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PROPOSED PLAN FOR THE ST. LOUIS DOWNTOWN SITE

This Proposed Plan describes the preferred remedy for cleaning up contaminants resulting from past uranium processing operations at the St. Louis Downtown Site (SLDS) in St. Louis, Missouri. The St. Louis Downtown Site is one of several properties (collectively referred to as the St. Louis Site) being addressed under the Superfund law (Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA]). This Plan is being published by the U.S. Army Corps of Engineers (USACE) in consultation with the U.S. Environmental Protection Agency (EPA). The Plan is being submitted as part of USACE's public participation responsibilities under Section 117 (a) of CERCLA. The purpose of the Proposed Plan is to outline the proposed approach for cleaning up radioactive contamination above health-based cleanup guidelines.

This Plan provides background information on the SLDS, describes the alternatives being considered to clean up the site, presents the rationale for selection of the preferred remedy, and outlines the public's role in helping USACE make a final decision on a cleanup approach. USACE and EPA have not made a decision on the remedy that will be implemented at the SLDS. Therefore, this Plan does not identify a final remedial action; however, it does identify USACE's preferred alternative.

The preferred cleanup approach is based on data and findings contained within the four key documents required by the Superfund law (CERCLA). These documents include: the Remedial Investigation (RI) report, which describes the nature and extent of radioactive materials and chemical contamination at the site; the Baseline Risk Assessment (BRA), which describes the potential risk to public health and the environment in the absence of cleanup; the Initial Screening of Alternatives (ISA), which identifies the range of alternatives initially considered; and the Feasibility Study (FS), which describes how the cleanup options were developed and evaluated.

The Remedial Investigation/Feasibility Study conducted under CERCLA is the primary method for environmental compliance associated with USACE remedial actions. The RI report and BRA have been summarized and thereby incorporated by reference in the SLDS FS. This Proposed Plan summarizes information that can be found in greater detail in these reports and other documents contained in the Administrative Record file for this site. The Administrative Record reports and documents are available for review at the locations listed at the end of this plan. USACE and EPA encourage the public to review these documents for a more comprehensive discussion of the alternatives and the basis for the preferred alternative.

USACE has identified the preferred remediation alternative described in this Proposed Plan based on the information available at this time. The final decision on the remedy to be implemented will be documented in a Record of Decision (ROD) only after consideration of all comments received and any new information presented. USACE, in consultation with EPA, may modify the preferred alternative presented here or select another option from this Plan based on the new information or public comments. Therefore, the public is encouraged to review and comment on all the alternatives identified in this Plan.

SITE BACKGROUND

History

Past uranium processing and waste management activities conducted by Mallinckrodt Inc., (Mallinckrodt) in support of early Federal Government programs to develop atomic weapons resulted in radiological contamination over portions of SLDS. From 1942 to 1957, Mallinckrodt was under contract with the Manhattan Engineer District (MED) and Atomic Energy Commission (AEC) to process uranium ore for the production of uranium metal. The process involved digestion of uranium ore with nitric acid, and extraction and reduction of the uranium to a metal form. Residuals of the process, including spent pitchblende ore, process chemicals and radium, thorium, uranium, and their decay products were inadvertently released into the

environment through handling and disposal practices accepted at that time.

Industrial activities were conducted at the SLDS prior to the uranium processing work conducted for the MED/AEC, and are ongoing today. The site has a history of chemical production operations dating to 1867 when the original plant was constructed. Mallinckrodt no longer processes uranium, but does have ongoing chemical operations at the site in areas which have been impacted by the former uranium operations.

The SLDS was formerly part of the Department of Energy (DOE) Formerly Utilized Sites Remedial Action Program (FUSRAP). In June 1990, DOE and the U.S. Environmental Protection Agency (EPA) signed a Federal Facility Agreement (FFA) addressing the St. Louis Site, including the SLDS. This agreement defined implementation and oversight roles for the agencies involved as well as an enforceable schedule for completing remedy selection measures for the St. Louis sites. Under the current FFA schedule, the ROD for SLDS will be submitted to EPA on July 3, 1998. In October of 1997 FUSRAP was transferred from DOE to USACE by Congress as part of the fiscal year 1998 Energy and Water Appropriations Act. None of the properties making up the SLDS are owned by the Federal Government.

Description of the Contaminated Properties

The St. Louis Downtown Site is located in an industrialized area on the eastern border of St. Louis, adjacent to the Mississippi River. SLDS consists of the Mallinckrodt property and adjacent commercial and city owned properties, collectively referred to as the vicinity properties (Figure 1). A large chemical manufacturing and process facility owned and operated by Mallinckrodt covers approximately 18 ha (45 acres) of the site. Buildings cover a large portion of the site, and most of the remainder of the site is covered with asphalt or concrete. A levee, located to the east of SLDS, protects the facility from flood waters. The Mallinckrodt facility is bordered by a large metal recycling company (McKinley Iron Works) to the north; the Mississippi River, a defunct food processing company (PVO Foods), and City of St. Louis property to the east; a large lumber yard (Thomas and Proetz Lumber) to the south; and North Broadway and small businesses to the west. Additionally, the Norfolk and Western Railroad; the Chicago, Burlington, and Quincy Railroad; and the St. Louis Terminal Railroad Association have active rail lines passing in a north/south direction throughout the Mallinckrodt facility. These businesses and railroads make up the vicinity properties. Land in the downtown area is heavily industrialized and is projected to continue under industrial use into the future.

FUSRAP has conducted site characterization activities at each of the properties described above, and shown in Figure 1. As detailed in the RI report for the St. Louis site (DOE 1994), characterization data were obtained from samples of the site's soil, groundwater, surface water, sediment, air, and structures. The results of sampling have confirmed the presence of several areas containing elevated radioactive contamination (primarily radium-226 (Ra-226), thorium-230 (Th-230), uranium-238 (U-238), and decay products). Figure 2 provides a summary of the areas at SLDS containing radioactive contamination greater than the composite criteria (5 pCi/g for surface soils and 15 pCi/g for subsurface soils containing radium and thorium, and 50 pCi/g for U-238).

Non-radiological contaminants at elevated concentrations have also been detected in soils at the SLDS. In particular, above background levels of selected heavy metals and various organic compounds have been delineated. While it is likely that most of the organic compounds are not related to MED/AEC material processing activities, several of the metals detected are natural constituents of uranium ore and ore processing reagents, and could be a result of MED/AEC activities.

Under the terms of the FFA, USACE authority is limited to implementing response measure necessary for MED/AEC-related radiological and chemical contamination at the site. In addition, any

Figure 1. Plan View of the Downtown Area (BNI 1992b)

Figure 2. Extent of Radiological Contamination at SLDS

non-MED/AEC contaminants that are commingled with MED/AEC contamination will be addressed as part of response measures implemented for the SLDS. A more detailed discussion of the nature and extent of site contaminants is available in the RI Report (DOE 1994a), and the RI Addendum Report (DOE 1995).

Scope of Action

As discussed above, USACE authority for cleanup activities at SLDS is limited to those contaminants associated with past uranium processing operations conducted by MED/AEC. Because these activities involved use of radioactive materials, it is expected that any areas of FUSRAP responsibility will contain radioactive materials greater than risk-based cleanup guidelines. For this cleanup action, the radioactive elements Ra-226, Th-230, and U-238 are considered primary or "signature" contaminants for FUSRAP authority. The boundary for FUSRAP remediation is considered the risk-based concentration guidelines for these radionuclides as discussed under the Alternative 4 description below. Removal of radioactive material exceeding these concentrations will reduce the risk from MED/AEC-related contaminants to acceptable levels. This action will not eliminate risks from chemical contamination from other (non-MED/AEC related) activities, but such contamination is not included in the USACE's remediation authority.

Although remediation of radiological contaminants is expected to reduce the residual risk from MED/AEC-related activities to acceptable levels, identification of MED/AEC non-radiological contaminants in quantities that significantly impact residual risk will cause remediation of such constituents. Remediation will be consistent with applicable Preliminary Remediation Goals (PRGs). If non-radiological contaminants are not identified as MED/AEC material, they will not be remediated as part of this Proposed Plan.

SUMMARY OF SITE RISKS

A Baseline Risk Assessment (BRA) (DOE 1993) was conducted to evaluate potential risks to human health and the environment from the radioactive and non-radioactive contaminants at the site. In accordance with EPA guidance, the primary health risks investigated were cancer and other chemical-related illnesses. The assessment evaluated the potential risks that could develop without cleanup and assumes there are no protective controls in place, such as fencing to control access. This assumption tends to overestimate risks since measures are currently in place at SLDS to protect workers, the public, and the environment.

The purpose of the Baseline Risk Assessment was to determine the need for cleanup and to provide a baseline against which the remedial action alternatives were compared. The BRA process assessed the potential for current and future workers or the public to be exposed to the site contaminants, and the likelihood that such exposure would result in adverse health effects. In addition, possible effects on animal and plant species were considered. The complete BRA report is available from the Administrative Record for this site. A brief summary is provided here.

Sampling and analyses performed for the SLDS, together with data from historical reports, were used to identify chemicals and radionuclides of potential concern. These were evaluated based on a comparison with naturally occurring levels, regulatory guidelines, and on the known or suspected toxicological or radiological properties of the compounds. The site is heavily urbanized, and no sensitive species or habitats are known to be present onsite or affected by site contaminants.

The BRA identified the means by which people and the environment may be exposed to contaminants present at the SLDS. This included evaluation of potential ingestion, inhalation, dermal and direct exposure routes for contaminated soil and water. Mathematical models were used to predict the possible effects on human health and the environment from exposure to radionuclides and

chemicals for both present and future uses at the site. The results of the BRA were developed using the EPA required reasonable maximum exposure (RME) concentrations (representing the highest expected exposures) of the contaminants present at the site.

The modeled risk estimates were then compared to an EPA-established "target risk range" for incremental cancer incidence (i.e., the excess probability that an individual would develop cancer over a lifetime as a result of being exposed to the contamination at the site) to determine if remediation is warranted. The point of departure for determining if cleanup actions are warranted is an excess cancer incidence of 1 cancer in an exposed population of 1 million persons (10^{-6}), and the upper bound of acceptable risk is considered a few in 10,000 (10^{-4}). For noncarcinogens, unacceptable risk is determined by a total hazard index (HI) of greater than 1.0.

It is important to note that this Proposed Plan addresses cleanup of only those contaminants associated with former MED/AEC activities, as determined by radioactive signature contaminants. Thus while risks for these contaminants will be reduced to protective levels, risks may remain from other contaminants at SLDS which the USACE is not authorized to address. Risks from all MED/AEC contaminants will be addressed so that the final remedy is protective of human health and the environment.

Radiological Health Risk

The primary radiological potential contaminants of concern at SLDS are Ra-226, Th-230, U-235 (including the actinium series decay products actinium-227 and protactinium-231), U-238, Ra-228, Th-232, and their decay products. The results of the BRA indicate that risks from exposures to these radiological contaminants under current site use conditions were within the EPA's risk range for all exposure scenarios evaluated except for potential construction worker exposures. Risks to a potential construction worker who works in direct contact with contaminated soil exceeded the EPA risk range under assumptions used in the BRA (including no consideration of protective measures). Current risks to workers were calculated on the basis of current site conditions and associated industrial land/resource use.

Risks associated with potential future exposures under residential conditions exceeded the upper bound of the EPA risk range. As required by EPA BRA guidance, potential future risks were calculated by assuming that no cleanup measures are implemented and that land use remains industrial or shifts towards onsite residential or recreational activities. These results indicate that some level of additional control is needed to prevent the possibility of unacceptable exposure to remaining contamination at the SLDS (DOE 1993).

Chemical Health Risk

The primary chemical potential contaminants of concern identified in the BRA included heavy metals, and some organic compounds. Under current exposure conditions, carcinogenic risks associated with chemical exposures were estimated to be within the EPA risk range for acceptable exposures. Potential noncarcinogenic risk evaluated under current risk scenarios showed a total Hazard Index less than 1.0, indicating no unacceptable effects would be expected. Risks from future residential exposures to chemical constituents were determined to exceed the EPA risk range using exposure assumptions in the BRA. In addition the noncarcinogenic risks associated with future residential exposures were determined to exceed the Hazard Index threshold of 1.0. The potential chemical contaminants of concern identified in the Feasibility Study as potentially related to MED/AEC activities include arsenic, cadmium, copper and nickel.

Ecological Risk

An ecological assessment was conducted to evaluate potential effects from contamination of the SLDS. Due to the urban environment, the downtown site area has limited wildlife habitat and biotic diversity. The ecological assessment compared contaminant concentrations detected in various media (soil, sediment, and water) at the site with

literature on contaminant toxicity to biota. This study indicated that only arsenic, thallium, and PAHs are at concentrations in soil that could potentially impact biota, and of these, only arsenic could be associated with uranium ores or uranium processing. The ecological assessment concluded that the significance of the SLDS with regard to ecological resources is minimal, and that potential human health effects would determine the need and levels for cleanup (DOE 1993).

SUMMARY OF REMEDIAL ALTERNATIVES

Detailed descriptions of the remedial alternatives can be found in the Feasibility Study (FS) (USACE 1998) for SLDS, which is available in the Administrative Record file. Six site-wide alternatives developed for the SLDS are discussed below. These alternatives are designed to reduce risks associated with MED/AEC contaminants to levels that are protective under future industrial land use. Because MED/AEC activities involved use of radium, thorium, and uranium, these radionuclides are the primary focus of the cleanup, with incidental removal of other contaminants which are present with the radionuclides.

The SLDS FS evaluated several potential radiological cleanup guidelines for the site ranging from federal criteria for cleanup of uranium mill tailings sites, to site-specific dose or risk-based cleanup guidelines based on limiting risks to within EPA's acceptable risk range. This approach resulted in the "composite criteria" referred to in the Alternative discussions below since no single source covers all contaminants. These composite criteria include limits for Ra-226, Ra-228, Th-230 and Th-232 of 5 pCi/g in surface soils (less than 6 inches deep), and 15 pCi/g for soils greater than 6 inches deep. The composite criteria also include a derived limit of 50 pCi/g for U-238 based on a dose assessment performed by DOE prior to transfer of FUSRAP to the USACE (Fiore 1990). Site specific dose or risk-based criteria are based on an analysis of the partial removal alternative (Alternative 4 below) performed as part of the FS. This analysis determined target removal levels for radionuclides which would limit potential human exposures to within EPA's acceptable risk range under industrial land use.

The analysis to determine appropriate dose and risk-based target removal levels used guidance from the Nuclear Regulatory Commission (NRC) and the EPA. This assessment incorporated NRC guidance for using the As Low As Reasonably Achievable (ALARA) process to determine appropriate target removal levels, as well as EPA guidance on risk limits for radiation exposure. The results of this assessment show that use of dose or risk-based cleanup guidelines which include consideration of the depth of contamination will provide a remedy that protects human health and the environment, and will also provide a reasonable balance between cost and protectiveness. The risk-based target removal levels of 50 pCi/g Ra-226, 100 pCi/g Th-230, and 150 pCi/g U-238 are referred to as the "ALARA criteria".

For the purposes of conducting a detailed analysis of remedial alternatives, the volume of inaccessible soils was calculated. However, these soils would not be removed under this remedial action. In order to minimize the disruption to owner operations and to maximize the efficiency of removal, all SLDS inaccessible soils will be combined and remediated as a separate operable unit (OU). To ensure protectiveness, institutional controls would remain in place until remediation is completed.

Alternative 1 - No Action

Alternative 1, No Action, is required by CERCLA to be retained throughout the entire Feasibility Study to provide a baseline against which all other cleanup alternatives are compared. Under this alternative no action is taken to implement remedial activities. Periodic environmental monitoring activities would be conducted, but there would not be access restrictions or maintenance of the site. Conditions would be reassessed every five years.

Alternative 2 - Institutional Controls and Site Maintenance

Under this alternative, institutional controls and site maintenance would be implemented to prevent unacceptable exposures to site contamination. Institutional controls would include onsite activity limitations through deed restrictions, land use constraints through zoning, and groundwater use restrictions through groundwater use advisories or well-drilling permits. Site maintenance would include upkeep of the grounds, roadways and structures to prevent deterioration that would compromise the effectiveness of the institutional controls or increase the health risks to workers or the public. Other maintenance activities would include periodic surveillance, environmental and personnel monitoring, and implementing minimal engineering controls. Access control would be provided by ongoing security measures at Mallinckrodt, such as manned entrance points, security patrols, fences and signs.

Alternative 3 - Containment

Alternative 3 incorporates containment, institutional controls, and environmental monitoring to reduce further spread of contaminants and reduce the potential for direct exposure. Under this alternative, accessible soils from SLDS and vicinity properties would be excavated and consolidated and capped at a downtown location such as the City Property or Plant 2 area. Soils beneath buildings and other structures made available prior to the capping phase of this alternative would be excavated and disposed of at the consolidation location. Surface contaminated buildings would be decontaminated using a combination of physical and chemical techniques. After decontamination is complete, the buildings would be released for unrestricted use. Decontamination of buildings will be delayed until it can be performed without major disruption to plant operations.

The excavated soils and waste would be transported, consolidated, and capped at the Plant 2 location or on the City Property between the levee and the Mallinckrodt property. The cap would consist of a low permeability clay cover compacted in multi-layers. The clay cover combined with a low permeability liner would be designed and constructed such that infiltration and movement of water into and through the system is minimized. Under Alternative 3, the City-owned property next to the levee or the Mallinckrodt Plant 2 property would be purchased and maintained by the Federal Government.

To reduce the potential for exposure and human intrusion, institutional controls would be implemented to control access and prevent damage to the soil cover in the consolidation area. Institutional controls similar to those described in Alternative 2 (but also including inspection of the cap) would be implemented for contaminated access-restricted soils remaining in place. Engineering controls for radon would be implemented in buildings with radon concentrations in excess of guidelines. Groundwater monitoring would continue at the site, and institutional controls would be implemented to restrict installation of wells and limit groundwater use.

A long-term management plan would be developed to address notification requirements for property owners as well as monitoring and maintenance requirements into the future. This plan would be developed as part of the design process. This plan would include provisions addressing how property owners should contact the federal agency responsible for long-term control of impacted areas, and how these areas will be reviewed, maintained, and monitored by the Federal Government after completion of Alternative 3.

Alternative 4 - Partial Excavation and Disposal

This alternative includes excavation of accessible soils in the upper 2 ft to the composite criteria of 5 pCi/g in surface soil (top 6 in) and 15 pCi/g in shallow subsurface soil (to 2 ft) (for Ra-226, Ra-228, Th-230, and Th-232), and 50 pCi/g for U-238 (at any depth). Site-specific dose and risk-based target removal levels of 50 pCi/g Ra-226, 100 pCi/g Th-230 and 150 pCi/g U-238 (the "ALARA criteria") would be used for excavation of soils below 2 ft for most site areas. Because the Ra-226 contamination in the Plant 7 area is localized and shallow, the composite criteria will be used for all depths at Plant 7. Excavated soil exceeding the ALARA criteria and wastes would be shipped off-

site for disposal at an appropriate disposal facility. Soils below the ALARA criteria may be used as backfill below two feet. Soils below the composite criteria may be used as backfill in the top two feet. Approved off-site borrow will be used to supplement backfill. Inaccessible soil beneath buildings and rail lines are being addressed under a separate remedial action. Contaminated building surfaces at SLDS would be decontaminated/ dismantled as described under Alternative 3.

Alternative 4 will result in remediation of the site to the more conservative composite criteria for the depth interval where workers are most likely to have contact with soil (to a depth of 2 ft.). The composite criteria are also used for small localized areas where excavation provides for complete removal to depth with minimal volume increase (e.g., Plant 7 area). Excavation below 2 ft. will be to risk-based ALARA criteria except in the Plant 7 area.

It is important to note for the ALARA criteria that the actual concentrations of Ra-226, Th-230, and U-238 must be much less than the target removal levels of 50 pCi/g, 100 pCi/g, and 150 pCi/g, respectively if all are present together at any location. This is necessary to meet the requirement that the sum of each radionuclide concentration divided by its target guideline must be less than 1.0 (this is the "Sum of Ratios" rule). As an example, if three nuclides were present at 1/3 of their limit, then a sum of ratios of 1 would be reached.

Based on the ALARA assessment, these risk-based, ALARA criteria will be protective at the SLDS under industrial use conditions. Appropriate land use restrictions will be effected to include ensuring that future residential use is precluded at the site.

To reduce the potential for intrusion and human exposure, institutional controls similar to those described in Alternative 2 would be implemented for areas containing soils with residual contamination greater than the composite criteria after implementation of this alternative. The ALARA criteria used to address soil below two feet in depth result in the removal of the concentrated contaminants from above and below the water table. The contamination source that may contribute to potential future groundwater contamination will be removed. However, because the SLDS is in an area expected to remain highly industrialized, agreements will be negotiated with state and local water authorities to restrict the installation of wells within specified areas to prevent unauthorized use of groundwater.

Groundwater monitoring and a long-term management and notification program similar to that described under Alternative 3 would be instituted to ensure continued long-term protectiveness.

Alternative 5 - Complete Excavation and Disposal

This alternative involves excavating accessible soil contaminated above the composite criteria regardless of depth. Soils below the composite criteria will be used as backfill and will be supplemented by off-site borrow, as required. Building decontamination and partial dismantlement described under Alternative 3 would also be performed under this alternative. Contaminated soils and waste would be disposed at an appropriate disposal facility, similar to Alternative 4.

Groundwater would be monitored and institutional controls would be implemented to limit groundwater use at SLDS until the remedy for inaccessible soils is determined. Groundwater monitoring and institutional controls would cease in areas where the source of the contamination was remediated and protection of human health and the environment is demonstrated by risk assessment. However, because the SLDS is in an area expected to remain highly industrialized, agreements will be negotiated with the state and local water authorities to restrict the installation of wells within a specified area to prevent unauthorized use of groundwater.

A long-term monitoring and notification program would be implemented as described in Alternative 3 for those areas with inaccessible soils. This program would continue until the remedy for inaccessible soils is determined.

Alternative 6 - Selective Excavation and Disposal

This alternative focuses on reducing the need for future studies, designs, and remedial actions, in addition to protection of human health and the environment relative to Alternative 4. The depth of excavation would be extended for the most stringent criteria (composite criteria), thereby further reducing residual risk. To address these concerns, the depth of excavation above the composite criteria was extended to 6 ft in most areas of the plant and to 4 ft in other areas. For the purposes of preparing cost estimates, it is assumed that excavation to the composite criteria would proceed to a depth of 6 ft west of the St. Louis Terminal RR Association tracks and at the former locations of Buildings 116, 117, 704, 705, 706, and 707. Excavation for the composite criteria would stop at 4 ft at all other areas at SLDS including the VPs and under the roads. The columbium-tantalum processing area beneath Plant 5 would not be remediated under this alternative. The boundary of this area would be delineated prior to initiating remedial activities.

Only approved off-site borrow would be used to fill in the excavations above 4 or 6 feet across SLDS and the VPs. As in Alternative 4, contamination exceeding the ALARA criteria would be excavated to whatever depth is required. Material below the ALARA criteria could be used as backfill at depths greater than the compositecriteria concentration depth. Thus, below 6 ft (or 4 ft in some areas), the material exceeding the ALARA criteria would be replaced with material less than the ALARA criteria for radionuclides, provided it does not exhibit a hazardous characteristic and is not listed. Hazardous characteristic tests would be conducted on samples of potential backfill from each excavation.

Inaccessible soils would be excavated under a separate remedial action. Institutional controls would remain in place to ensure continued protectiveness until the remedy for inaccessible soils is determined.

EVALUATION OF THE SITE-WIDE ALTERNATIVES

The alternatives described in the previous section were evaluated using the nine CERCLA criteria to determine the most favorable actions for cleanup of the Downtown Site. These criteria consist of two threshold criteria which the selected alternative must satisfy, five balancing criteria to assist in selecting among alternatives that satisfy the threshold criteria, and two modifying criteria. This section provides a description of each of the CERCLA criteria, and summarizes the results of the detailed evaluation of remediation alternatives against these criteria. A more detailed analysis can be found in the Feasibility Study report (USACE 1998).

Glossary of Evaluation Criteria

Threshold Criteria

- ***Overall Protection of Human Health and the Environment*** – addresses whether an alternative provides adequate protection and describes how risks are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

- ***Compliance with Federal and State Environmental Regulations*** – addresses if a remedy would meet all of the applicable or relevant and appropriate requirements (ARARs) of other Federal and State environmental laws.

Balancing Criteria

- ***Long-Term Effectiveness and Permanence*** – addresses the remaining risk and the ability of an alternative to protect human health and the environment over time, once cleanup goals have been met.

- ***Short-Term Effectiveness and Environmental Impacts*** – addresses the impacts to the community and site workers during cleanup including the amount of time it takes to complete the action.

- ***Reduction in Toxicity, Mobility, or Volume through Treatment*** – addresses the anticipated performance of treatment that permanently and significantly reduces toxicity, mobility, or volume of waste.

- ***Implementability*** – addresses the technical and administrative feasibility of an alternative, including the availability of materials and services required for cleanup.

- ***Cost*** – compares the differences in cost, including capital, operation, and maintenance costs.

Modifying Criteria

- ***State Acceptance*** – evaluates whether the State agrees with, opposes, or has no comment on the preferred alternative.

- ***Community Acceptance*** – addresses the issues and concerns the public may have regarding each of the alternatives.

These modifying criteria are addressed as part of the Responsiveness Summary after public and state comments are received on the Feasibility Study and Proposed Plan.

ALTERNATIVE COMPARISON

The purpose of the following analysis is to weigh the advantages and disadvantages of the alternatives, when compared with each other, based on the evaluation criteria. This information is used to select a preferred alternative.

Overall Protection of Human Health and the Environment. Alternatives 2, 3, 4, 5, and 6 would be protective of human health and the environment, while Alternative 1 is not. Therefore Alternative 1 cannot be implemented at the SLDS because it would not achieve the protectiveness threshold criterion required by CERLCA. Alternative 2 uses institutional controls exclusively to achieve overall protection of human health and the environment, while Alternative 3 would use engineered containment and institutional controls to achieve overall protectiveness. Alternative 4 uses a combination of removal of soils contaminated above ALARA criteria, with institutional controls to achieve protection of human health and the environment. Alternative 6 is as protective as Alternative 4 and requires fewer restrictions on use following implementation.

Alternatives 3, 4, 5, and 6 remove the source of potential future groundwater contamination from below the water table. Alternatives 3, 4, 5, and 6 are as effective as Alternative 2 in controlling access to groundwater contamination, and are more effective than Alternatives 1 and 2 at minimizing the potential for future groundwater contamination.

Alternative 5 provides the best protection of human health and the environment by removing the soil exceeding the composite criteria regardless of the soils depth or inaccessibility. Alternatives 2, 3, 4, 5, and 6 will reduce the long-term risks associated with existing contamination to levels comparable with natural background exposures at selected sites within the United States.

Compliance with ARARs. Alternative 1 would not comply with ARARs and therefore does not satisfy either of the threshold criteria. Alternative 2 would rely on institutional controls to meet ARAR requirements for the contamination left in place. Alternatives 3, 4, 5, and 6 would comply with ARARs. Supplemental standards under 40 Code of Federal Regulations (CFR) 192.22 may be used under Alternative 3 for soil left onsite and for Alternatives 4 and 6 for deep soil.

Supplemental standards are allowable when it can be demonstrated that contamination left in place presents no significant exposure hazard, remedial action would cause environmental harm that is excessive compared to health benefits, remedial action would pose a clear and present risk of injury to workers, and where cleanup costs are unusually high. Alternative 4 would include the use of site specific dose assessment to demonstrate compliance with the public dose limit specified in 10 CFR 20 Subpart E. Because Alternative 6 excavates more soil to the composite criteria to a greater depth, worker doses and risks would be lower under Alternative 6 than under Alternative 4.

Consequently, a separate dose assessment for Alternative 6 would not be necessary. Alternative 5 is the only alternative that completely complies with ARARs without implementing supplemental standards, since soil exceeding composite criteria would be removed without regard to depth.

Long-Term Effectiveness and Permanence. A primary measure of the long-term effectiveness of an alternative is the magnitude of residual risk to human health after remediation. The adequacy and reliability of engineering and/or institutional controls used to manage residual materials that remain onsite must also be considered. Over the long term, the containment and removal remedies, Alternatives 3, 4, 5, and 6, are the most effective in protecting human health and the environment. Alternative 5 has the highest degree of long-term effectiveness and permanence because contaminated accessible and access-restricted soils are removed from the site for permanent disposal. Alternatives 3, 4, and 6 have a high degree of long-term effectiveness and permanence compared to Alternative 1 and 2 because accessible contaminated soils and contaminated building materials are removed for permanent containment and disposal. Alternative 2, as well as Alternatives 3, 4, and 6 to a lesser extent, rely on institutional controls for protection from the contaminated soil, and therefore are only effective as long as these controls are in place and in compliance.

Implementing site-wide Alternatives 3, 4, 5, or 6 would result in permanent removal of contaminated soil from the site and permanent commitment of land for waste disposal. Since Alternative 5 removes contaminated soil and debris exceeding the composite criteria from the site, no continued maintenance would be required. Alternatives 2, 3, 4, and 6 require some maintenance to varying degrees. Alternative 5 is the only action that allows use of the land after the site is remediated and redeveloped without institutional controls.

Short-Term Effectiveness. Short-term effectiveness is measured with respect to protection of community and workers, short-term environmental impacts during remedial actions, and time until remedial action objectives are achieved. An increase in the complexity of an alternative typically results in a decrease in short-term effectiveness because of increased handling and processing. Compared to Alternative 1, Alternative 2 is the most effective in protecting the community and workers because there is no handling of the waste material or construction activities, and Alternative 2 can be implemented quickly. Because Alternatives 3 and 5 have the longest and most difficult onsite construction, they would have the greatest potential for adverse effects on Mallinckrodt workers and the public from radiological exposure, fugitive dust and industrial accidents. Alternative 4 would expose the onsite worker and the public to these risks to a lesser extent, because it requires less earth to be excavated/backfilled and removes the excavated soil immediately off-site. Alternative 6 would present more risk to workers and the public than Alternative 4 because of the greater volume of excavation and the return of soil below the ALARA criteria to areas below 4 and 6 feet.

The risk of transportation-related lifetime cancer incidence, accidents, or fatalities is greatest for Alternative 5 since it involves the greatest amount of radiological material to haul compared to Alternatives 3, 4, and 6, and an increased hauling distance compared to Alternative 3. The risk of injury and fatalities from transporting waste long distances are much greater than radiological cancer incidence, with the greatest projected number of accidents and fatalities involving the public rather than the transportation crew.

As compared to Alternative 1, which does not control groundwater use, Alternatives 2, 3, 4, 5, and 6 are comparable in short-term effectiveness of groundwater contamination control.

Reduction in Contaminant Volume, Toxicity, and Mobility through Treatment. Treatment is not a component of any of the retained cleanup alternatives; however, it has been retained as a conditional part of the remedy in Alternatives 3, 4, 5, and 6. The addition of treatment (if warranted in the future) could be achieved as a modular-type step for Alternatives 3, 4, 5, or 6. The FS reviewed available

treatment studies for St. Louis soils from other sites. No studies have demonstrated the proven capability to effectively treat area soils, but the option to treat soils will still be available if future studies develop viable technologies and processes for this site.

Alternatives 4, 5, and 6 provide for off-site containment at a final disposal location and any treatment required to meet the standards of the off-site facility. Therefore, alternatives 4, 5, and 6 will achieve reduction in mobility, and possibly will reduce the toxicity or volume of the contaminants depending on the disposal facility's requirements.

Implementability. All the Alternatives are readily implementable. Alternatives 1 and 2 are the easiest and fastest to implement because they require no remedial activity. The design, engineering, and administrative requirements of Alternatives 1 and 2 are minor and materials are commercially accessible.

The excavation alternatives (3, 4, 5, and 6) are all technically and administratively feasible with Alternative 3 having the most engineering and design complexity. The institutional controls associated with Alternatives 3, 4, and 6 are similar in intricacy to Alternative 2, however Alternative 6 requires fewer restrictions following implementation. Materials and services for the removal of contamination and environmental monitoring activities for the various alternatives are readily available. The degree of difficulty in implementing alternatives increases with the amount and type of contaminated soils to be excavated (i.e., access-restricted soils), the level of the permitting required to dispose of soils in accordance with applicable regulations, and the time/coordination involved in completing the alternative.

Alternatives 3 and 5, logistically, are the most complex and difficult to implement because of the large volume of soil removed and the obstacles the excavations must negotiate. Of the three excavation alternatives Alternative 4 would be the fastest and the easiest to implement and Alternative 5 would be the slowest and most difficult.

Cost. The comparative analysis of costs examines the differences in capital, operations and maintenance (O&M), and present-worth values. Costs for each alternative, itemization of individual components, and the sensitivity analysis for each alternative were developed and presented in the Feasibility Study. The total 30-year costs for the six alternatives are given in Table 1. To provide comparability across alternatives, cost estimates were based on addressing all impacted soil, accessible and inaccessible, for each alternative. This approach does not substantively impact the alternatives analysis.

DESCRIPTION OF AND RATIONALE FOR THE PREFERRED ALTERNATIVE

The USACE prefers Alternative 4, Partial Excavation with Off-site Disposal. This alternative was selected based on the following rationale.

Table 1. Implementation Costs for St. Louis Downtown Site

Alternative	Description	Cost (in 1998 $)
1	No Action	$22 million
2	Institutional Controls and Site Maintenance	$29 million
3	Consolidation and Capping	$100 million
4	Partial Excavation with Off-site Disposal	$92 million
5	Complete Excavation with Off-site Disposal	$140 million
6	Selective Excavation and Disposal	$114 million

- It provides for protection of human health and the environment through use of risk-based target cleanup levels.

- It assures no further degradation of resources, and mitigates the potential for future impacts to the environment.

- It enables local businesses to continue normal operations with minimal impacts from remedial actions.

- It provides the best balance of effectiveness, cost, and implementability compared to the other alternatives considered.

This preferred alternative includes the following components.

- Excavation of accessible soils in the surface to 2 ft depth interval which exceed the composite criteria (5/15 pCi/g for Ra-226, Ra-228, Th-230, and Th-232 and 50 pCi/g for U-238).

- For soils below 2 ft deep, site-specific, risk-based, ALARA criteria (50 pCi/g Ra-226, 100 pCi/g Th-230, and 150 pCi/g U-238) will be used as the target cleanup levels. These criteria will be implemented using standard methods for dealing with mixtures of radionuclides (Sum of Ratios method) which will require lower individual radionuclide concentration limits when multiple radionuclides are present.

- Because of the minimal volume of localized and shallow Ra-226 contamination at Plant 7, excavation in this area will not use the ALARA criteria but will continue until the area meets the composite criteria shown above.

- Buildings will be decontaminated and dismantled if necessary as they are made available by the owner.

- Excavated soils above the ALARA criteria and contaminated debris will be shipped off-site to an appropriate disposal facility.

- Soil below ALARA and composite criteria would be reused below two feet, and in the top two feet, respectively.

- Institutional controls, site monitoring, and 5-year reviews would be implemented for those areas where soils containing greater than the composite criteria remain.

- A long-term monitoring and notification plan will be included as part of implementation of this alternative. This plan will be developed as part of the overall St. Louis Site FS. It will address federal agency responsibilities, institutional controls, monitoring, site maintenance, and property owner notification requirements into the future.

COMMUNITY ROLE IN SELECTION PROCESS

Public input is encouraged by USACE to ensure that the remedy selected for the St. Louis Downtown Site meets the needs of the local community in addition to being an effective solution to the problem. The Administrative Record file contains all of the documentation used to support the preferred alternative and is available at or through the following locations:

USACE Public Information Center
9170 Latty Avenue
Hazelwood, Missouri 63042

Government Information Section
St. Louis Public Library – Central Library
1301 Olive Street
St. Louis, Missouri 63103

St. Louis County Library
Prairie Commons Branch
915 Utz Lane
Hazelwood, Missouri 63042

The public is encouraged to review and comment on all alternatives described in this Proposed Plan and in the supporting Feasibility Study.

Comments on the proposed remedial action at the St. Louis site will be accepted for 30 days following issuance of the Feasibility Study and Proposed Plan. A public meeting will be held during the comment period to receive any verbal comments the public wishes to make. Written comments the public wishes to make or submit regarding the preferred alternative or any other aspect of the Feasibility Study and Proposed Plan will be received at the meeting or during the 30-day comment period.

USACE will respond to all significant comments submitted during the comment period in a Responsiveness Summary. After considering these comments, USACE and EPA will make a final decision on the cleanup remedy for the site, which will be outlined in a document called the Record of Decision (ROD). The Responsiveness Summary will be an attachment to the ROD.

All written comments should be addressed to:

Dr. Rob Mullins, Jr.
U.S. Army Corps of Engineers
St. Louis District
9170 Latty Ave.
St. Louis, MO 63134

REFERENCES

10 Code of Federal Regulations Part 20, *Standards for Protection Against Radiation*, Subpart E – *Radiological Criteria for License Termination*.

40 Code of Federal Regulations Part 192. *Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings.*

DOE Order 5400.5. *Radiation Protection of the Public and Environment*, 1990

DOE 1993. *Baseline Risk Assessment for Exposure to Contaminants at the St. Louis Site, St. Louis Missouri*, DOE/OR/23701-41.1, Oak Ridge, TN, November.

DOE 1994a. *Remedial Investigation for the St. Louis Site*, DOE/OR/21949-280, Oak Ridge, TN.

DOE 1995. *Remedial Investigation Addendum for the St. Louis Site*, DOE/OR/21950-132, September.

Fiore 1990. DOE Office of Environmental Restoration, Memorandum to L.K. Price, Former Sites Restoration Division, on *Uranium Cleanup Guidelines for St. Louis Missouri FUSRAP Sites*, November.

USACE 1998. *Feasibility Study for the St. Louis Downtown Site*, March.