the effectiveness of the federal review in relation to the Project within 90 days following the issue of the RAs' EA course of action decisions. The level of effort and format of the evaluation will be appropriate to the scale of the issues encountered.

Amendments

The Parties may recommend to the MPMO whether a change to the federal review or to the Project warrants an amendment to the Agreement. Where there is agreement that an amendment is warranted, and where such amendment is considered significant, the MPMO, on behalf of the Parties, will provide the proposed amendment to the Major Projects Deputy Ministers for consideration.

Unless otherwise determined by the MPMO in collaboration with the Parties, amendment of the Agreement shall not cause the federal review to stop with respect to any Agreement-related activities that might be ongoing at the time when the need for amendment is identified.

9.0 PROJECT AGREEMENT

The Parties hereto have signed the Agreement, in counterpart, on the dates indicated below.

Original Signed by
Cassie Doyle
Deputy Minister
Natural Resources Canada November 13, 2009 Date

Original Signed by
Peter Sylvester
President
Canadian Environmental Assessment Agency November 18, 2009 Date

Michael Binder
President
Canadian Nuclear Safety Commission November 20, 2009 Date

Original Signed by
Claire Dansereau
Deputy Minister
Fisheries and Oceans Canada November 19, 2009 Date

Original Signed by
Yaprak Baltacioğlu
Deputy Minister
Transport Canada November 20, 2009 Date

Original Signed by
Michael Wernick
Deputy Minister
Indian and Northern Affairs November 18, 2009 Date

Original Signed by
Ian Shugart
Deputy Minister
Environment Canada November 28, 2009 Date

APPENDIX E
MILLENNIUM PROJECT DESCRIPTION (CANADA)

APPENDIX E: MILLENNIUM PROJECT DESCRIPTION (CANADA)

Project Specific Guidelines Scoping Document found at
http://www.nuclearsafety.gc.ca/.

Members of the public seeking information and status updates should access the following websites:

The federal public registry
Canadian Environmental Assessment Registry (CEAR)
http://www.ceaa-acee.gc.ca/050/index_e.cfm.
The CEAR reference number for the project is 09-03-49928;

The Province of Saskatchewan's project specific webpage at
http://www.environment.gov.sk.ca/Default.aspx?DN=e3550966-c17a-4f74-af21-292680d5dc94;

and

The CNSC's project specific webpage at
http://www.nuclearsafety.gc.ca/eng/ea/ealist/ongoing/saskatchewan/EA_09_03_49928.cfm

Project timelines can also be tracked online via the MPMO Tracker, available at
http://www2.mpmo-bggp.gc.ca/MPTracker/search-chercher.aspx.

APPENDIX F
THE GENERAL TERMS AND CONDITIONS OF A CANADIAN PROVINCIAL SURFACE LEASE

PART I LAND TENURE

- Lease of Land
- Rental Charges
- Use of Lands
- Payment of Taxes
- Improvements and Railways
- Access to Lease Lands

PART II OCCUPATIONAL HEALTH AND SAFETY

- Occupational Health and Safety

PART III ENVIRONMENTAL

- Environmental Considerations
- Environmental Protection

PART IV SOCIO-ECONOMIC

- Direct Employment and Economic Benefits
- Employment Policies and Practices
- Training and Development Program
- Commercial Opportunities
- Monitoring
- Compensation
- Other Commitments

PART V MISCELLANEOUS PROVISIONS

- Compliance and Relevant Statutes
- Termination of Agreement

- Arbitration
- Assignments
- Indemnity
- Force Majeure
- Notices
- Term of Agreement
- Place of Business
- Confidentiality
- Binding Efforts
- Other Leases
- Scope of Covenant
- Continuing Obligations

PART VI CONSTRUCTION OF AGREEMENT

- Definitions
- Interpretation
- Entire Agreement

APPENDICES

- Occupational Health and Safety of Workers
- Guidelines for Environmental Protection during Road Construction
- Guidelines for Environmental Protection during Development and Restoration of Sand and Gravel
- Surface Lease Maps
- Financial Security for Decommissioning

APPENDIX G
REVIEW OF EMERGING ISSUES – ICRP RECOMMENDATIONS

REVIEW OF EMERGING ISSUES – ICRP RECOMMENDATIONS

1.0 ROLE OF THE ICRP IN DEVELOPMENT OF RADIATION PROTECTION REGULATIONS

Documents published recently by the International Commission on Radiological Protection (ICRP) were reviewed to identify emerging issues that might impact potential regulations to be promulgated by the state of Virginia in conjunction with potential uranium recovery operations.

1.1 Mission of the ICRP

The International Commission on Radiological Protection (ICRP), established in 1928, is a consensus body of more than two hundred radiation protection experts representing thirty countries. The ICRP has developed and maintained the International System of Radiological Protection which provides a common basis for radiological protection standards, legislation, guidelines, programs and practice.

1.2 Role in International Radiation Protection

The recommendations of the ICRP are generally adopted by most nations and incorporated into the International Atomic Energy Agency guidance in regard to radiation protection. The proposed revisions to the International Basic Safety Standards (BSS) promulgated by the International Atomic Energy Agency (IAEA) have focused on aligning requirements with the current ICRP recommendations.

1.3 History of Adoption of ICRP Recommendations in the US

In general, international regulatory bodies adopt ICRP recommendations relatively soon after they are published. However, in the United States, the current radiation protection regulations, implemented in 1991, are based on recommendations published in ICRP Publication 26 (ICRP, 1977) and in the case of 10 CFR 50, Appendix I, ICRP 2 (ICRP, 1959) calculation methodology. The ICRP published revised recommendations in 1990 (ICRP, 1990). The US adopted revisions to 10 CFR 20 in 1991 to be consistent with ICRP 1977 recommendations. Consideration of the 1990 ICRP recommendations was postponed until those recommendations were re-affirmed by the 2007 recommendations. The US Nuclear Regulatory Commission is currently considering options for aligning US radiation protection regulations with the 2007 ICRP recommendations.

2.0 CURRENT ICRP RECOMMENDATIONS

2.1 Publication 103: The 2007 Recommendations of the International Commission on Radiological Protection. (ICRP, 2007)

The ICRP published radiation protection recommendations in 2007 to "contribute to an appropriate level of protection for people and the environment against the detrimental effects of radiation exposure without unduly limiting the desirable human actions that may be associated with

such exposure." The 2007 recommendations essentially reiterate the 1990 ICRP recommendations in Publication 60 (ICRP, 1990).

ICRP 103 maintains the basic principles of radiation protection:

> *Justification:* the process of determining whether a planned activity involving radiation is beneficial or a proposed remedial action in an emergency or existing exposure situation is likely to be beneficial.
>
> *Optimization:* the process of determining the level of protection that makes exposures as low as reasonably achievable, economic and societal factors being taken into account.
>
> *Limitation:* the process of setting a dose limit to individuals from planned exposures that shall not be exceeded.

ICRP 103 describes situations in which a person may be exposed to radiation above background levels due to a deliberate action as "planned exposures" as differentiated from exposures due to emergency situations or from existing conditions.

ICRP 103 also applies the concept of "dose constraint", i.e., a prospective and source-related restriction on individual dose from a source, which provides a basic level of protection for the most highly exposed individuals from a source. The dose constraint is an upper bound on the dose in optimization of protection for that particular source.

ICRP 103 also recommends clarification of dosimetric terminology and retains collective dose as a useful instrument particularly for occupational exposures as a means of optimization. However, the Commission notes that calculations of radiation exposure detriments based on summing radiation exposures over a wide range of doses, long periods of time, and large geographic areas are not useful because of the large uncertainties (p. 253).

ICRP 103 provides recommendations for source-specific dose constraints, medical exposures, emergency exposures and "existing exposure situations". The existing exposure situations include radon in the home and at work and exposure to Naturally Occurring Radioactive Material (NORM), natural background, and radioactive residues in human habitat. The ICRP recommendations for radon are in the process of revision and are discussed in Section 2.3. The ICRP 103 recommendation for "reference levels" for doses from existing exposure situations is between 1 mSv and 20 mSv per year depending on the situation. The reference level represents the level of dose above which it is "inappropriate to plan to allow exposures to occur."

Elements of the ICRP 103 recommendations for planned exposures are shown in Table 1:

Table 1: Comparison of ICRP 103 Dose Limits to 10CFR20 Dose Limits

	ICRP 103 Dose Limit	**Current 10CFR20 Dose Limit (units as written in 10CFR20)**
Occupational Exposure		
Effective dose	20 mSv/y (2 rem/y) averaged over 5 years with no more than 50 mSv (5 rem) in any one year	5 rem/y (0.05 Sv/y)
Lens of the eye	150 mSv/y (15 rem/y) [recommendation changed in 2011 to 20 mSv/y (2 rem/y)	
Skin	500 mSv/y (50 rem/y)	50 rem/y 0.5 Sv/y)
Hands and Feet	500 mSv/y (50 rem/y)	50 rem/y (0.5 Sv/y)
Other organs	No equivalent	50 rem/y (0.5 Sv/y)
Pregnant woman	1 mSv (0.1 rem)for the remainder of the pregnancy (after declaration)	0.5 rem (0.005 Sv) for the period of gestation (requires determination of dose prior to declaration)
Members of the Public (during operation)		
Effective Dose	1 mSv/y (0.1 rem/y)	0.1 rem/y (1 mSv/y) with provision for doses up to 0.5 rem/y under specified conditions and with prior approval.
Lens of the eye	15 mSv/y (1.5 rem/y)	No equivalent
Skin	50 mSv/y (5 rem/y)	No equivalent

Other important recommendations in ICRP 103 include the following:

- Effective dose should not be used for epidemiologic studies or retrospective investigations of individual exposure and risk.
- Aggregation of very low individual doses over extended periods of time is not appropriate.
- The number of cancer deaths expected should not be calculated based on collective effective doses from trivial individual doses.
- The combined detriment for cancer and heritable defects is about 5% per sievert.
- The principle of optimization of protection is reinforced
- An approach should be developed for a framework to demonstrate protection of the environment.

2.2 ICRP Publication 104 (2008)

ICRP Publication 104, Scope of Radiological Protection Control Measures (ICRP, 2008) is a companion document to ICRP 103. The intention of the ICRP with this document is not to get involved in regulatory matters but to advise national bodies and other competent authorities to help clarify the scope of regulatory control as summarized below:

- The concepts of "exclusion", "exemption" and "clearance" are defined in the document.
  - Exclusion refers to the deliberate omission of situations from regulatory control
  - Exemption refers to situations that are under regulatory control but regulatory control is waived as it is deemed not warranted.
  - Clearance refers to relinquishing regulatory control if it is no longer warranted.
- Planned exposure situations are normally within the scope of regulatory control; existing exposure situations may fall outside the scope of regulatory requirements because the criteria for exclusion are met.
- The public generally demands greater control of "artificial" exposure situations than "natural" situations.
- Exemption for planned exposures should be granted only if:
  - Individual radiation risks are acceptably small
  - Protection must be considered to be optimized
  - The likelihood of unintended scenarios that would lead to failure to meet the other conditions is small.
- For situations involving artificial sources, an individual dose criterion of 0.01 mSv/year (1 mrem/year) has been suggested in the past for the purpose of exemption. The Commission, however, has never recommended the use of the concept of *de minimis* dose and that the principle of exemption should "lose its historical and dogmatic connotation with the single value of 0.01 mSv/year" (p 48).

The Report clarifies the fact that the system of radiological protection recommended by the ICRP is based on the assumption that at doses below 100 mSv (10 rem) a given increment in dose will result in a proportionate increase in risk, i.e., linear non-threshold model is a prudent basis for radiation protection.

The concepts of justification and optimization are defined as:

Justification: any decision that alters the radiation exposure situation should do more good than harm. (Regulatory control measures should achieve sufficient benefit to offset the detriment they may cause.)

Optimization: the likelihood of incurring exposure, the number of people exposed, and the magnitude of their individual doses should all be kept as low as reasonably achievable, taking into account economic and societal factors.

The ICRP has suggested that for emergency situation reference levels for residual dose in the range of 20 mSv to 100 mSv be applied in the process of optimization (p. 63).

The Commission recommends that regulators should consider application of the concept of exclusion to exposure situations that are either uncontrollable or not amenable to control through regulation including:

- Radioactive material from past activities and events that are not amenable to control through regulation because of dispersion in the environment,
- Radioactive material that has been lawfully discharged to the environment from a regulated human activity,
- Raw material extracted from the ground that contains radionuclides of natural origin in concentrations below a specified value. (p. 99)

The Commission concludes that application of regulatory controls should achieve a net benefit in protection or regulatory control is not justified (p. 102).

2.3 Draft ICRP Radon Recommendations (2011)

The draft radon recommendations were distributed for consultation in December, 2011 (ICRP, 2011a). ICRP 103 had recommended no change in the dose coefficients or recommendations from ICRP Publication 65, Protection Against Radon at Home and at Work (ICRP, 1993). However, in November 2009, the ICRP issued a statement recognizing that the reference levels recommended in ICRP 65 were no longer valid given the more recent epidemiological and dosimetric information (ICRP, 2009a). The statement included a recommendation to reduce the upper value for the reference level for radon in dwellings from 600 Bq/m^3 (16.2 pCi/L) to 300 Bq/m^3 (8.1 pCi/L) with the consideration that national authorities should consider setting lower reference levels "according to local circumstances". The statement also recommended a radon gas concentration of about 1000 Bq/m^3 (27 pCi/L) as the "entry point" for applying occupational protection requirements for existing exposure situations.

The 2011 ICRP Draft Radon Report re-affirms the reference level of 300 Bq/m^3 for dwellings and also recommends a reference level of 300 Bq/m^3 for the workplace. The draft report cites a detriment-adjusted risk coefficient of 8×10^{-10} per $Bq\text{-}h/m^3$ (5×10^{-4} per working level month). The draft report states that there is no consistent evidence of any excess cancer risk for tumors other than lung cancer due to inhalation of radon decay products. The report notes that national authorities have the responsibility to set their own reference levels taking into account economic and societal circumstances. The principle of optimization should also apply to radon. The draft report recommends a graded approach to occupational exposures and that in workplaces in which radon concentrations remain above a dose reference level of 10 mSv/year after all reasonable efforts to reduce radon exposures have been applied, the workers should be considered occupationally exposed and relevant requirements applied. The graded approach involves:

1) Application of the reference level for dwellings (300 Bq/m^3)

2) Application of the dosimetric reference level of 10 mSv/year taking into account the exposure duration
3) Application of the relevant occupational exposure requirements when reasonable efforts do not reduce the concentration to levels below the 10 mSv/year reference level.

(Note: Assuming an equilibrium factor for radon decay products of 0.5, a radon gas concentration of 8.1 pCi/L would result in an annual dose of approximately 0.5 rem per year for 2,000 hours occupancy.)

The draft recommendations specific to the uranium mining industry note that regulatory authorities may apply the system of protection for planned exposure situations from the outset. Exposures should be controlled by the optimization process and the ICRP recommends a dose constraint or optimized dose. The recommendations also include use of real-time monitors and personal dosimeters in situations with high and variable radon concentrations. Periodic monitoring would be sufficient where radon concentrations are low and stable.

2.4 Other New ICRP Publications with Guidance not reviewed.

Two ICRP publications with implications for radiation control regulations have also been published within the last five years. The publications are not directly applicable to the establishment of a regulatory program but may impact the implementation of programs by licensees and review by regulatory bodies.

ICRP Publication 114 – Environmental Protection: Transfer Parameters for Reference Animals and Plants (2009b)

ICRP Publication 103 recommends that a set of reference animals and plants be developed as a basis for relating exposure to dose and dose to radiation effects for different types of animals and plants. The NRC is not considering additional regulations with regard to environmental protection at this time since it is still of the opinion that if humans are protected, the environment will also be protected. Therefore, Publication 114 is not likely to have an impact on federal and state regulations in the near term.

ICRP Publication 116 – conversion Coefficients for Radiological Protection Quantities for External Radiation Exposures (2010)

ICRP Publication 116 provides dose conversion coefficients for effective dose and organ doses for various types of external exposures in accordance with the recommendations of ICRP 103. No direct impact on regulations but may have an effect on how doses are calculated to demonstrate compliance with regulatory dose limits.

3.0 US NRC Response to ICRP 103 Recommendations

The US NRC is in the process of determining how the ICRP 103 guidance will be incorporated into federal regulations, and thus at some point, into agreement state regulations. While

not technically an ICRP document, the NRC memo in response to the ICRP recommendations is relevant to development of Virginia regulations regarding uranium recovery facilities. The NRC Staff memo to the Commission, Recommendations for Policy and Technical Direction to Revise Radiation Protection Regulations and Guidance (NRC, 2012), was made available in April, 2012 after a series of stakeholder meetings in 2010. The document includes a technical description of the issue and a discussion of the stakeholder comments. The three stakeholder meetings were aimed at specific audiences, i.e., nuclear power, medical, and industrial. In general, the stakeholders did not support a change in the dose limits. In summary, the NRC staff recommends that the Commission approve development of policy and technical information to:

1) Update the regulations to recognize and use current scientific information models, numerical values, and terminology for radiation exposure;
2) Reduce the occupational dose limit for effective dose, lens of the eye, and the embryo/fetus of a declared pregnant worker; and
3) Consider the benefits and impacts of increased use of the International System (SI) of units and the reporting of occupational exposure information by additional categories of licensees.

The NRC document notes that the ICRP reaffirmed the nominal value of 5×10^{-4} per rem for overall radiation risk, also recognizing the evolution towards consideration of morbidity as well as mortality, and a dose limit aimed at limiting the lifetime occupational dose to 100 rem. The NRC noted that the ICRP had recommended a change in the dose limit for the lens of the eye, from 15 rem/year to 2 rem/year (ICRP, 2011b).

The NRC document describes the issues raised by ICRP 103, the results of stakeholder interaction, the potential options and the staff recommendations for ten technical areas. Two of the issues are specific to nuclear power plants and are not applicable to uranium facilities so were not reviewed for this document:

1) Methodology and terminology

The staff recommends that the regulatory framework be updated to reflect the new terminology and dose calculation methodologies. (The document notes that the more recent dose coefficients for uranium and thorium are smaller than the 1977 dose coefficients. Licensees have requested permission to use the newer information.)

2) Limits for Occupational Total Dose Equivalent

The staff recommends pursuing changes to 10 CFR 20 to address occupational exposures near the current dose limit and that a reduction in the occupational Total Effective Dose Limit to 2 rem per year be explored in greater detail. The staff also recommended that a provision be developed to allow a licensee to use a dose limit of 5 rem in any one year, with a limit of 10 rem in five years.

3) Occupational Limit for the Lens of the Eye

The staff recommends a reduction in the dose limit for the lens of the eye to a value of 5 rem per year lens dose equivalent. (Note: This could be an issue for uranium recovery operations because of the relatively high energy of the Pa-234m beta particle (decay product of U-238).)

4) Occupational Limit for the Embryo/Fetus

The staff recommends a change in the dose limit for the embryo/fetus to 100 mrem applicable over the gestation period remaining after declaration to align the regulatory requirements to the scientific information that the embryo fetus is more sensitive to radiation.

5) ALARA Planning

Continue with the existing general requirement for ALARA but consider development of additional regulatory guidance. International recommendations for ALARA should not be adopted as regulatory requirements.

6) Protection of the Environment

The staff believes there is no need for additional requirements.

7) Units of Radiation Exposure and Dose

Consider modification of 10 CFR 20 to list dose units in SI first with English in parentheses and continue discussions with stakeholders to assess the implications of such a change.

8) Reporting of Occupational Exposure

Explore with stakeholders the specific benefits and impacts of requiring additional categories of licensees to report occupational exposure and work with agreement states to identify methods to increase the availability of the information.

Table 2: ICRP Recommendations Relevant to Virginia DEQ Uranium Regulations

Issue	Relevance to potential VA uranium regulations
Reduction in the occupational dose limit from 5 rem per year to 2 rem per year	The NRC is studying the potential impact of reducing the dose limit. The licensees most impacted would be medical institutions and nuclear logging licensees. Radiation doses in the uranium recovery industry are generally below 0.5 rem per year.
Reduction in the dose limit to the lens of the eye from 15 rem per year to 2 rem per year averaged over 5 years with no more than 5 rem in any single year.	If the dose limit to the lens of the eye is reduced to 2 rem per year based on new data that suggests a much lower threshold for induction of cataracts than previously assumed, the lens of the eye would be the limiting factor for occupational doses.
Dose limit to the fetus	The current dose limit to the fetus is 0.5 rem for the period of gestation. The ICRP 103 dose limit would be 0.1 rem from the time the pregnancy is declared to the birth of the child. Some concern has been raised with regard to whether a woman would deliberately avoid declaring her pregnancy in order to maintain a position where exposures in excess of the limit are possible.
Distinguishing between "planned exposures" and "existing exposures" with different dose limits for members of the public	Current regulations do not distinguish between existing exposures (e.g., contaminated land from previous NORM activities) and planned exposures that can be controlled in advance.
Draft radon dose limit for occupational exposure.	Exposure to radon concentrations at levels greater than 300 Bq/m3 (8.1 pCi/L) that are under the control of the employer, would be considered occupational doses, particularly in the uranium recovery industry.
Dose limits to members of the public	No change
Change to SI units and other terminology	Would impact VA regulations
Protection of the environment	NRC is not contemplating any changes at this time
ALARA programs	NRC is not contemplating any changes at this time but may produce more guidance for licensees; the NRC already has ALARA guidance for uranium recovery facilities (Regulatory Guide 8.31)
Establishment of constraints	The NRC has not suggested any changes. Stakeholders commented that constraints become de facto limits.

References:

ICRP, 1977. Recommendations of the International Commission on Radiological Protection, ICRP Publication 26, Ann. ICRP 1(3).

ICRP, 1993. Protection Against Radon-222 at Home and at Work. ICRP Publication 65. Ann. ICRP 23(2).

ICRP, 2007. The 2007 Recommendations of the International Commission on Radiological Protection. ICRP Publication 103, Ann. ICRP 37(2-4).

ICRP, 2008. Scope of Radiological Protection Control Measures. ICRP Publication 104.

ICRP, 2009a. International Commission on Radiological Protection Statement on Radon. ICRP Ref 00/902/09.

ICRP, 2009b. Environmental Protection: Transfer Parameters for Reference Animals and Plants. ICRP Publication 114, Ann. ICRP 39(6).

ICRP, 2010. Conversion Coefficients for Radiological Protection Quantities for External Radiation Exposures. ICRP Publication 116, Ann. ICRP 40(2-5).

ICRP, 2011a. Radiological Protection against Radon Exposure. Draft Report for Consultation. ICRP ref 4829-9671-6554. December 6.

ICRP, 2011b. Statement on Tissue Reactions. ICRP ref 4826-3093-1464. April 21.

U.S. Nuclear Regulatory Commission. 2012. Recommendations for Policy and Technical Direction to Revise Radiation Protection Regulations and Guidance. SECY-12-0064. April 25.