

OUTLINE

I. Introduction - What is uranium mining and why is it important?

Surface mining of uranium

Examples: St. Anthony uranium mine, NM – no reclamation more than 20 years after operations ended

Coles Hill deposit cross-section – much of the deposit is shallow enough for surface mine extraction

Exposure Pathways for Health and Environmental Risks of Uranium Mill Tailings/Gaseous Radon-222 Inhalation

Potential Health and Environmental Issues from Uranium Mill Tailings

II. International Atomic Energy Agency Guidance on Uranium Mine and Mill Waste Management – 1 – 6

Background, Radiological Protection of the Public, Non-radiological Considerations, Strategy for Waste Management, Options for Waste Management - Mill Tailings, and Other Wastes – mine waste.

Examples of mine and mill sites: France – mine and mill reclamation plan designed and implemented after closure of operations;

US – Three uranium mill tailings piles on the Superfund NPL due to groundwater contamination decades after releases detected

III. Concerns about Virginia Uranium Mining Regulations – 1 – 4

Existing regulations do not clearly provide: for full-third party cost of reclamation being covered in bonds; full recovery of cost of mine reclamation and natural resource damage; full recovery of cost of natural resource damage or control operations of “bad actors”, long-term monitoring and maintenance after reclamation; thorough hydrologic evaluation, monitoring or restoration; thorough acid drainage assessment, prevention or remediation;

Examples: South Carolina gold mines regulated by state mining legislation:

Ridgeway – Reclaimed and converted to non-profit ecological center, not returned to pre-mining land use;

Brewer – Operator abandoned site before reclamation; site generated 40 mil-long spill zone; on Superfund NPL

Gannon thesis recognized complex hydrology at Coles Hill not understood;

Jerden dissertation identified sulfide minerals with heavy metal content in Coles Hill deposits,

IV. Intermittent operations rather than continuous operations should be address in future permitting 1- 2

Uranium price fluctuations show sustained, long-term high price very unlikely

Example: Denison uranium mill – single operating uranium mill in the US, has had stop and start operations since licensing in 1979 including 2009-2010.

V. Emerging issues at reclaimed uranium mill tailings piles in the US – 1 – 4

Including: Cover deterioration including significant higher permeability than predicted; deep roots penetrating covers; groundwater protection standards exceeded at both “purpose-built” and “reclaimed in place” uranium mill tailings bill more than 15 years after completion of reclamation.

Examples: DOE long-term stabilization research

Uranium contamination increase at purpose-built Durango site

Uranium stand exceeded at Bluewater reclaimed in place tailings site

VI. Where will uranium come from in the next twenty years? 1 – 4

Including: Long-term supply assurance from IAEA; more US uranium licensing capacity in place or plan for next five years that projected by IAEA; Low level of uranium production from US needed to meet uranium demand projections for next 25 years.

Examples: US DOE and IAEA current and projected uranium production projections

Virginia Uranium Mining Moratorium

“Notwithstanding any other provision of law, permit applications for uranium mining shall not be accepted by any agency of the Commonwealth prior to July 1, 1984, and until a program for permitting uranium mining is established by statute.”

Virginia Code § 45.1-283 (1982)

What is uranium mine reclamation and why is it important?

EPA defines “mining reclamation” as the act of returning a mine to a long-term stable condition, or its original contour to ensure the safe reuse of the site by both current and future generations. **When possible, a reclamation plan aims to return the affected areas to previously existing environmental conditions. Differing views as to what is an acceptable environmental condition for reclaimed mining sites explain the varying regulatory requirements for uranium mining sites.** The existence of bonding requirements and/or financial guarantees in the cases where private parties are involved in the mine may also play an important role in determining the extent of reclamation.”

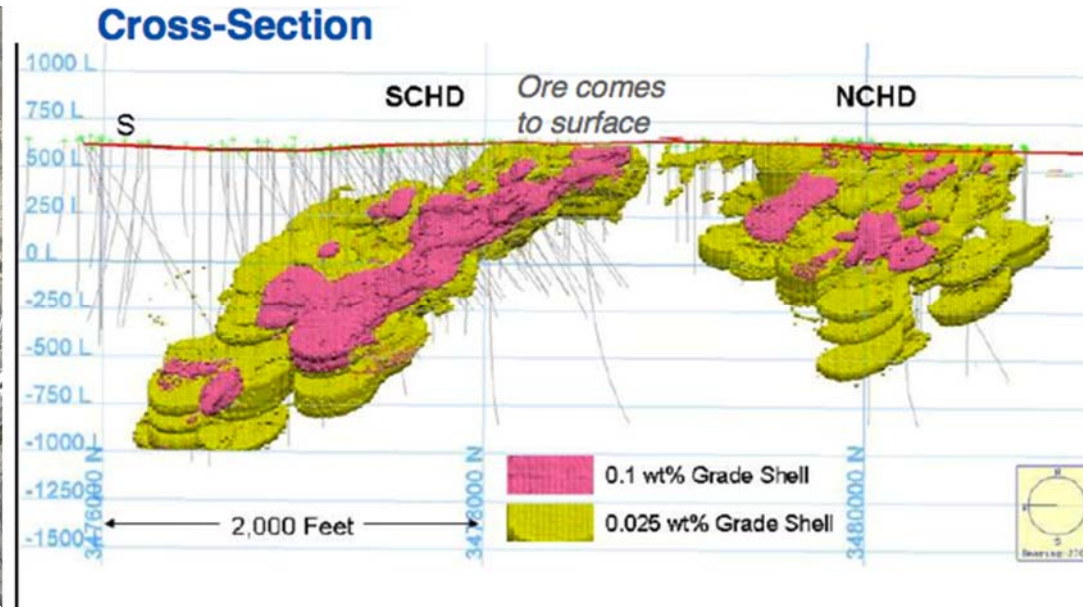
“Site reuse is a significant issue for radiation sites. The extent to which a uranium mine site can be reused for other purposes where humans may spend periods of time for work, recreation, or even residential purposes is highly dependent on the extent of cleanup and removal of the potential for radiation exposure. Therefore, the end state of reclaimed uranium sites and the techniques used to achieve the end state, will vary on a site-by-site basis, and dependent upon the regulatory agencies involved.” (Vol I P. 4-1)

“Wastes from conventional uranium mining (both surface and underground) are not subject to NRC regulation, but are considered to be TENORM, and thus subject to U.S. Environmental Protection Agency (EPA) and State agency oversight.” (Vol. 2 P. vi)

Source: <http://www.epa.gov/rpdweb00/tenorm/uranium.html>, <http://www.epa.gov/rpdweb00/tenorm/pubs.html#402-r-08-005i>
<http://www.epa.gov/rpdweb00/tenorm/pubs.html#402-r-08-005ii> *Technologically Enhanced Naturally Occurring Radioactive Materials From Uranium Mining*



St. Anthony open pit uranium mine, NM, unreclaimed more than 20 years after operations ended. Mine owner unsuccessfully challenged jurisdiction of NM Mining Act over uranium mines



Cross-sections of Coles Hill deposits shows both North and South deposits contain substantial volumes of higher grade uranium resources are shallow, <200 m, below surface – depths that provide potential for surface, or open pit, mining

SURFACE URANIUM MINING

“Uranium production from surface mining operations generates large volumes of overburden with either ambient or elevated, but below-ore-grade, concentrations of uranium and its decay products.

Smaller amounts of waste rock are produced by underground uranium mines. The ratio of overburden to ore has increased as less-accessible and lower-grade ores have been exploited. In the 1950s, the ratio was about 10:1; by the 1980s, it had increased to about 60:1. Most of the mines in question are in the western states: Arizona, Colorado, New Mexico, South Dakota, Texas, Utah, and Wyoming. A 1989 survey showed the average radium-226 concentration in uranium-mine overburden to be about 0.9 kBq/kg (25 pCi/g).

Those mining wastes are distinct from uranium mill tailings (UMT), which are the ore residues discharged to a waste pond after extraction of the uranium, typically by sulfuric acid leaching. “

Source: NAS (National Academy of Sciences). 1999a. *Evaluation of Guidelines for Exposures to Technologically Enhanced Naturally Occurring Radioactive Materials*. Washington, DC: National Academy Press, 1999, http://www.nap.edu/catalog.php?record_id=6360, p. 61.

Exposure Pathways for Health and Environmental Risks of Uranium Mill Tailings

“The[re are] five on-site environmental pathways through which these tailings impoundments pose a risk...

- “(i) The release of gaseous radon-222 to the atmosphere and subsequent inhalation
- (ii) Possible dust loading of contaminants from the impoundment due to natural wind conditions
- (iii) The localized effect of direct external gamma radiation exposure from the tailings impoundment
- (iv) Groundwater seepage and subsequent contamination of local aquifers, which has the potential to affect the water supply
- (v) Dam failure due to erosion or natural disasters (flood, earthquake, etc.)
- (vi) Improper use of tailings as a building material.”

Gaseous Radon-222 Inhalation

“Radon-222 is an inert radioactive gas that can readily diffuse to the surface of a tailings impoundment where it would be released to the atmosphere. **The main hazard of radon inhalation is the damage to the lung from four of its shorter-lived decay products (Po-218, Pb-214, Bi-214, and Po-214). Of particular concern are the two isotopes of polonium (Po-218 and Po-214), because they produce alpha particles, which are approximately 20 times more destructive than gamma or beta radiation.** Because radon-222 has a half-life of approximately 3.8 days, it has the opportunity travel a significant distance in the atmosphere before decaying. U.S. EPA (1983) states that the health of populations living at a distance greater than 80 km from a tailings pile might be affected. **The radon concentration at the edge of a typical tailings pile is approximately 4 pCi/l (WISE 2004). Using the methodology outlined in Chapter 1 of [TENORM VOL. 2], a year-long exposure under these conditions would correspond to a lifetime risk of lung cancer of 1.1×10^{-2} [1:110].”**

<http://www.epa.gov/rpdweb00/tenorm/pubs.html#402-r-08-005ii> *Technologically Enhanced Naturally Occurring Radioactive Materials From Uranium Mining Volume 2: Investigation of Potential Health, Geographic, and Environmental Issues of Abandoned Uranium Mines,*

Potential Environmental and Health Issues from Mill Tailings

The wastes produced during the milling process and stored in tailings impoundments are the principal source of milling-related health and environmental hazards.

Typical properties of these mill tailings are shown in Table AIV-1 [below]. During the milling process, nearly 90% of the uranium contained in the ore is removed, and so the primary radiological concern is the remaining progeny associated with uranium such as thorium, radium, radon, and lead.

The actual activity of these uranium progeny can vary depending on the specific methods employed; however, as much as 50- 86% of the original activity of the ore is retained in the mill tailings.

Hazardous stable elements are also extracted from the ore and transferred to the tailings piles, including arsenic, copper, selenium, vanadium, molybdenum, and other trace heavy metals. (Vol. 2 - App. IV)

Table AIV-1: Typical Properties of Uranium Mill Tailings

This table displays the chemical and radiological properties of the three classifications of uranium mill tailings (sand, slime, and liquid). Table was adapted from U.S. NRC 1980 and found in U.S. EPA 2006

Tailings Component	Particle Size (µm)	Chemical Composition	Radioactivity Characteristics
Sands	75 to 500	SiO ₂ with <1 wt% complex silicates of Al, Fe, Mg, Ca, Na, K, Se, Mn, Ni, Mo, Zn, U, and V; also metallic oxides	0.004 to 0.01 wt % U ₃ O ₈ ^a Acid Leaching: 26-100 pCi ²²⁶ Ra/g; 70 to 600 pCi ²³⁰ Th/g
Slimes	45 to 75	Small amounts of SiO ₂ , but mostly very complex clay-like silicates of Na, Ca, Mn, Mg, Al, and Fe; also metallic oxides	U ₃ O ₈ and ²²⁶ Ra are almost twice the concentration present in the sands Acid leaching: ^b 150 to 400 pCi ²²⁶ Ra/g; 70 to 600 pCi ²³⁰ Th/g
Liquids	^c	Acid leaching: pH 1.2 to 2.0; Na ⁺ , NH ₄ ⁺ , SO ₄ ²⁻ , Cl, and PO ₄ ³⁻ ; dissolved solids up to 1 wt % Alkaline leaching: pH 10 to 10.5; CO ₃ ²⁻ and HCO ₃ ⁻ ; dissolved solids 10 wt %	Acid leaching: 0.001 to 0.01% U; 20 to 7,500 pCi ²²⁶ Ra/L; 2,000 to 22,000 pCi; ²³⁰ Th/L Alkaline leaching: 200 pCi ²²⁶ Ra/L; essentially no ²³⁰ Th (insoluble)

^a U₃O₈ content is higher for acid leaching than for alkaline leaching

^b Separate analyses of sands and slimes from alkaline leaching process are not available. However, total ²²⁶Ra and ²³⁰Th contents of up to 600 pCi/g (of each) have been reported for the combined sands and slimes.

^c Particle size does not apply. Up to 70 % vol. of the liquid may be recycled. Recycle potential is greater in the alkaline process.

<http://www.epa.gov/rpdweb00/tenorm/pubs.html#402-r-08-005ii> Technologically Enhanced Naturally Occurring Radioactive Materials From Uranium Mining Volume 2: Investigation of Potential Health, Geographic, and Environmental Issues of Abandoned Uranium Mines,

INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA)

GUIDANCE ON URANIUM MINE AND MILL WASTE MANAGEMENT - 1

INTRODUCTION – BACKGROUND: 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.

Radioactive waste arises from all stages of mining and milling processes and includes, in addition to mill tailings, waste rock¹, mineralized waste rock² and process water, including leaching solutions. Rainfall and snowmelt runoff and seepage from stockpiles and areas of uranium process plants should also be managed.

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.

¹ Waste rock is material that is excavated from a mine and which does not present any significant radiological hazard requiring management to protect human health or the environment. Waste rock may still require management for other reasons, such as to control erosion to prevent the siltation of local surface water bodies.

² Mineralized waste rock is material that is excavated from a mine and which has chemical and/or radiological characteristics which necessitate its management to protect human health or the environment.

France – Uranium mine and mill reclamation designed and implemented after closure of mine and mill operations is not likely to be permit-able in most uranium mining districts.



IAEA GUIDANCE ON URANIUM MINE AND MILL WASTE MANAGEMENT - 2

RADIOLOGICAL PROTECTION OF THE PUBLIC - 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 with the BSS¹.

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.

Although mining and milling waste contains only naturally occurring radionuclides, these radionuclides cannot be considered to be in their original states or concentrations, since their physical and chemical forms may have been altered substantially, and exposures may be influenced by the operation of the waste management facilities. Exposures attributable to such waste should not be regarded as exposure to natural background radiation and exposures of the public attributable to all mining and milling waste should be included in the system of radiation protection for practices as required in the BSS¹.

Source: "MANAGEMENT OF RADIOACTIVE WASTE FROM THE MINING AND MILLING OF ORES - SAFETY GUIDE," INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 2002, p. 10, http://www-pub.iaea.org/MTCD/publications/PDF/Pub1134_scr.pdf

¹ BSS - International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No. 115, IAEA, Vienna (1996).

US – Three uranium mill tailings piles remain on the Superfund National Priorities List more than 30 years after groundwater contamination was discovered and more than 20 years after closure.



Cotter – Canon City, CO
Uranium Mill and Tailings

Image © 2011 DigitalGlobe



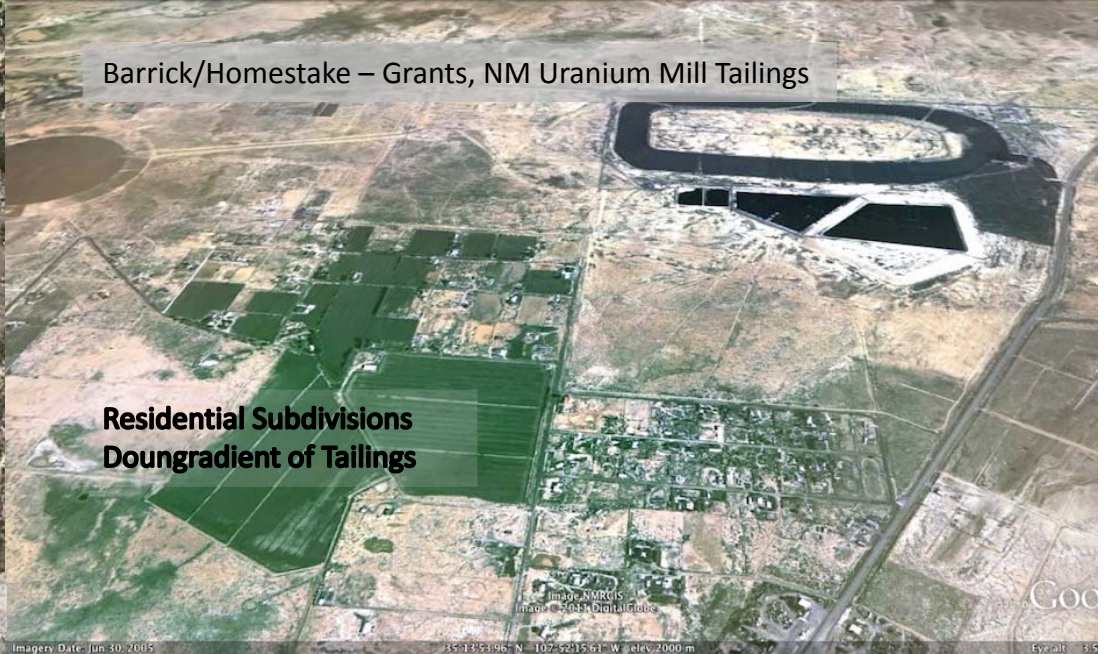
Rio Algom/Kerr
McGee Mine

Navajo Homes

GE/UNC -
Northeast
Churchrock
Mine

GE/United Nuclear – Churchrock, NM Uranium Mill Tailings

35° 39' 02.19" N 108° 30' 31.18" W elev 2135 m



Barrick/Homestake – Grants, NM Uranium Mill Tailings

Residential Subdivisions
Downgradient of Tailings

Image NMRGIS
Images © 2011 DigitalGlobe

Imagery Date: Jun 30, 2005

35° 13' 54.96" N 107° 52' 15.61" W elev 2000 m

Eye alt: 3.5

IAEA GUIDANCE ON URANIUM MINE AND MILL WASTE MANAGEMENT - 3

NON-RADIOLOGICAL CONSIDERATIONS: Waste from mining and milling activities will also give rise to non-radiological hazards to humans and to the environment. Some of these non-radiological hazards will be similar to those arising from other mining and milling activities. Both radiological and non-radiological hazards should be taken into account in planning the management of this waste.

For radioactive contaminants, any chemical toxicity may cause deleterious environmental impacts at concentrations well below those necessary to produce radiological effects. Such concentrations may occur even for releases that comply with criteria established specifically for the radiological protection of humans, especially if the critical group is distant from the source.

These potential impacts should be considered at the planning stage of a mining and milling project and should be periodically reassessed throughout the project's lifetime. Good mining practice should be followed in a manner consistent with the need for radiological protection, while it is sought to minimize the contaminant source terms, sediment loads and acid generation by means of careful design, construction, operation and closure. Any release of contaminants and sediments to the receiving environment should comply with the criteria prescribed by the appropriate regulatory body.

Various processes should be considered in assessing these impacts. For example, contaminants may be transported to the environment by seepage and surface runoff (dissolved contaminants and suspended sediments) and in mine effluents. Acid mine drainage is a particular concern with sulphidic ores. Acid generation can lead to a reduction in the pH of adjacent water systems and an increase in the mobilization of contaminants, particularly heavy metals, which may adversely affect surface water ecosystems. In addition to chemical effects, sediments arising from erosion at waste management facilities may increase turbidity or cause excessive siltation in surface water systems within the catchment area, damaging downstream ecosystems. In addition to chemical effects, sediments arising from erosion at waste management facilities may increase turbidity or cause excessive siltation in surface water systems within the catchment area, damaging downstream ecosystems.

Source: "MANAGEMENT OF RADIOACTIVE WASTE FROM THE MINING AND MILLING OF ORES - SAFETY GUIDE," INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 2002, p. 13-14, http://www-pub.iaea.org/MTCD/publications/PDF/Pub1134_scr.pdf

IAEA GUIDANCE ON URANIUM MINE AND MILL WASTE MANAGEMENT - 4

STRATEGY FOR WASTE MANAGEMENT: 4.1 The principles of radioactive waste management set out in the IAEA Safety Fundamentals (see Ref. [3], para. 107) apply to the goals of waste management strategies for mining and milling waste.

4.2. The development of a waste management strategy is usually a complex process that has the aim of achieving a reasonable balance between two, often conflicting, goals: maximization of risk reduction and minimization of financial expenditure. The process is one of optimization of protection in which the available alternatives for siting, design and construction, operation, management of waste streams, and closure are evaluated and compared, with account taken of all associated benefits and detriments and any constraints (such as an annual dose constraint) that are required to be imposed. The characteristics of the alternatives (or options) that should be considered include: (a) The radiological and non-radiological impacts on human health and the environment during operation and in the future; (b) The requirements for monitoring, maintenance and control during operation and after closure; (c) Any restrictions on the future use of property or water resources; (d) The financial costs of the various alternatives and the resources available for implementing the alternatives; (e) The volumes of the various wastes to be managed; (f) The socioeconomic impacts, including matters relating to public acceptance; (g) Good engineering practices.

4.3. The steps taken towards deciding how to manage the waste arising from mining and milling facilities should include: (a) Definition of the criteria for human health and environmental protection; (b) Characterization of the waste; (c) Identification and characterization of the site options; (d) Identification and characterization of the waste management options, including engineering controls; (e) Identification and description of options for institutional control; (f) Identification and description of potential failures of institutional and engineering controls; (g) Definition and characterization of the critical group of the population; (h) Estimation of the radiological and other consequences for each combination of options being considered (the 'safety analysis'), including scenarios of potential exposure for each option; (i) Comparison of the estimated doses and risks with appropriate constraints; (j) Optimization of protection so as to arrive at the preferred management option.

4.4. The evaluation criteria and procedures used to select the preferred options and to develop the waste management strategy that will achieve the optimal balance among the above considerations should be clearly defined and presented to the different interested parties in the project, including the public.

4.5. The design of mining and milling facilities will influence the optimization of protection from exposure due to radioactive waste and should therefore be considered with waste management in mind. The mining and milling activities should be designed to reduce, as far as practicable, the amount of waste to be managed. This can be accomplished through the choice of appropriate mining methods and milling processes, and the recycle and reuse of equipment, materials and waste.

4.6. The closure of the waste management facilities should be considered in all phases of the mining and milling operation, that is, during siting, design, construction and operation. Planning for the management of mining and milling waste at closure should not be delayed until the closure stage. For example, taking measures at an early stage to reduce the migration of water-borne and airborne contamination to the surrounding environment will facilitate management of the closure phase.

4.7. The design, construction, operation and closure of facilities for the management of waste from mining and milling should be in accordance with the elements of a quality assurance programme as outlined in Section 7. In particular, facilities should be constructed, operated and closed only according to approved plans and procedures.

4.8. Paragraphs 4.9–4.27 outline the important characteristics and desirable features of the options that should be considered in the siting and management of waste from mining and milling, considerations in the design, construction, operation and closure of facilities, and procedures for the release of materials.

IAEA GUIDANCE ON URANIUM MINE AND MILL WASTE MANAGEMENT - 5

OPTIONS FOR WASTE MANAGEMENT TAILINGS: 4.9 Of the different waste streams produced by mining and milling operations, tailings represent the greatest challenge, particularly in terms of long term management, because of the large volumes produced and their content of very long lived radionuclides and heavy metals. The preferred management option for achieving the protection goals will depend on specific conditions at the site, the characteristics of the ore body, the specifics of the mining and milling processes, and the characteristics of the tailings.

4.10. To conform to the principles for managing radioactive waste [3], access to and dispersion in the environment of the hazardous constituents of the tailings should be restricted for long periods into the future. The key issues which should be considered in the design of a tailings management facility include: (a)The stability of the pit, underground mine void, or surface impoundment in relation to natural processes such as earthquakes, floods and erosion. (b)The hydrological, hydrogeological and geochemical characteristics of the site. (c)The chemical and physical characteristics of the tailings in relation to the potential for the generation and transport of contaminants. (d)The volume of material that will be retained on the site as waste. (e)The use of neutralization agents, radium precipitating additives, artificial or natural liners, radon barriers and evaporation circuits, with the reliability, longevity and durability of such agents factored in.

4.11. A thorough investigation of these issues should be undertaken at an early stage when considering options for the management of tailings. Details on the application of relevant technologies can be found in other IAEA pubs [18, 19].

4.12. The design of a facility for the management of tailings should incorporate drainage systems to consolidate tailings before closure and to reduce excess pore water pressure. In the case of a surface impoundment or a pit, this could be achieved by the installation of a drainage system prior to or during the emplacement of tailings, or by the use of wicks driven into the tailings after emplacement. The base and cap of the impoundment should be built of a material of low permeability, if possible using material of natural origin. The addition of a stabilizing agent (such as cement) to the tailings immediately prior to their deposition has the potential to reduce significantly the permeability of the tailings mass, thus retarding the transport of contaminants and binding any pore water. However, in certain cases, a confined, poor quality water covering in a pit may possess excellent characteristics as a radon barrier, thereby obviating the need to perform dewatering to any significant degree. The decision on which approach to take should be optimized so as to match barrier characteristics with available site conditions. In the case of disposal in underground mines, the increase in structural integrity gained by using concrete with the tailings mass may allow mining to be continued immediately adjacent to the tailings. Prior to adopting this strategy, possible chemical interactions between the stabilizing agent, the tailings and the host rock should be carefully investigated to ensure that the transport of contaminants would not be enhanced at some time in the future.....

IAEA GUIDANCE ON URANIUM MINE AND MILL WASTE MANAGEMENT - 6

Other wastes 4.23 Other solid and liquid wastes that are generated in the mining and milling of ores and which should be managed throughout the lifetime of the mining and milling facilities include sludges, contaminated materials, waste rock, mineralized waste rock, process water, leaching fluids, seepage and runoff. Of these other wastes, waste rock and mineralized waste rock are generally the more difficult to manage. The management of sludges and contaminated materials should be undertaken in compliance with the requirements and recommendations established in other IAEA safety standards [10, 20]. It should be ensured that all material placed in the disposal facility for tailings waste meets the closure requirements.

4.24. While the radiological hazards associated with waste rock and mineralized waste rock are usually much less significant than those for tailings, non-radiological hazards will remain and should be recognized as often being among the more important matters to be considered in the selection and optimization of management options. There are many possible options for managing waste rock and mineralized waste rock. Whichever management option represents the optimum one will depend on the particular mineralogy, radioactivity and chemical reactivity of these wastes.

4.25. Options for managing waste rock and mineralized waste rock include their use as backfill materials in open pits and in underground mines, and for construction purposes at the mine site. The need to cover mineralized waste rock with inert waste rock should be taken into account.

4.26. As with tailings, consideration should be given to the extent to which the various options will help ensure that, when managed on the surface, piles of waste rock and mineralized waste rock are stable and resistant to erosion and rainwater infiltration, and do not result in unacceptable environmental impacts on the water catchment area.

4.27. The main liquid waste will include: process water; leaching fluids; rainfall runoff from the process plant area, waste management area and ore stockpiles; seepage from mill tailings, stockpiles and waste rock disposal areas; and mine water (for example, groundwater which has entered open pits or underground mines). **All liquid waste should be managed on the basis of its quality and quantity, with account taken of environmental and human health impacts, rather than on the basis of its sources.** The water management system should be designed to minimize the volume of contaminated water. This could be achieved, for example, by the diversion of clean water away from sources of contamination, the reuse of wastewater in the process circuit and the use of wastewater for dust suppression.

Concerns about Virginia Uranium Mining Regulations - 1
Virginia's current metal mining regulations do not clearly provide full third-party cost covered by financial assurance for mine reclamation and appear to limit reclamation bonds to \$1,000/acre.



Kennecott – Ridgeway gold mine and mill complex, South Carolina

Reclaimed Mine and Mill Tailings as Center for Ecological Research – South Carolina

http://naturalsciencesacademy.org/Research_CER.htm

The Kennecott Ridgeway Mine is located in Fairfield County, South Carolina, approximately five miles east of the town of Ridgeway and 25 north of Columbia, the state capital. Ridgeway was an open cut, precious metal mine that operated from 1988 to 1999.

The entire operation is on private land. During its 10 years of operation, the mine worked to improve relations with local communities by actively engaging mine opponents and through information sharing and regular site meetings with local community groups to discuss mining plans and issues of community concern. When operations ceased at the Ridgeway Mine in November 1999, the Kennecott Minerals Company implemented successful reclamation and closure plan designed to minimize environmental impacts on the site's land. Since the end of mining operations, all previously disturbed land surfaces have been subsequently reclaimed and restored, or retained for future sustainable uses. In October 2002, Ridgeway signed a Memorandum of Understanding with the Southeastern Natural Sciences Academy to create the Center for Ecological Restoration on the site of the reclaimed mine. The Center focuses on providing environmental education and research about sustainable programs for economic growth, balanced with environmental protection.

Reclaimed Hard Rock Mines and Tailings Piles in the South: South Carolina - 1

The reclaimed Ridgeway gold mine and mill tailings site has become a Center for Ecological Research

Concerns about Virginia Uranium Mining Regulations - 2

Virginia's current metal mining regulations do not clearly provide for recovery of the full cost of natural resource damage or control operations by "bad actors"



Brewer Gold Mine Superfund Site – EPA ID SCD987577913

"Brewer Gold Company owns approximately 1,000 acres of land along a small north-south ridgeline that divides Little Fork Creek and the Lynchies River. About one-quarter of the 1,000 acres has been disturbed by mining operations. Brewer Gold Mine was one of the oldest and most productive gold mines in the eastern United States.

"Brewer Gold Company, a subsidiary owned by the British Costain Limited Group (Costain), secured ownership of the mine in 1986, with the first gold production occurring in August 1987. Ore was mined using conventional open pit methods until January 1995. ...Waste rock was used as fill for facility construction or hauled to a disposal area to the south of the Brewer Pit

After 1995, Costain/Brewer maintained a minimum presence at the mine to pump and treat acidic ground water seeps with a high metal loading to keep them from entering Little Fork Creek. In the process, seep water is pumped into a double-lined 18,000,000-gallon lagoon. Treated water and sludge are stored in an unlined 3-acre basin. The treated water is eventually discharged to Little Fork Creek under a State-issued National Pollutant Discharge Elimination System (NPDES) permit.

On November 11, 1999, Costain abruptly shut down all activity at the mine despite, and in violation of, several Consent Orders with South Carolina Department of Health and Environmental Control (SCDHEC)."

"In 1990, a failure of an overflow pond at the mine resulted in a release of a sodium-cyanide solution containing cyanide, copper, and mercury. This release caused a fish kill along 49 miles of the Lynchies River. Sampling investigations conducted subsequent to the overflow pond failure have shown that releases of chromium, cobalt, nickel, and selenium also have occurred. Metals, including copper and mercury, have been detected in ground water underlying the former mining activities." Source: <http://www.epa.gov/superfund/sites/npl/nar1725.htm>

Reclaimed Hard Rock Mines and Tailings Piles in the South: South Carolina - 2

The Brewer gold mine and heap-leach tailings complex was abandoned by its owner after permit violations and liquid waste spills and is now a Superfund Site.

Concerns about Virginia Uranium Mining Regulations - 3

Virginia's current metal mining regulations do not clearly provide long-term monitoring and maintenance after reclamation is completed

DEFUNCT URANIUM MINE CONTAMINATING GROUNDWATER NEAR RESERVOIR

By Bruce Finley *The Denver Post* April 16, 2010

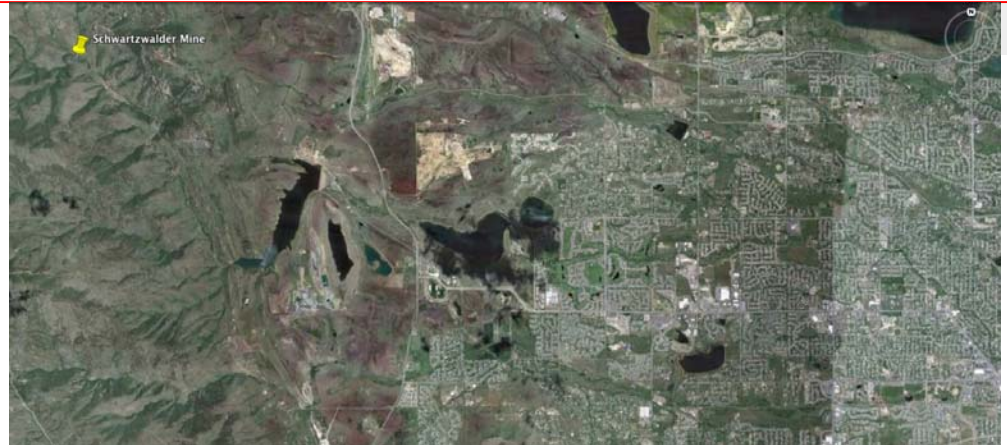
A defunct uranium mine in Jefferson County is contaminating groundwater near a reservoir, but government regulators and mine executives have not yet settled on a plan for cleanup.

Uranium concentrations in groundwater 30 feet beneath the brim of the Schwartzwald Mine exceed the human health standard for uranium by more than 1,000 times, according to state records reviewed Thursday.

Unhealthy concentrations also were detected in Ralston Creek, which eventually enters Denver Water's Ralston Reservoir. The reservoir supplies water to Denver and Arvada.



Photo by mining inspectors of Schwartzwald mine west of Denver along Ralston Creek. (CO Division of Reclamation, Mining and Safety) http://www.denverpost.com/news/ci_16129132



Post-April 2010 Chronology

- **State board imposes additional \$39,000 penalty against Cotter for failure to clean up contaminated mine water at Schwartzwald: DP** Nov. 18
- Cotter sues Colorado over cleanup order for contaminated mine water at Schwartzwald: DP Oct. 7
- **Cotter defies State orders to clean up contaminated mine water at Schwartzwald: DP** Sep. 21
- Cotter performs only partial cleanup of contaminated mine water at Schwartzwald: DP Aug. 27
- **Water cleanup started at closed Schwartzwald uranium mine: DP** July 9
- **Cleanup set for uranium-tainted water at closed Schwartzwald: DP** June 15
- **State rejects plan for water cleanup of Cotter's defunct Schwartzwald: DP** May 21

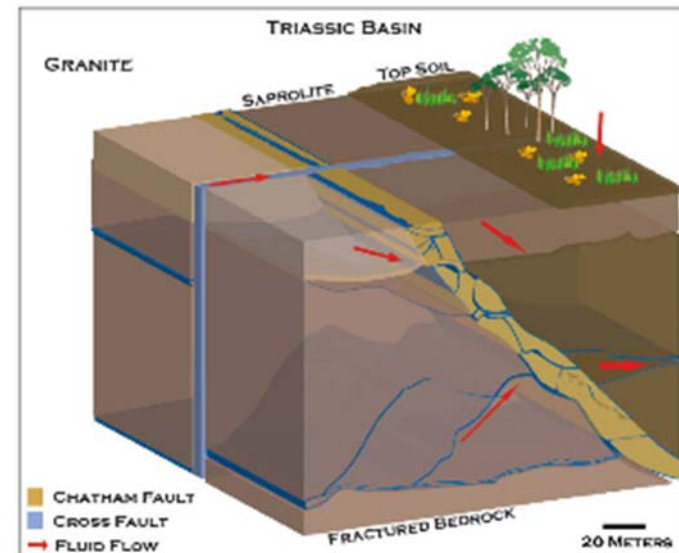
Source: <http://www.wise-uranium.org/umopusa.html#SCHWARTZW>

No Schwartzwald Mine page or links identified on CO Division of Reclamation, Mining and Safety page at <http://mining.state.co.us/>

UNDERGROUND URANIUM MINE WATER TREATMENT AND DISCHARGE PROBLEMS CAN OCCUR YEARS AFTER CLOSURE AS AT SCHWARTZWALDER URANIUM MINE, COLORADO

Concerns about Virginia Uranium Mining Regulations - 4

Virginia's current metal mining regulations do not clearly provide for thorough hydrologic assessments, thorough ground and surface water monitoring or groundwater restoration.



Conceptual model of groundwater flow at the South Springs Study area, Coles Hill, VA

Conclusions

“The data collected in this study characterizes the hydrogeology of the south spring site area of Coles Hill as a complexly interconnected system of fractures in the upper 100 m of bedrock. Water moves through a network of fractures, with the abundance of fractures generally decreasing with depth. The fracture networks can produce small or large amounts of water and are often connected with one another.”

“This study has illustrated the complexity of hydrogeology of the Coles Hill area. The question of origin of recharge for the site remains unanswered, we can only speculate knowing the nature of flow at the site and the general age of the water.”

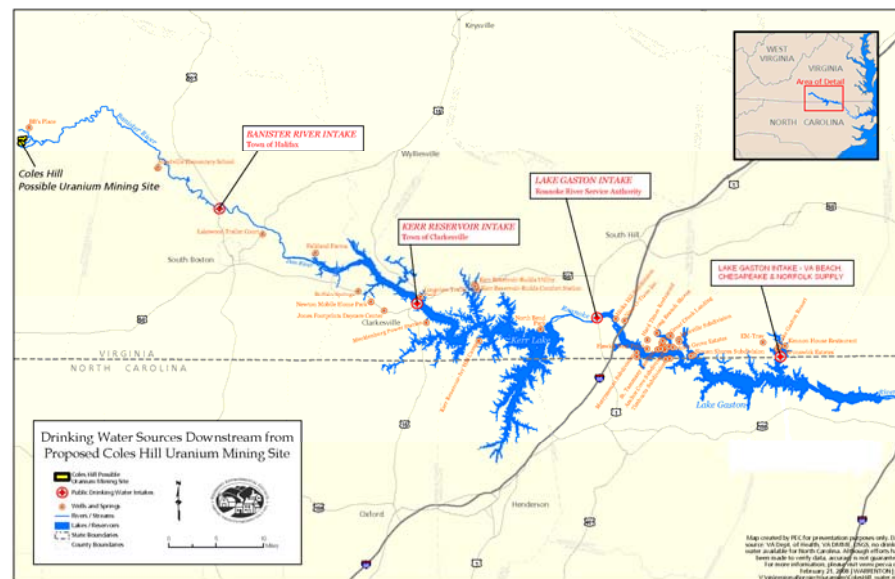
“It is clear from this study that a more detailed hydrogeologic investigation surrounding the deposit is warranted in order to make any conclusions about the effects a potential mine would have on the groundwater of the area surrounding Coles Hill.”

Source: Gannon, JP, Evaluation of Fracture Flow at the Coles Hill Uranium Deposit in Pittsylvania County, VA using Electrical Resistivity, Bore Hole Logging, Pumping Tests, and Age Dating Methods, 2009

http://scholar.lib.vt.edu/theses/available/etd-09242009-102707/unrestricted/Gannon_JP_T_2009.pdf

Concerns about Virginia Uranium Mining Regulations - 5

Virginia's current metal mining regulations do not clearly provide for thorough assessment of acid drainage potential, or acid drainage generation methods in mine operation and reclamation plans.



The calcite-uraninite assemblage occurs mostly as 10 to 100 micron thick zones along the margins of calcite +pyrite veins that containing accessory chalcopyrite, sphalerite and trace amounts of galena. The sequence of mineral growth within these veins is: (1) hematite and trace amounts of uraninite along vein walls, (2) calcite and uraninite in vein interiors, (3) sulfides (pyrite, sphalerite, galena) along calcite grain boundaries. p. 13

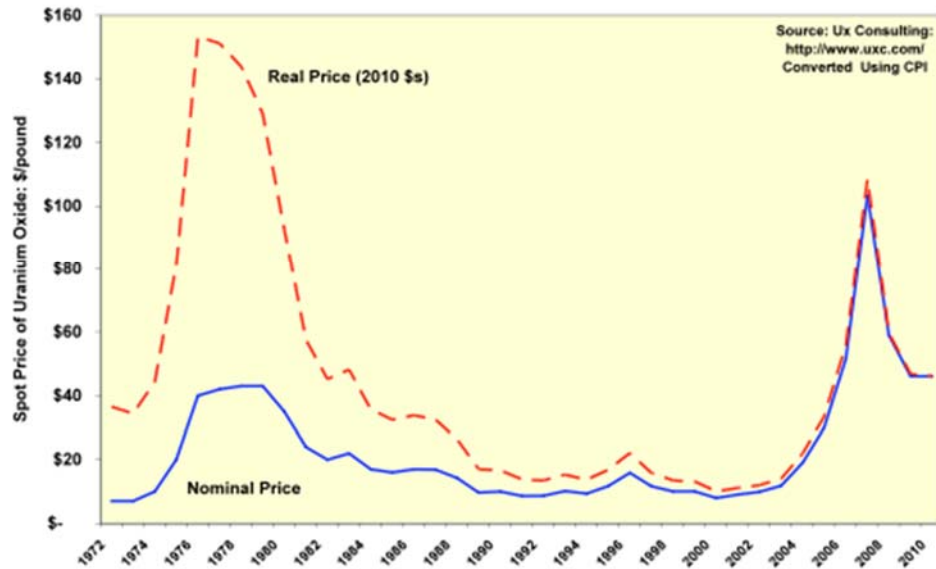
The Coles Hill primary ore contains three distinct U(IV)-mineral assemblages (see Chapter 1). The oldest and most abundant consists of fine-grained (10-20 microns long) fluor- apatite laths surrounded by thin (0.5–5 micron) rims of crypto-crystalline coffinite. Fracture zones that host this assemblage also contain minor amounts of uraninite, subhedral coffinite, chlorite, titanium oxides and accessory sulfides. The apatite-coffinite assemblage is cross-cut by fractures containing coarse-grained calcite, colloform uraninite, minor coffinite and accessory sulfides. These zones are cross-cut by fractures containing massive barium zeolite (harmotome), colloform uraninite, coffinite, pyrite, quartz and titanium oxides. All three primary uranium mineral assemblages are locally cross-cut by barren fracture zones and veins containing barite, quartz or calcite +/- sulfides. P. 51

Source: Jerden, JL, Origin of Uranium Mineralization at Coles Hill Virginia (USA) and its Natural Attenuation within an Oxidizing Rock-Soil-Ground Water System, 2001

<http://scholar.lib.vt.edu/theses/available/etd-10032001-141240/unrestricted/JerdenDissertation.pdf>

Intermittent – “start and stop cycle” - rather than continuous operations should be addressed for future uranium mine and mill permits - 1

Uranium Spot Market Prices: Annual Average, Nominal and Real



The uranium market has been subject to major fluctuations since it became commercial in the early 1970s. Intermittent operations, like at the Denison-White Mesa uranium mill in UT and Denison mines in UT and AZ, are much more likely than continuous, multi-decade operations of uranium mines and mills projected by VA mine owners. Stop and start operations require planning for long-term stand-by status or closure prior to completion of projected operations

Powers, T. M., Socio-economic Analysis of Impact of Proposed Pinon Ridge Uranium Mill..., Dec 2010, P. 71

http://www.sheepmountainalliance.org/ftp/SOCIOECON/SOCIOECON_comments.pdf



Intermittent – “start and stop cycle” - rather than continuous operations should be addressed for future uranium mine and mill permits - 2

White Mesa Uranium Mill, near Blanding UT - Owned and Operated by Denison Mines. Has operated intermittently for most of the past 30 years. Tailings cell liner had to be replaced after long-term exposure to open air prior to use for tailings disposal. The only currently operating uranium mill in the US.

1980's

circa 2006



“Our costs are higher than the current spot market price,” said Denison Mines President Ron Hochstein when he announced that Denison's White Mesa Mill, the nation's only operating uranium mill, has ceased its regular milling operations for the remainder of the year in May 2009.

- <http://www.wise-uranium.org/umopwm.html>

“Costs of mining & milling surpasses current spot price (\$44.00/lb - 4/09)”.

Denison cost of mining and milling: - 2008 U.S. unit cost: \$65.86/lb

- 2008 CDN unit cost: \$55.29/lb”

http://www.denisonmines.com/SiteResources/data/MediaArchive/pdfs/investor_presentations/agm_apr_30_09_web.pdf


Emerging Issues at Reclaimed Tailings Sites - 1

Got It Covered?
Design, Performance, and Renovation of Disposal Cell Covers at DOE Legacy Waste Sites

April 17, 2008

Jody Waugh
 S.M. Stoller Corporation*
 Grand Junction, Colorado

*S.M. Stoller Corporation for the U.S. Department of Energy
 Office of Legacy Management under DOE contract no. DE-AC01-02GJ79491.



<http://www.swanaoregon.org/Docs/Symposium%202008/Session%202/Jody%20Waugh%20Got%20it%20Covered.pdf>



“Woody plants root through compacted soil layers. Likely causes:

- Soil structure developing faster than predicted;
- plant roots and burrowing animals;
- Freeze-thaw cracking and desiccation; and
- well developed borrow soils”

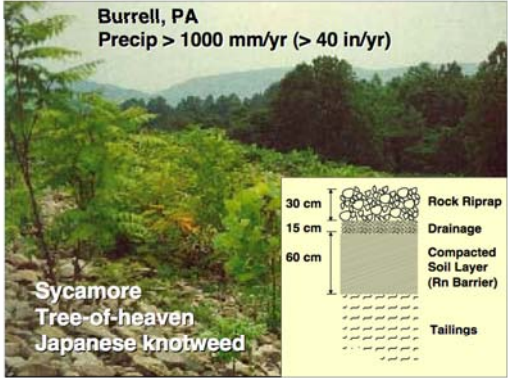
ISSUES RELATED TO LONG-TERM STABILIZATION AT RECLAIMED URANIUM MILL TAILINGS IN ARID AND HUMID CLIMATES FOCUS OF DOE RESEARCH

- SEE 2010 DOE-EM LONG-TERM SURVEILLANCE AND MAINTENANCE CONFERENCE PRESENTATION AT [HTTP://WWW.LM.DOE.GOV/LTSM_CONFERENCE/INDEX.HTM](http://www.lm.doe.gov/LTSM_CONFERENCE/INDEX.HTM) AMONG OTHER SOURCES

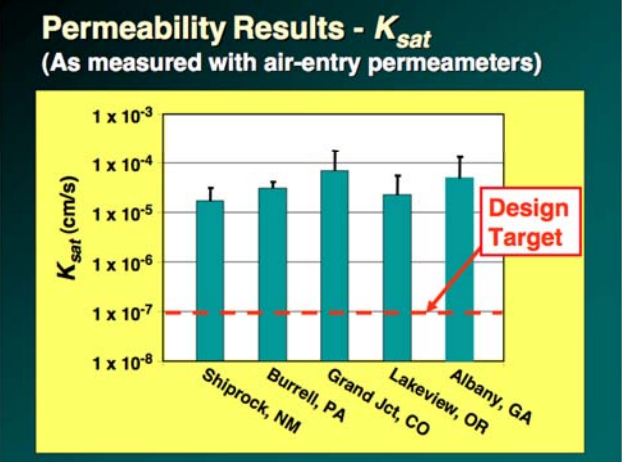
Some Lessons Learned

Conventional Covers

- ◆ Rock covers create habitat for deep-rooted plants
- ◆ Root intrusion and soil development increase the permeability of compacted soil layers
- ◆ High percolation rates have raised concerns about long-term groundwater protection
- ◆ Conventional covers will likely require high levels of maintenance or renovation to sustain long-term performance



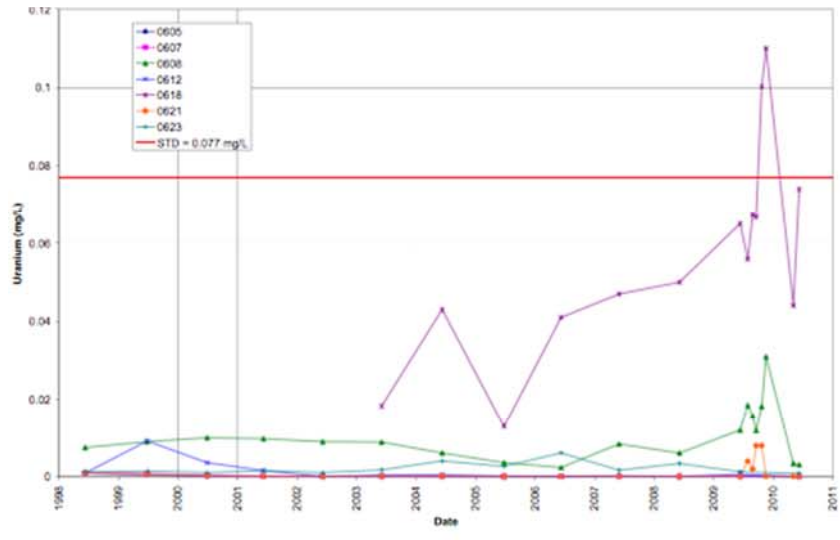
“Rock covers create habitat for deep-rooted plants”



“Root intrusion and soil development increase permeability and percolation 100x-1000x greater than design target”

Emerging Issues at Reclaimed Tailings Sites - 2

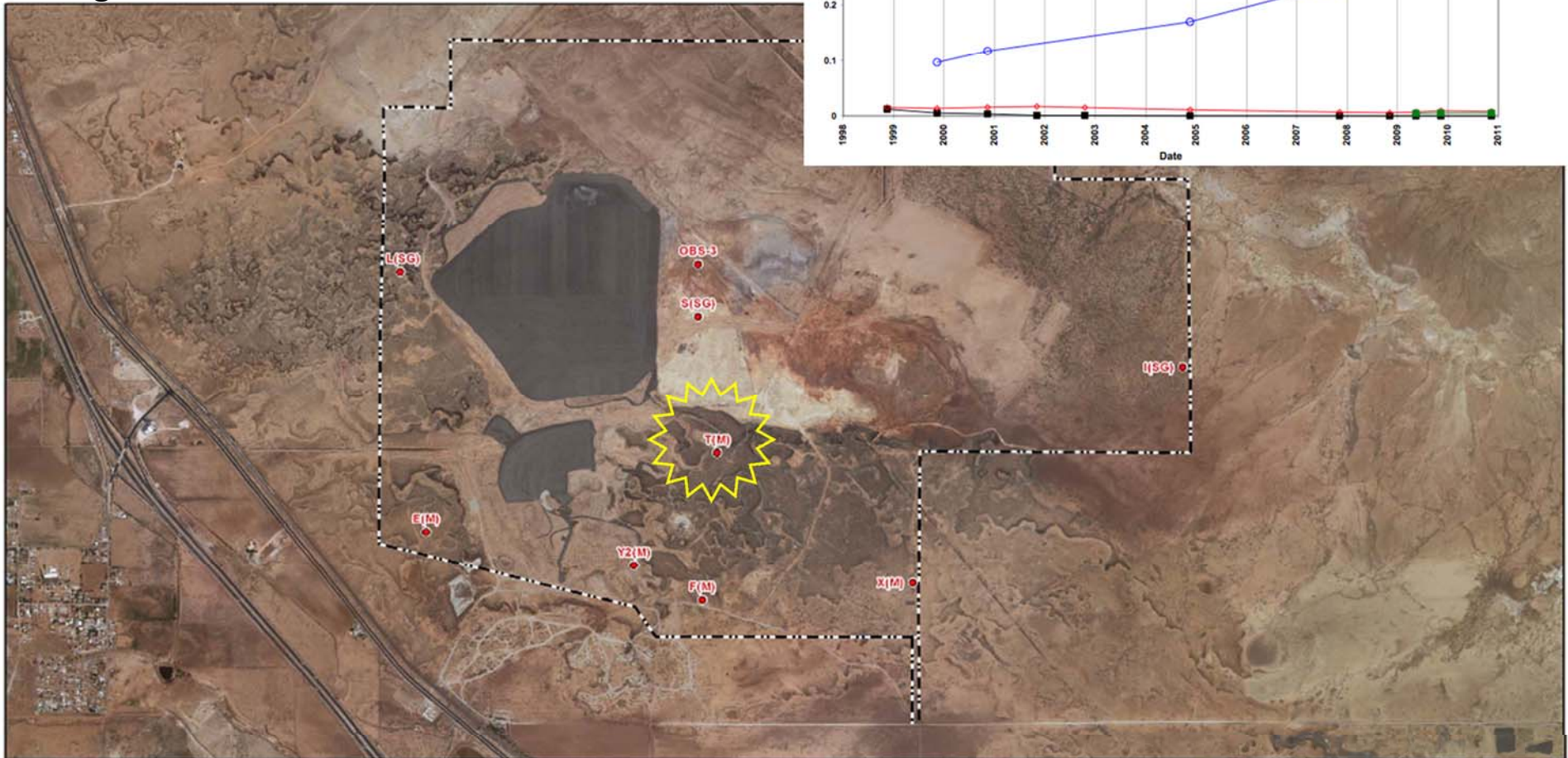
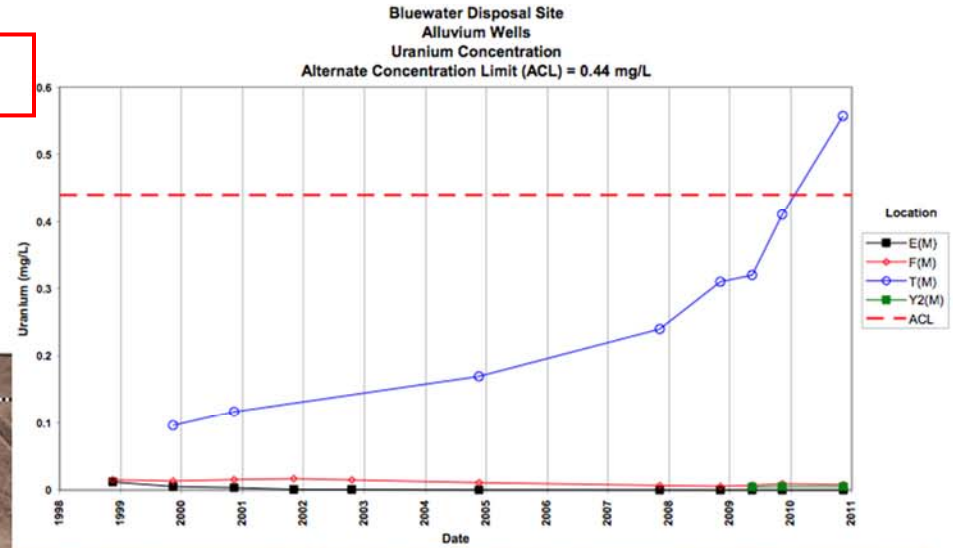
Durango, Colorado - Uranium standard exceedance at groundwater monitoring well at reclaimed purpose-built below grade tailing site.



LEGEND ● WELL TO BE SAMPLED ○ EXISTING WELL - - - SITE BOUNDARY	<p>Durango, CO Uranium Mill Tailings Disposal Sites Data Validation Package – June 2010 GW and SW Sampling www.lm.doe.gov/Durango/S00610_DUR.pdf</p>	N SCALE IN FEET 0 100 200 300	<table border="1" style="font-size: small;"> <tr> <td>U.S. DEPARTMENT OF ENERGY MINE AND TALENTE DEVELOPMENT</td> <td>S.M. Stoller Corporation A subsidiary of S.M. Stoller Inc.</td> </tr> <tr> <td colspan="2" style="text-align: center;">Planned Sampling Map Durango, CO, Deposal Site June 2010</td> </tr> <tr> <td>August 18, 2010</td> <td>80652100-02</td> </tr> </table>	U.S. DEPARTMENT OF ENERGY MINE AND TALENTE DEVELOPMENT	S.M. Stoller Corporation A subsidiary of S.M. Stoller Inc.	Planned Sampling Map Durango, CO, Deposal Site June 2010		August 18, 2010	80652100-02
U.S. DEPARTMENT OF ENERGY MINE AND TALENTE DEVELOPMENT	S.M. Stoller Corporation A subsidiary of S.M. Stoller Inc.								
Planned Sampling Map Durango, CO, Deposal Site June 2010									
August 18, 2010	80652100-02								

Emerging Issues at Reclaimed Tailings Sites - 3

Bluewater, New Mexico - Uranium standard exceedance at groundwater monitoring well at reclaimed-in-place above-grade impoundment tailing site.

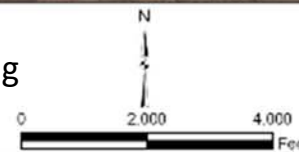


- Legend**
- Well to be Sampled
 - - - Site Boundary

Bluewater, NM Uranium Mill Tailings Disposal Site

Data Validation Package – November 2010 Water Sampling

www.lm.doe.gov/Bluewater/S01110_BLU.pdf

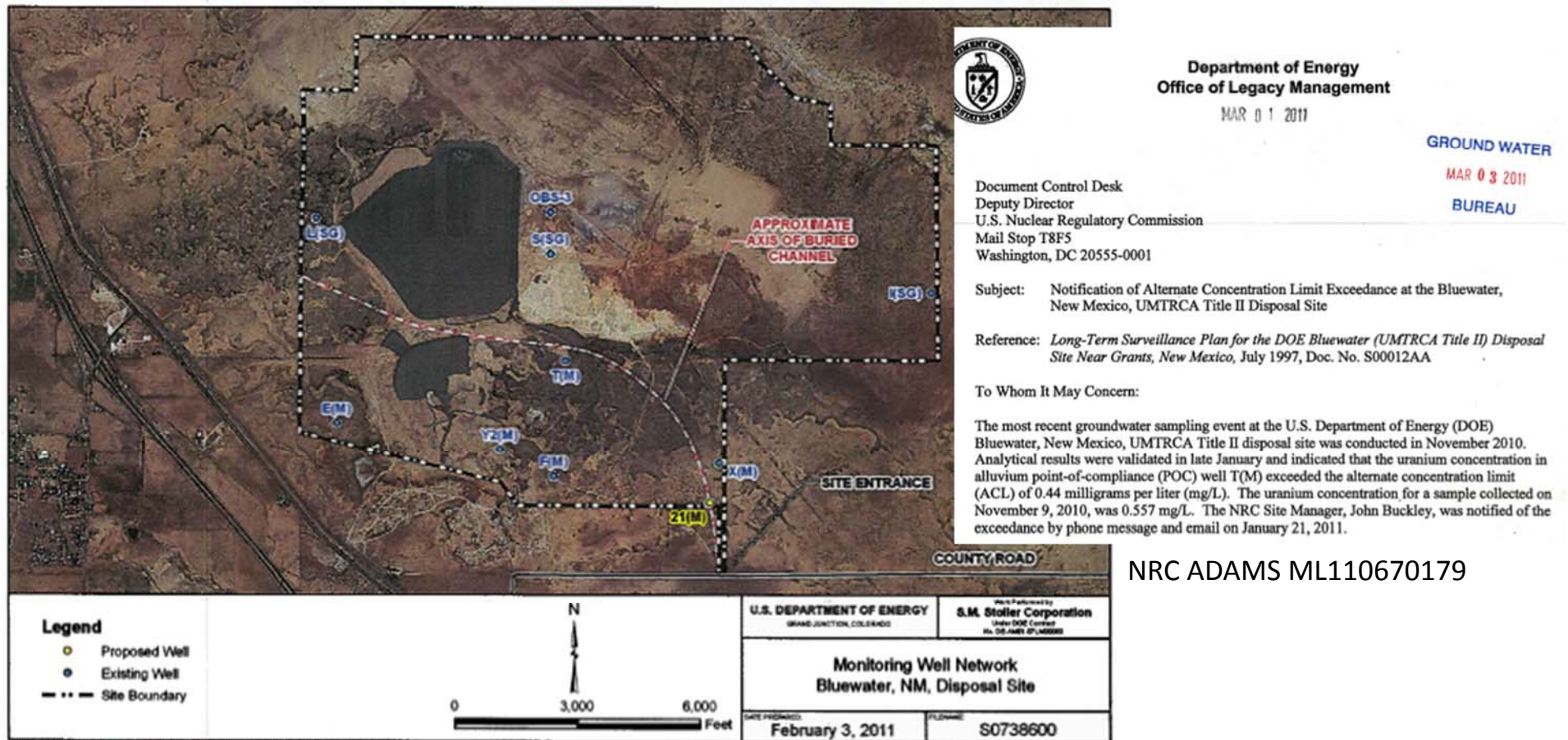


U.S. DEPARTMENT OF ENERGY WASH. DC 20585-0001	Prepared by S.M. Stoller Corporation 1000 P.O. Box 100 10000 S.W. 10th St. Miami, FL 33150
Planned Sampling Map Bluewater, NM, Disposal Site November 2010	
DATE PREPARED January 3, 2011	FIG. NO. S0709900

Emerging Issues at Reclaimed Tailings Sites - 4

The Bluewater, NM ACL exceedance notification letter from DOE to NRC March 3, 2011 says....

Analytical results were validated in late January and indicated that the uranium concentration in alluvium point-of-compliance (POC) well T(M) exceeded the alternate concentration limit (ACL) of 0.44 milligrams per liter (mg/L). The uranium concentration for a sample collected on November 9, 2010, was 0.557 mg/L. The NRC Site Manager, John Buckley, was notified of the exceedance by phone message and email on January 21, 2011.



NRC ADAMS ML110670179

Where will uranium come from in the next twenty years? - 1

Latest Data Shows Long-Term Security of Uranium Supply --Paris/Vienna, 20 July 2010

According to “Uranium 2009: Resources, Production and Demand” [Uranium Red Book] just published by the OECD Nuclear Energy Agency (NEA) and the International Atomic Energy Agency (IAEA), uranium resources, production and demand are all on the rise. Exploration efforts have increased recently in line with the expected expansion of nuclear energy in the coming years. Total identified resources have grown but so too have costs of production. Worldwide exploration and mine development expenditures have more than doubled since the publication of the previous edition, “Uranium 2007: Resources, Production and Demand.” These expenditures have increased despite declining uranium market prices since mid-2007.

The uranium resources presented in this edition, reflecting the situation as of 1 January 2009, show that total identified resources amounted to 6 306 300 tU, an increase of about 15% compared to 2007, including those reported in the high-cost category (<USD 260/kgU or <USD 100/lbU₃O₈), reintroduced for the first time since the 1980s.

This high-cost category was used in the 2009 edition in response to the generally increased market prices for uranium in recent years, despite the decline since mid-2007, expectations of increasing demand as new nuclear power plants are being planned and built, and increased mining costs. Although total identified resources have increased overall, there has been a significant reduction in lower-cost resources owing to increased mining costs.

At 2008 rates of consumption, total identified resources are sufficient for over 100 years of supply.

Source: <http://www.iaea.org/newscenter/pressreleases/2010/prn201009.html>

Where will uranium come from in the next twenty years? - 2

In its February 2011 report, DOE identified currently US operating licensed uranium production capacity at In Situ Leach (ISL) mines of 6,000,000 pounds per year of uranium operating production capacity – the equivalent of 3,250 tons per year.

DOE identified Projected ISL uranium production capacity of 22,000,000 pounds – the equivalent of 11,000 tons per year is identified.

Source: http://www.eia.gov/cneaf/nuclear/dupr/qupd_tbl4.html

Data for 4th Quarter 2010
Report Date: February 8, 2011
Next Release Date: May 2011

Table 4. U.S. Uranium In-Situ-Leach Plants by Owner, Capacity, and Operating Status

In-Situ-Leach Plant Owner	In-Situ-Leach Plant Name	Production Capacity (pounds U ₃ O ₈ per year)	Operating Status at End of				
			2009	1st Quarter 2010	2nd Quarter 2010	3rd Quarter 2010	4th Quarter 2010
Cameco	Crow Butte Operation	1,000,000	Operating	Operating	Operating	Operating	Operating
Hydro Resources, Inc.	Church Rock	1,000,000	Partially Permitted And Licensed	Partially Permitted And Licensed	Partially Permitted And Licensed	Partially Permitted And Licensed	Partially Permitted And Licensed
Hydro Resources, Inc.	Crownpoint	1,000,000	Partially Permitted And Licensed	Partially Permitted And Licensed	Partially Permitted And Licensed	Partially Permitted And Licensed	Partially Permitted And Licensed
Lost Creek ISR LLC	Lost Creek Project	2,000,000	Developing	Developing	Developing	Developing	Developing
Mestena Uranium, LLC	Alta Mesa Project	1,000,000	Producing	Producing	Producing	Producing	Producing
Power Resources Inc. dba Cameco Resources	Smith Ranch-Highland Operation	5,500,000	Operating	Operating	Operating	Operating	Operating
Powertech Uranium Corp	Centennial Project	-	Undeveloped	Undeveloped	Undeveloped	Undeveloped	Undeveloped
Powertech Uranium Corp	Dewey Burdock Project	-	Undeveloped	Undeveloped	Undeveloped	Undeveloped	Undeveloped
South Texas Mining Venture	Hobson ISR Plant	1,000,000	Permitted And Licensed	Standby	Standby	Permitted And Licensed	Operational
South Texas Mining Venture	La Palangana	1,000,000	Permitted And Licensed	Permitted And Licensed	Permitted And Licensed	Permitted And Licensed	Operating
South Texas Mining Venture	Nichols Project	-	Developing	Developing	Developing	Developing	Shutdown
URI, Inc.	Kingsville Dome	1,000,000	Standby	Standby	Standby	Standby	Standby
URI, Inc.	Rosita	1,000,000	Standby	Standby	Standby	Standby	Standby
URI, Inc.	Vasquez	800,000	Restoration	Restoration	Restoration	Restoration	Restoration
Uranerz Energy Corporation	Nichols Ranch ISR Project	-	Developing	Developing	Developing	Developing	Partially Permitted And Licensed
Uranium Energy Corporation	Goliad ISR Uranium Project	1,000,000	Partially Permitted And Licensed	Partially Permitted And Licensed	Partially Permitted And Licensed	Partially Permitted And Licensed	Partially Permitted And Licensed
Uranium One Americas, Inc.	Jab and Antelope	2,000,000	Developing	Developing	Developing	Developing	Developing
Uranium One Americas, Inc.	Moore Ranch	500,000	Partially Permitted And Licensed	Partially Permitted And Licensed	Partially Permitted And Licensed	Partially Permitted And Licensed	Permitted And Licensed
Uranium One USA, Inc.	Christensen Ranch	1,000,000	Standby	Standby	Developing	Permitted And Licensed	Operating
Uranium One USA, Inc.	Irigaray Ranch	1,300,000	Standby	Standby	Under Construction	Permitted And Licensed	Operational
Uranium One USA, Inc.	Texas Operations	0	Reclamation	Reclamation	Reclamation	Reclamation	Reclamation
Total Production Capacity:		22,100,000					

- = No data reported.

Notes: Production capacity for 4th Quarter 2010. An operating status of "Operating" indicates the in-situ-leach plant usually was producing uranium concentrate at the end of the period. La Palangana did produce uranium, but Hobson ISR Plant did not produce uranium during the 4th Quarter 2010. ISR stands for in-situ recovery. Christensen Ranch and Irigaray Ranch did not produce uranium during the 4th Quarter 2010.

Source: U.S. Energy Information Administration: Form EIA-851A and Form EIA-851Q, "Domestic Uranium Production Report."

Where will uranium come from in the next twenty years? - 3

In its February 2011 report, DOE identified current US operating licensed uranium production capacity at uranium mills of 2,000 tons per day, equivalent to 1,825 tons of uranium is identified, assuming 0.25% uranium ore, 2,000 tons per day would produce 5 tons per day x 365 = 1,825 tons per year.

DOE identified projected uranium milling capacity of up to 6,650 tons per day of ore, equivalent to 6,069 tons of uranium per year, assuming 0.25% uranium ore, 6,650 tons per day would produce 16.625 tons per pay x 365 = 6,069 tons per year.

Source: http://www.eia.gov/cneaf/nuclear/dupr/qupd_tbl3.html

Data for 4th Quarter 2010
 Report Date: February 8, 2011
 Next Release Date: May 2011

Table 3. U.S. Uranium Mills by Owner, Capacity, and Operating Status

Mill Owner	Mill Name	Milling Capacity (short tons of ore per day)	Operating Status at End of				
			2009	1st Quarter 2010	2nd Quarter 2010	3rd Quarter 2010	4th Quarter 2010
Cotter Corporation	Canon City Mill	400	Standby	Standby	Standby	Standby	Standby
Denison White Mesa LLC	White Mesa Mill	2,000	Operating	Operating	Operating	Operating	Operating
Energy Fuels Resources Corp.	Piñon Ridge Mill	500	Developing	Developing	Developing	Developing	Developing
Kennecott Uranium Company/Wyoming Coal Resource Company	Sweetwater Uranium Project	3,000	Standby	Standby	Standby	Standby	Standby
Uranium One Exploration USA, Inc.	Shootaring Canyon Uranium Mill	750	Standby	Standby	Standby	Standby	Standby
Total Milling Capacity:		6,650					

Notes: Milling capacity for 4th Quarter 2010. An operating status of "Operating" indicates the mill was producing uranium concentrate at the end of the period.
 Source: U.S. Energy Information Administration: Form EIA-851A and Form EIA-851Q, "Domestic Uranium Production Report."

Where will uranium come from in the next twenty years? - 4

The 2010 Uranium Red Book identifies World Uranium Production Capacity to 2035. That table shows that uranium production from “existing and committed production centers” is projected to reach 96,145 tons in 2015; 98,295 tons in 2020 and 79,730 tons in 2025.

World uranium production capacity at “existing, committed planned and prospective centers” is projected to reach 121,780 tons in 2015, 140,640 tons in 2020 and 129,335 tons in 2025.

US uranium production capacity is projected to be <6,600 tons for at least at the next 25 years.

Source: http://www.oecd-ilibrary.org/nuclear-energy/uranium-2009_uranium-2009-en , P. 55

Table 24. World uranium production capability to 2035

(in tonnes U/year, from RAR and Inferred Resources recoverable at costs up to USD 130/kgU, except as noted)

COUNTRY	2010		2015		2020		2025		2030		2035	
	A-II	B-II	A-II	B-II	A-II	B-II	A-II	B-II	A-II	B-II	A-II	B-II
Argentina	120	120	300	300	500	500	500*	500*	500*	500*	500*	500*
Australia	9 700	9 700	10 100	16 600	10 100	24 200	10 100	27 900	9 800	27 600	9 800	27 600
Brazil	340	340	1 600	1 600	2 000	2 000	2 000	2 000	2 000*	2 000*	2 000*	2 000*
Canada	16 430	16 430	17 730	17 730	17 730	19 000	17 730	19 000	17 730	19 000	17 730	19 000
China*	940	1 040	940	1 040	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200
Czech Republic	500	500	50	50	50	50	50	50	30*	30*	20*	20*
India*	295	980	980	980	980	1 200	1 000	1 600	1 000	2 000	1 000	2 000
Iran, Islamic Rep. of*	20	20	70	70	100	100	100	100	100	100	100	100
Jordan*	0	0	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000
Kazakhstan	18 000	18 000	28 000	28 000	24 000	24 000	14 000	14 000	12 000	12 000	5 000	6 000
Malawi*	0	500	1 270	1 270	1 425	1 100	0	0	0	0	0	0
Mongolia*	0	0	0	500	150	1 000	150	1 000	150	1 000	150	1 000
Namibia*	5 000	6 500	6 000	15 000	8 000	19 000	6 000	14 000	5 000	10 000	5 000	7 500
Niger	4 000	4 000	9 500*	11 000*	9 500*	10 500*	5 000*	9 500*	5 000*	5 000*	5 000*	5 000*
Pakistan* (a)	65	65	65	110	140	155	140	140	140	650	140	650
Romania* (a)	230	230	230	230	350	475	350	475	350	630	350	630
Russian Federation	3 520	3 520	5 240	5 900	7 600	11 990	7 600	13 800	6 800	13 900	6 800	13 400
South Africa (b)	4 860	4 860	4 860	6 320	4 860	6 320	4 860	6 320	4 860	6 320	4 860	6 320
Ukraine	960	1 700	810	3 230	810	5 500	250	5 500*	170	5 500*	170*	5 500*
United States (c)	2 900	4 600	3 400	6 100	3 800	6 600	3 700	6 500	3 100	5 600	3 100*	5 600*
Uzbekistan (c)	2 300	2 300	3 000	3 750*	3 000	3 750*	3 000	3 750*	3 500	3 500	3 500*	3 500*
TOTAL	70 180	75 405	96 145	121 780	98 295	140 640	79 730	129 335	75 430	118 530	68 420	109 520

A-II Production Capability of Existing and Committed Centres supported by RAR and Inferred Resources recoverable at <USD 130/kgU.

B-II Production Capability of Existing, Committed, Planned and Prospective Centres supported by RAR and Inferred Resources recoverable at <USD 130/kgU.

NA Data not available or not reported.

* Secretariat estimate.

(a) Projections are based on reported plans to meet domestic requirements but will require the identification of additional resources.

(b) From resources recoverable at costs <USD 40/kgU.

(c) Data from previous Red Book.