REMEDIATION AND RECYCLING OF LINDE FUSRAP MATERIALS

Peter W. Coutts,
Project Manager, IT Corporation

John P. Franz,
Program Manager, IT Corporation

Michelle R. Rehmann,
Environmental Manager, International Uranium (USA) Corporation

ABSTRACT

During World War II, the Manhattan Engineering District (MED) utilized facilities in the Buffalo, New York area to extract natural uranium from uranium-bearing ores. The Linde property is one of several properties within the Tonawanda, New York Formerly Utilized Sites Remedial Action Program (FUSRAP) site, which includes Linde, Ashland 1, Ashland 2, and Seaway. Union Carbide Corporation's Linde Division was placed under contract with the Manhattan Engineering District (MED) from 1942 to 1946 to extract uranium from seven different ore sources: four African pitchblende ores and three domestic ores. Over the years, erosion and weathering have spread contamination from the residuals handled and disposed of at Linde to adjacent soils.

The U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA) negotiated a Federal Facilities Agreement (FFA) governing remediation of the Linde property. In Fiscal Year (FY) 1998, Congress transferred cleanup management responsibility for the sites in the FUSRAP program, including the Linde Site, from the DOE to the U.S. Army Corps of Engineers (USACE), with the charge to commence cleanup promptly. All actions by the USACE at the Linde Site are being conducted subject to the administrative, procedural, and regulatory provisions of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) and the existing FFA. USACE issued a Proposed Plan for the Linde Property in 1999 and a Final Record of Decision (ROD) in 2000. USACE worked with the local community near the Tonawanda site, and after considering public comment, selected the remedy calling for removing soils that exceed the site-specific cleanup standard, and transporting the contaminated material to off-site locations. The selected remedy is protective of human health and the environment, complies with Federal and State requirements, and meets commitments to the community.

As a rule, the USACE performs a formal Value Engineering (VE) Study on all projects with cost estimates greater than $2 million. A proposal to consider recycling of FUSRAP 11e.(2)-like uranium byproduct materials, as an option to direct disposal, was proffered in a FUSRAP VE study in 1998. Consistent with this proposal, the contractor selected to perform the cleanup

activities, IT Corporation (IT), the Total Environmental Remediation Contractor (TERC) for the USACE in the region, was tasked to provide the best value clean-up results that met all of the criteria established in the Record of Decision for the site. To this end, rather than focusing solely on disposal-only options, IT also evaluated options that included possible beneficial reuse; effectively reducing the cost associated with disposal as well.

During the solicitation process, International Uranium (USA) Corporation (IUC), the operator of the White Mesa Uranium Mill, a Nuclear Regulatory Commission (NRC)-licensed mill near Blanding, Utah, responded with a proposal to perform uranium extraction on the excavated materials. The Mill's proposal provided beneficial use of the material consistent with the Resource Conservation and Recovery Act (RCRA) intent to encourage recycling and recovery, while also providing a cost-effective means of material disposal.

Remediation of the Linde site began in August of 2000. Excavation and shipment of material from the Linde site is expected to continue through approximately October 2003, depending upon funding, and recycling of the material will commence after a majority of the material has been received at the Mill.

Challenges that are being met to implement the Linde project include: (1) identifying the best-value locations to accept the excavated material; (2) coordinating with the New York State Department of Environmental Conservation (NYSDEC) to apply Technical Administrative Guidance Memorandum (TAGM) action levels to make contained-in/contained-out determinations on a batch by batch basis; (3) preparing a Linde Site Preliminary Material Characterization Report, pre-excavation profile sampling plan, and a TAGM Sampling Work Plan, to be approved by NYSDEC, specifying how the media will be sampled and analyzed during excavation/remediation to confirm that no contaminant exceeds any action level in the TAGM; (4) meeting regulatory requirements, through IUC obtaining an NRC license amendment to accept and process the material as an alternate feed in a licensed uranium mill (which included IUC ensuring that NYSDEC's application of the TAGM was consistent with the IUC agreement with the State of Utah for determining that Uranium Material to be shipped to the Mill is not RCRA listed hazardous waste); and (5) excavating and preparing the material for shipment, then shipping the material to the Mill for uranium recovery. For the Linde FUSRAP site, the Corps is meeting these challenges while remediating the site in an environmentally protective and safe manner, and gaining the added value of environmental and cost benefits of using recycling as an alternative to direct disposal. In addition, use of the VE concept is expected to result in a total avoidance of more than $11 million in additional Federal taxpayer costs, while reducing the radioactivity of the byproduct requiring disposal, and providing for environmentally protective disposal of such byproduct.

INTRODUCTION

During World War II, the Manhattan Engineering District (MED) utilized facilities in the Buffalo, N.Y. area to extract natural uranium from uranium-bearing ores. The U.S. Department of Energy (DOE) was tasked to clean up MED waste sites throughout the United States under the Formerly Utilized Sites Remedial Action Program (FUSRAP). During the 1980s and early 1990s, the DOE conducted several site investigations and evaluated remedial alternatives. In

1993, the DOE proposed a solution for its Tonawanda, New York sites that involved on-site containment of the radiologically emplaced material. Due to overwhelming public opposition to this plan, it was not implemented and other alternatives were investigated. In FY 1998, Congress transferred the cleanup management responsibilities to the United States Army Corps of Engineers (USACE, or the Corps) with the charge to commence cleanup promptly.

PROJECT OVERVIEW

USACE worked with the local community near the Tonawanda site, and after considering public comment, selected the remedy calling for removing soils that exceed the site-specific cleanup standard, and transporting the contaminated material to off-site locations. The selected remedy is protective of human health and the environment, complies with Federal and State requirements, and meets commitments to the community.

U.S. Army Corps of Engineers Value Engineering Approach

As a rule, the Corps performs a formal Value Engineering (VE) Study on all projects with cost estimates greater than $2 million. A proposal to consider recycling of FUSRAP 11e.(2)-like uranium byproduct materials, as an option to direct disposal, was proffered in a FUSRAP VE study in 1998. Consistent with this proposal, the contractor selected to perform the cleanup activities, IT Corporation (IT), the Total Environmental Remediation Contractor (TERC) for the USACE in the region, was tasked to provide clean-up results that met all of the criteria established in the Record of Decision for the site. To this end, rather than focusing solely on disposal-only options, IT also evaluated options that included possible beneficial reuse; effectively reducing the cost associated with disposal as well. During the solicitation process, International Uranium (USA) Corporation (IUC), the operator of the White Mesa Uranium Mill, a Nuclear Regulatory Commission (NRC)-licensed mill near Blanding, Utah, responded with a proposal to perform uranium extraction on the excavated materials. The Mill's proposal provided beneficial use of the material consistent with the Resource Conservation and Recovery Act (RCRA) intent to encourage recycling and recovery, while also providing a cost-effective means of material disposal.

Remediation of the Linde site began in August of 2000. Excavation and shipment of material from the Linde site is expected to continue through approximately October 2003, depending upon funding, and recycling of the material will commence after a majority of the material had been received at the Mill.

Details of the Linde project include: (1) identifying the best-value locations to accept the excavated material; (2) coordinating with the New York State Department of Environmental Conservation (NYSDEC) to apply Technical Administrative Guidance Memorandum (TAGM) action levels to make contained-in/contained-out determinations on a batch by batch basis; (3) preparing Linde Site Preliminary Material Characterization Report, pre-excavation profile sampling plan, and a TAGM Sampling Work Plan, to be approved by NYSDEC, specifying how the media will be sampled and analyzed during excavation/remediation to confirm that no contaminant exceeds any action level in the TAGM; (4) meeting regulatory requirements, through IUC obtaining an NRC license amendment to accept and process the material as an

alternate feed in a licensed uranium mill (which included IUC ensuring that NYSDEC's application of the TAGM was consistent with the IUC agreement with the State of Utah for determining that Uranium Material to be shipped to the Mill is not RCRA listed hazardous waste); (5) excavating and preparing the material for shipment, then shipping the material to the Mill for uranium recovery. For the Linde FUSRAP site, the Corps is meeting these challenges while remediating the sites in an environmentally protective and safe manner, and gaining the added value of environmental and cost benefits of using recycling as an alternative to direct disposal. In addition, use of the VE concept is expected to result in a total avoidance of more than $11 million in additional Federal taxpayer costs, while reducing the radioactivity of the byproduct requiring disposal, and providing for environmentally protective disposal of such byproduct.

ORIGIN AND HISTORY OF THE LINDE FUSRAP MATERIALS

During World War II the MED utilized the Linde facility in Tonawanda, New York to extract natural uranium from uranium-bearing ores. The Linde property is one of several properties within the Tonawanda, New York FUSRAP site, which includes Linde, Ashland 1, Ashland 2, and Seaway. Union Carbide Corporation's former Linde Air Products Division purchased the Linde property and constructed a ceramics plant at the location in 1942. One of the ceramics processes conducted by Union Carbide Linde Division at this location consisted of extraction of uranium from ores to produce uranium salts, for coloration of product glasses. Based on their experience, Union Carbide was placed under contract with the MED from 1942 to 1946 to extract uranium from seven different ore sources: four African pitchblende ores and three domestic ores. Laboratory and pilot plant studies were conducted from 1942 to 1943. From 1943 to 1946, Linde conducted full scale processing of 28,300 tons of ore. The Linde Division contract with the MED ended in the early 1950's.

The domestic ores processed at Linde were in fact residuals from commercial processing at other facilities which removed vanadium. The vanadium removal process also removed radium and other daughter products in the decay chain. As a result, the domestic uranium ores supplied to Linde had reduced concentrations of radium relative to the uranium and thorium levels. The African ores contained uranium in equilibrium with all the daughter products in its decay chain. Three-phase processes were used for domestic and foreign ores. Triuranium octoxide (U_3O_8) was separated from the feedstock by acid digestion, precipitation, and filtration. The solid, gelatinous filter cake from this step was discarded as solid waste in a temporary tailings pile on the Linde site. Insoluble precipitates from the solution steps were combined with the filter cake for disposal on site. Approximately 8,000 tons of filter cake and precipitates were later relocated to Ashland 1. U_3O_8 was converted to uranium dioxide and uranium tetrafluoride at the Linde site. Residuals from these two steps were reprocessed. Five buildings at the site were involved in MED activities. Building 14 had been constructed by Union Carbide in the mid-1930's. Buildings 30, 31, 37, and 38 were constructed at the location by MED, and their ownership was transferred to Linde when the MED contract ended.

Residues from uranium ore processing at the Linde facility were disposed of and/or stored at the Ashland 1, Ashland 2 and Seaway properties. The majority of Linde facility residues were disposed of on the Ashland 1 property between 1944 and 1946. No material was transferred

from Linde to Ashland 1 after this period. In 1974, the subsequent owner of the Ashland 1 property excavated a portion of the Linde residues and soils from the Ashland 1 site, and relocated them to the Ashland 2 property.

Renovation of the facility over the years has resulted in consolidation of the MED wastes and radioactively contaminated soils remaining at the property. In 1977, MED contaminated soil was removed from the construction area for the new building 90, and placed in two windrows along the northern property line. The windrows were consolidated into one pile between 1979 and 1982, and covered in 1992.

The DOE and the EPA negotiated an FFA governing remediation of the Linde property. In 1997, Congress transferred management responsibility for the sites in the FUSRAP program, including the Linde Site, to the USACE. All actions by the USACE at the Linde Site are being conducted subject to the administrative, procedural and regulatory provisions of the CERCLA and the existing FFA. USACE issued a Proposed Plan for the Linde Property and a Final Record of Decision (ROD) in 2000.

As presented previously at Waste Management Symposia, remediation of the Ashland 2 site began in spring of 1998; and remediation of the Ashland 1 site in mid-June of 1999. The Ashland 2 material has been recycled, and Ashland 1 material will be processed for recycling following receipt of all of the material from the site. This paper focuses on remediation of the Linde site, and materials which are being sent offsite for recycling and disposal.

DESCRIPTION OF THE MATERIAL

Over the years, erosion and weathering have spread contamination from the residuals handled and disposed of at Linde to adjacent soils, increasing the volume of contaminated materials to be removed during the remedial excavation. Physically, the material is moist material consisting of byproducts from uranium processing operations (i.e., "tailings"), mixed with site soils. Initial estimates of the volume of soil to be excavated from the entire Linde property ranged from approximately 35,000 to 70,000 cubic yards (CY) or somewhat more, depending on conditions encountered during excavation. These volumes, however, were estimates only. It is difficult to estimate the extent to which surrounding soils have been contaminated by the tailings, and hence the potential volumes, with precision.

In addition to soils, information provided during the solicitation for proposals for recycling/disposal services described an estimated percentage of debris contained in the soils. The amount of debris is estimated as being up to 23.5 percent of the total material. Debris is defined as material, in the form of concrete and asphalt, greater than 5.6 cubic feet in size.

COST CONSIDERATIONS

For the Linde project, USACE challenged IT to develop cost-effective and timely disposal options as part of the site cleanup. The first step was to identify licensed disposal locations in the U.S., along with their disposal criteria. During the solicitation process, the idea of looking at innovative locations or methods was pursued.

As a rule, the Corps performs a formal Value Engineering (VE) Study on all projects with cost estimates greater than $2 million. A proposal to consider recycling of FUSRAP 11e.(2)-like uranium byproduct materials, as an option to direct disposal, was proffered in a FUSRAP VE study in 1998. Consistent with this proposal, the contractor selected to perform the cleanup activities, IT Corporation (IT), the Total Environmental Remediation Contractor (TERC) for the USACE in the region, was tasked to provide the best value clean-up results that meet all of the criteria established in the Record of Decision for the site. To this end, rather than focusing solely on disposal-only options, IT also evaluated options that included possible beneficial reuse; effectively reducing the cost associated with disposal as well.

During the solicitation process, IUC, the operator of the White Mesa Uranium Mill, an NRC-licensed mill near Blanding, Utah, responded with a proposal to perform uranium extraction on the excavated materials. The Mill's proposal was selected as the best value when all technical and cost factors identified in the RFP were evaluated. The Mill's proposal included recycling and provided beneficial use of the material consistent with the RCRA intent to encourage recycling and recovery and also provided a cost-effective means of material disposal. Such recycling encourages conservation of energy and natural resources, while realizing the benefit of reduced disposal costs.

REGULATORY

Regulatory issues included amendment of the Mill's NRC license to accept these alternate feed materials, and coordinating a review of the data on hazardous constituents potentially in the materials between IUC and IT, and with the NYSDEC.

NRC Guidance for Acceptance of Alternate Feed at Licensed Uranium Mills

On August 15, 1997, the NRC issued its "Final Position and Guidance on the Use of Uranium Mill Feed Material Other Than Natural Ores" ("Alternate Feed Guidance"). Under this policy the NRC permits licensees to process alternate feed material (material other than natural ore) in uranium mills provided that:

1. The feed material meets the definition of "ore" which is "a natural or native matter that may be mined and treated for the extraction of any of its constituents or any other matter from which source material is extracted in a licensed uranium or thorium mill". This would include processing ores that have been previously beneficiated for other minerals and which are now outside of the owner's legal or technical ability to further process.

2. The feed material does not contain listed hazardous waste. Environmental Protection Agency (EPA) regulations that implemented RCRA exempt those potential alternate feed materials that exhibit only a characteristic of hazardous waste (ignitable, corrosive, reactive, toxic) from hazardous waste classifications by providing that byproducts that are being reclaimed are not regulated as hazardous waste (40 CFR 261.2c(3)).

3. The ore is being processed primarily for its source material content. Recent judicial pronouncements have held that an ore is being processed primarily for its source material content if it is being processed at a licensed uranium mill and it is reasonable to expect that uranium will be extracted from the material.

The White Mesa Mill, for example, processes "natural" (i.e., mined, native) uranium ores, and uranium-bearing "alternate feed materials" for recovery of uranium, often followed by recovery of additional minerals. These alternate feed materials are generally processing byproducts from other extraction procedures. The NRC granted IUC an amendment to the Mill's NRC license for the Linde FUSRAP materials in June of 2000. This feed-specific amendment approach is being revised to a more flexible, performance-based acceptance standard. This will eliminate the need for individual amendments such as those obtained for the Linde FUSRAP material.

Coordinating with New York State Department of Conservation

A detailed site characterization of the Linde property was conducted by USDOE and described in the Remedial Investigation (RI). Additional information relating to the Linde property was presented in the Proposed Plan for the Linde Site, and the Linde Site Preliminary Material Characterization. The studies include a detailed site and area history; uranium activity data; and metals and organic contaminant concentration data.

The NYSDEC has published a Technical Administrative Guidance Memorandum (TAGM) addressing contaminants contained in environmental media. This TAGM defines NYSDEC's policy regarding contaminants (chemicals, compounds, and compound groups) associated with RCRA listed hazardous wastes detected in environmental media (soil sediment and water). The TAGM provides specific action levels (concentrations) for each contaminant. If all contaminants in a given media are present at levels lower than the specified action levels, then the media does not "contain" RCRA listed hazardous waste. NYSDEC makes a contained-in/contained-out determination for the volatile organic compounds (VOCs) in the Uranium Material, on a batch by batch basis, subject to the NYSDEC TAGM.

Characterization Report, Pre-Excavation Profile Sampling Plan, and Sampling Work Plan

The remainder of the contaminants – Semi-Volatile Organic Compounds (SVOCs) (specifically PAHs and phthalates), and metals, have been determined in the Linde Site Preliminary Material Characterization Report (PMCR) not to result from RCRA listed wastes.

IUC required the following analyses on pre-excavation samples:

Table I. Pre-Excavation Required Analyses

Analysis	**Analytical Method**	**Purpose**
pH	SW9045	RMPR
Paint filter test	SW9095A	RMPR
Reactive Sulfide	SW846 Chap7	RMPR
Flash Point	SW1010/1020A	RMPR
Cyanide	SW9010B/9213	RMPR
Total VOCs	SW846 Method 8260B	Listed Waste Evaluation*
Total SVOCs	SW846 Method 8270C	Listed Waste Evaluation*
Total Metals	SW6010B/7000A/3050B	Listed Waste Evaluation*
PCBs and Pesticides	SW8082/3541	RMPR

A summary table of pre-excavation data from pre-excavation test pit samples, and a copy of the Radioactive Material Profile Record (RMPR) completed based on the pre-excavation results was provided to IUC. IT considered the parameters identified by asterisks in Table in making listed hazardous waste determinations for Linde material, and advised IUC that, as discussed in the Linde PMCR, the only contaminants potentially associated with RCRA listed sources were the six halogenated VOC compounds. IT reported that none of the SVOCs or metals detected to date were associated with RCRA listed sources. In addition, in accordance with the protocol IUC developed in conjunction with, and accepted by, the State of Utah Department of Environmental Quality (UDEQ) ("Protocol for Determining Whether Alternate Feed Materials are Listed Hazardous Wastes", November 22, 1999), IUC conducted a Source Investigation of chemical contamination information and agency determinations available to date, and both IUC and IUC's independent consultant agreed with USACE/IT's determination.

To supplement the preliminary TAGM determinations, IT developed a pre-excavation Profile Sampling Plan, which was designed to confirm the VOC levels reported in the RI. IT completed this sampling and reported results to USACE and NYSDEC during the second quarter of 2000. Further, NYSDEC's TAGM specifies that for the contained-in/contained-out determination to be applied to excavated media from any site, the owner must prepare a TAGM Sampling Work Plan, (TAGM SWP) to be approved by NYSDEC, specifying how the media will be sampled and analyzed during excavation/remediation to confirm that no contaminant exceeds any action level in the TAGM. IT prepared a TAGM Sampling Work Plan for NYSDEC review. In accordance with NYSDEC policy, this Plan specified that any material that exceeds any TAGM action level will either:

1. be considered RCRA listed hazardous waste and shipped to a disposal facility licensed to receive RCRA hazardous wastes; or

2. may be treated on site at Linde until the concentrations of all chemicals, compounds or groups are below all TAGM action levels, then shipped off site, to the Mill or other location, as non-hazardous waste.

EXCAVATION, TRANSPORTATION, RECEIVING, AND STORAGE

Upon receipt of the NRC license amendments, the shipping and manifesting requirements could be simplified. As the material was classified as an alternate feed source, the transportation requirements followed where those in Section 49 of the U.S. Code of Federal Regulations (CFR). The shipping requirements were streamlined to meet the needs of 49 CFR and IUC. Both needs were met using less paperwork with fine-tuned data, thus saving many man-hours on the projects, while still ensuring safe transport of the materials. In addition to transportation requirements, operations at the Linde Site must meet all water and air emission standards. Full time air monitoring stations were established, and soil and erosion control measures were undertaken to preclude any runoff problems. Decontamination areas were established in the work zones to clean equipment. Most importantly, all aspects of human health and safety requirements are established and enforced.

Workers involved in excavation wear radiation monitors. In addition, the entire work areas are surrounded by full-time air monitoring equipment to confirm that the construction process generates no off-site exposures. Decontamination trailers were established for access and egress into the excavation locations. Also, the sites are secured by a guard force and an eight-foot chain link fence. The project is being completed with no lost time accidents, and with all regulatory requirements being met.

The excavation task at the Linde FUSRAP site is straightforward. First, the site is radiologically surveyed, and sampling is performed in accordance with TAGM requirements detailed above. Construction of soil and erosion control structures, haul roads, perimeter air sampling systems, a load out pad, and decontamination pads was completed. Excavation then began in lifts using rough terrain excavators and roll off dump trucks. After scanning confirms no external contamination, the soil is transported using roll off dump trucks via constructed haul roads to the rail site on the property. Prior to loading each intermodal container, a radiation analysis of the soil is conducted by the on site field laboratory and a bill of lading for each container is developed in accordance with 49 CFR. As noted above, the soil is shipped as alternate feed material rather than waste. The designation of alternate feed material allows for a simpler streamlined shipping documentation system that results in secondary cost savings, while still ensuring safe transport of the material. The soil is transported by rail to off-load sites in southern, Utah and trucked to the White Mesa Mill near Blanding, Utah for processing. A round trip per rail car averages about 23 days. An added benefit of this rail transport scenario is that no demurrage results due to the quick off-load and reload of intermodal containers at the Utah site.

Intermodal containers received at the Mill are weighed and stockpiled into 500 cubic yard (CY) lots for management prior to recycling and disposal. Containers are lined with a 6-mil plastic liner to aid in containment of the soil and assist in protection of the container shell, which ultimately makes decontamination of the container easier.

MILL PROCESS

The White Mesa Mill was permitted and constructed in the early 1980s, originally to process uranium and vanadium ores from the historic Colorado Plateau mining district, and later from the high-grade breccia pipe mines in northern Arizona. Throughout its operating history, the Mill has demonstrated the flexibility to adapt to wide variations in ore grades and processing parameters, resulting in exceptional recoveries of uranium and vanadium values from over three and one-half million tons of native ores. The Mill circuit can operate at leach temperatures up to 90 degrees centigrade and pH levels as low as 0.5, utilizing sulfuric acid. More recently, the Mill has demonstrated recoveries of 90 percent of contained tantalum/niobium values using a combination of sulfuric and hydrochloric acid leach. The Mill has eight high capacity thickeners, which are capable of being configured into groups or series of parallel stages. Three separate solvent extraction (SX) circuits and an ion exchange (IX) circuit are capable of handling aqueous flows up to 800 gallons per minute. Final products can be dewatered, dried, or calcined at temperatures up to 650 degrees centigrade. The resulting uranium product, commonly referred to as "yellowcake", is sent for further processing to produce energy-producing fuel for used in power plants.

Amenability Testing

Soil samples are tested to determine the optimum processing conditions for recovery of uranium values. Based on IUC's prior Ashland 2 experience and amenability testing that has been done on Ashland 1 material, it is anticipated that the Linde material will be treated using a sulfuric acid leach with moderate heat. Leach solutions will be washed and then the uranium recovered through a resin IX system. Based on the Ashland 2 experience, IX is more effective than the SX process.

Process Description

The soil (ore) material will be introduced into the milling process by use of a trommel screen which breaks up large lumps and washes and removes any organic material. The ore from the trommel screen is then pumped to the pulp storage tanks at a 35-50% density, by weight. The ore slurry is then leached for approximately 2-4 hours in an atmospheric leach utilizing sulfuric acid. The slurry is then transferred to liquid/solid separation where the solids are washed and discharged to the tailings ponds at 30-40% density. The solution bearing the uranium values is clarified and then fed to the IX circuit, where the uranium values are further concentrated and purified. The concentrated strip solution from the IX circuit is neutralized with anhydrous ammonia to precipitate the uranium values. The precipitated uranium is then dewatered and calcined to make a U_3O_8 product.

Processing Debris

The fact that the material contains debris is not an issue for the Mill, as it is normal for conventional ore from mining operations to contain a certain amount of debris including drill steel, rock bolts, railroad ties, etc. Therefore, the Mill's processing circuit is built to handle this debris. For conventional ore, the Mill is equipped with a grizzly to remove larger debris, and a

semi-autogenous (SAG) mill, which grinds the ore and any smaller debris. For the FUSRAP projects, IUC installed a trommel screen to wash/leach the debris and then remove it from the soils. Through process testing, it was found that the use of the trommel screen was superior to the SAG mill for reducing the size of the Ashland 2 material prior to introduction to the acid leach circuit, because the large amount of clay in the material tended to adhere to the interior of the SAG mill.

To the extent that the Linde material contains debris that cannot be handled by the trommel, another processing option for recovering the uranium from the surface contamination on such debris will be employed. Prior to processing, large pieces of debris will be removed from the material and placed on a concrete pad. A concrete curb, to collect all solutions, will surround the pad. The debris will be washed with either water or recycled process solution to leach the uranium from the debris. As stated above, the smaller debris will be washed/leached in the trommel screen. The solutions from the leaching of the large debris will be collected and pumped to a pulp storage tank, to then be mixed with the solutions from the leaching of the soils, smaller debris and other materials. The solutions will then be pumped to either solvent extraction or ion-exchange uranium extraction circuits to remove the uranium from the solutions. Once thus leached and processed for uranium extraction, both the large debris and smaller debris are managed as byproduct.

Byproduct Management

Waste streams that result from the ore processing are discharged from the washing circuit in the form of a 30- to 40-percent solid/liquid slurry. The slurry is pumped to the tailings management system where the solids are allowed to settle and the liquids are evaporated or recycled back to the Mill for use as wash water. Solids resulting from debris processing are also placed in the tailings management system, and liquid tailings from the IX circuit are pumped to the tailings system, where they are either evaporated or recycled.

Long-Term Care and Monitoring

The tailings or wastes generated during the process are disposed of as 11e.(2) byproduct material in tailings system impoundments which are subject to stringent regulatory criteria set forth in 10 CFR Part 40, Appendix A. These requirements conform to EPA's active mill tailings site regulations set forth at 40 CFR Part 192. The Appendix A criteria impose soil and groundwater protection standards for radioactive and nonradioactive (hazardous) waste constituents that provide protection equivalent to that provided by RCRA. With respect to potential impacts of byproduct material to groundwater, the White Mesa Mill tailings impoundments are separated from the nearest aquifers by at least 1,000 feet of impermeable rock. In addition, the long-term management and monitoring of uranium mill tailings facilities is regulated under the Uranium Mill Tailings Radiation Control Act (UMTRCA), which requires measures sufficient to provide reasonable assurance of stability without active ongoing maintenance for at least 200 years and as long as 1,000 years, far beyond the regulatory horizon of RCRA. Unlike RCRA facilities, UMTRCA requires that upon closure, title and custody of the 11e.(2) byproduct material impoundments will be transferred to the DOE (or the State) which, in turn, will become an NRC licensee with the primary responsibility for perpetual maintenance and surveillance of such sites.

As of this time, no State has expressed any interest in accepting custody to 11e.(2) tailings sites, so it is highly likely that the DOE will become the long-term custodian and licensee of such sites. Post-closure funds will be transferred from the NRC to the DOE at the time of the license transfer, providing a long-term surveillance fund for perpetual management and monitoring, at no cost to the Government.

EMPLOYEE RADIATION SAFETY

The radiation safety program which exists at the Mill, pursuant to the conditions and provisions of NRC License Number SUA-1358, and applicable Regulations of the Code of Federal Regulations, Title 10, is adequate to ensure the maximum protection of the worker and environment, and is consistent with the principle of maintaining exposures of radiation to individual workers and to the general public to levels As Low As Reasonably Achievable (ALARA). Because the level of radiological components in the Linde FUSRAP ore is no greater than in conventional uranium/vanadium ores and other alternate feed materials that the Mill processes, no extraordinary health and safety precautions beyond the existing Radiation Health and Safety Program are required. The normal programs include monitoring and control of dust on the ore pad and continuous monitoring of employees for exposures throughout the milling process.

The Linde material is delivered to the Mill in closed intermodal containers via truck, and will be processed in the Mill circuit in virtually the same manner as conventional ore. The material will proceed through the leach circuit, CCD circuit, and into the solvent extraction circuit or ion exchange circuit, in normal process fashion as detailed above. Since there are no major process changes to the Mill circuit, and since the extraction process sequence is very similar to processing conventional uranium solutions, it is anticipated that no extraordinary safety hazards will be encountered.

Employee exposure potential during initial material handling operations was determined to be no more significant than what is normally encountered during conventional milling operations. Based on data collected during initial receipt operations, no respiratory protection was required. Samples of the Linde material indicate it is a neutral material. Therefore, no unusual personal protective equipment (PPE) apparel is required, other than coveralls and rubber gloves, during material handling activities.

The efficiency of airborne contamination control measures during the material handling operations is assessed while the ore is in stockpile. Airborne particulate samples and breathing zone samples are collected in those areas during initial material processing activities and analyzed for gross alpha. The results are used to establish health and safety guidelines that will be implemented throughout the material processing operations. Additional environmental air samples are be taken at nearby monitoring locations in the vicinity of material handling and processing activities to ensure adequate contamination control measures are effective and that the spread of uranium airborne particulates is prevented.

After the material has been offloaded at the Mill site, a radiation survey of the intermodal container is be performed in accordance with Mill Standard Operating Procedures (SOPs). In

general, radiation levels are in accordance with applicable values contained in the NRC Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material, U.S. NRC, May, 1987. If radiation levels indicate values in excess of the above limits, appropriate decontamination procedures are implemented. However, these limits are appropriate for materials and equipment released for unrestricted use only, and do not apply to restricted exclusive use shipments. Shipments of Linde material to and from the Mill are dedicated, exclusive loads; therefore, radiation surveys and radiation levels consistent with DOT requirements are applied to returning containers that are "empty packages" being reused on the project.

SUMMARY AND CONCLUSIONS

USACE worked with the local community near the Tonawanda site, and after considering public comment, selected the remedy calling for removing soils that exceed the site-specific cleanup standard, and transporting the contaminated material to off-site locations. The selected remedy is protective of human health and the environment, complies with Federal and State requirements, and meets commitments to the community.

As a rule, the Corps performs a formal VE Study on all projects with cost estimates greater than $2 million. A proposal to consider recycling of FUSRAP 11e.(2)-like uranium byproduct materials, as an option to direct disposal, was proffered in a FUSRAP VE study in 1998. Consistent with this proposal, the contractor selected to perform the cleanup activities, IT, the TERC for the USACE in the region, was tasked to provide the best value clean-up results that meet all of the criteria established in the ROD for the site. To this end, rather than focusing solely on disposal-only options, IT also evaluated options that included possible beneficial reuse; effectively reducing the cost associated with disposal as well. During the solicitation process, IUC, responded with a proposal to perform uranium extraction on the excavated materials. The Mill's proposal provided beneficial use of the material consistent with the RCRA intent to encourage recycling and recovery, while also providing a cost-effective means of material disposal.

Remediation of the Linde site began in August of 2000. Excavation and shipment of material from the Linde site is expected to continue through approximately October 2003, depending upon funding, and recycling of the material will commence after a majority of the material had been received at the Mill.

Challenges that are being met to implement the Linde project include: (1) identifying the best-value locations to accept the excavated material; (2) coordinating with the New York State Department of Environmental Conservation (NYSDEC) to apply Technical Administrative Guidance Memorandum (TAGM) action levels to make contained-in/contained-out determinations on a batch by batch basis; (3) preparing Linde Site Preliminary Material Characterization Report, pre-excavation profile sampling plan, and a TAGM Sampling Work Plan, to be approved by NYSDEC, specifying how the media will be sampled and analyzed during excavation/remediation to confirm that no contaminant exceeds any action level in the TAGM; (4) meeting regulatory requirements, through IUC obtaining an NRC license amendment

to accept and process the material as an alternate feed in a licensed uranium mill (which included IUC ensuring that NYSDEC's application of the TAGM was consistent with the IUC agreement with the State of Utah for determining that Uranium Material to be shipped to the Mill is not RCRA listed hazardous waste); (5) excavating and preparing the material for shipment, then shipping the material to the Mill for uranium recovery. For the Linde FUSRAP site, the Corps is meeting these challenges while remediating the sites in an environmentally protective and safe manner, and gaining the added value of environmental and cost benefits of using recycling as an alternative to direct disposal. In addition, use of the VE concept is expected to result in a total avoidance of more than $11 million in additional Federal taxpayer costs, while reducing the radioactivity of the byproduct requiring disposal, and providing for environmentally protective disposal of such byproduct.