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ER-074/01
October 3, 2001

Mr. Richard B. Provencher, Director
Miamisburg Environmental Management Project
U. S. Department of Energy
P. O. Box 66
Miamisburg, OH 45343-0066

ATTENTION: Robert S. Rothman

SUBJECT: Contract No. DE-AC24-97OH20044
**ACTION MEMORANDUM – CONTINGENT REMOVAL ACTION FOR
CONTAMINATED SOIL – PUBLIC REVIEW DRAFT**

REFERENCE: Statement of Work Requirement C.7.1d—Regulator Data Requests

Dear Mr. Provencher:

Rob Rothman from your office has approved the release of the enclosed Action Memorandum – Contingent Removal Action for Contaminated Soil – Public Review Draft. Also enclosed are responses to comments from OEPA on the Draft version of this document. These comments were resolved informally in a series of conference calls prior to the start of the public review period on September 12. Transmittal of this enclosure formally closes the comment resolution process.

If you or members of your staff have any questions regarding the document, or if additional support is needed, please contact Dave Rakel at extension 4203.

Sincerely,

Monte A. Williams
Project Manager, Environmental Restoration

MAW/DAR:jdg

Enclosures

cc: Tim Fischer, USEPA, (1) w/attachments
Brian Nickel, OEPA, (4) w/attachments
Ruth Vandegrift, ODH, (1) w/attachments
Frank Schmaltz, DOE/MEMP, (1) w/attachments
Dave Rakel, BWXT of Ohio, (1) w/attachments
Karen Arthur, BWXT of Ohio, (1) w/attachments
Monte Williams, BWXT of Ohio, (2) w/attachment
DCC

RESPONSES TO COMMENTS FROM
OHIO EPA AND ODH/BRP ON THE
ACTION MEMORANDUM EE/CA
CONTINGENT REMOVAL ACTION FOR CONTAMINATED SOIL
DRAFT REVISION 0
JULY 2001

General Comments

1. As indicated on page 2, Section 2.1.1, there are a number of "not yet discovered" sites that are to be covered by this memorandum. This seems somewhat problematic particularly with regard to public notice. Can Ohio EPA make meaningful comments about actions that are yet to be determined?

Response

This concern was resolved in a series of conference calls and the resultant revisions in the document from Draft to Public Review Draft.

2. To help our immediate need to remediate PRS 421 and PRS 276, we believe this action memorandum needs to focus on these two PRSs in Phase 1. To streamline the process, it is acceptable to combine the two in a single action memorandum and submit it for public comment. We are concerned with the public review process proposed in this Contingent Removal Action (CRA). Under the Mound 2000 Work Plan, a 30 day public comment period is required for each action memorandum. This allows us to meet the objective of the NCP to involve the public in the remedial decision process, including the establishment of cleanup objectives. Portions of the plan eliminate this opportunity for input. We are open to discussion regarding various approaches and wish to continue this dialogue for creating more efficient cleanup approaches, including the removal of small isolated "hot spots." But, for immediate need of remediating Phase 1, our focus should be on the two PRSs in the Phase scheduled for the next parcel transfer.

Response

This concern was resolved in a series of conference calls and the resultant revisions in the document from Draft to Public Review Draft. The public notice approach used in the Draft document was revised to allow the public more opportunity to comment. The public review approach in the Public Review Draft is consistent with the approach used in the DOE/EPA Factsheet "Expediting Cleanup Through Contingent Removal Actions" (March 1997).

Specific Comments

1. Section 1
Page 1 of 21, Second Paragraph

Remove "Contingent" and "C" from CRA so that it reads: "... justify application of Removal Action (RA) consistent with CERCLA, to propose the RA described herein, and allow public input (USEPA 1990)." All other references to "CRA," including text, will need to be adjusted to narrow the focus to PRS 276 and PRS 421.

Response

By continuing discussion, US EPA, OEPA, DOE, and BWXTO reached agreement without restricting the applicability to PRS 276 and 421.

2. Section 2.1.1

Page 2 of 21

Delete the last sentences referencing the CRA.

Response

By continuing discussion, US EPA, OEPA, DOE, and BWXTO reached agreement without restricting the applicability to PRS 276 and 421.

3. Section 2.1.2

Page 2 of 21

See general comments and comment above regarding Section 1 and Section 2.1.1.

Response

By continuing discussion, US EPA, OEPA, DOE, and BWXTO reached agreement without restricting the applicability to PRS 276 and 421.

4. Section 2.2

Page 2 of 21, First Sentence

Please change "between" to "among."

Response

The text was changed as requested.

5. Figure 21

Page 3 of 21

Eliminate all PRSs except PRS 276 and PRS 421. Also note that the boundaries of PRS 75 extend west under the current soil loading area. This PRS was deferred because the contaminated soil loading area will continue to be utilized.

Response

By continuing discussion, US EPA, OEPA, DOE, and BWXTO reached agreement without restricting the applicability to PRS 276 and 421. PRS 75 was removed.

6. Table 2.1

Page 5 of 21

Please eliminate all PRSs except PRS 276 and PRS 421.

Response

By continuing discussion, US EPA, OEPA, DOE, and BWXTO reached agreement without restricting the applicability to PRS 276 and 421.

7. Section 5.1, Page 9 of 21

First Paragraph, Last Sentence

Remove the last sentence in this paragraph, and modify the "CRA" to "RA" in the second sentence.

Response

By continuing discussion, US EPA, OEPA, DOE, and BWXTO reached agreement on implementing a contingent removal action.

8. Section 5.1.1

Page 9 of 21, First Paragraph

Indicate in the first paragraph that the following components listed below (the bulleted paragraphs) will be described in greater detail in the Removal Action Work Plan for PRS 276 and PRS 421.

Response

By continuing discussion, US EPA, OEPA, DOE, and BWXTO reached agreement without restricting the applicability to PRS 276 and 421.

9. Section 5.1.1

Page 9 of 21, First Bullet

Project Planning – include soil erosion controls as one of the objectives.

Response

Soil erosion controls were added to the Site Preparation step.

10. Section 5.1.1

Page 9 of 21, Second Bullet

Public Notification – delete all but the first sentence. Are we really giving sufficient notice if the first the public knows about the location is in the public notice and the notice is being published at the same time as the fieldwork is starting?

Response

By continuing discussion, US EPA, OEPA, DOE, and BWXTO reached agreement on a different approach. In addition to the public notice published in a newspaper, a factsheet will be developed and made available to the MAC and MRC.

11. Section 5.1.1

Page 9 of 21, Third Bullet

Site Preparation – include soil erosion controls as one of the steps.

Response

Soil Erosion controls were added to this step.

12. Section 5.1.1
Page 10 of 21, Second Bullet (from top of page)
Verification – The list of contaminants of concern (COC) referenced as cleanup objectives in Table 5.1 were much greater for PRS 407, the area from which the contamination migrated. The COC and verification for PRS 421 need to be consistent unless adequate justification can be provided. PRS 276 received soils from many contaminated areas. We need to evaluate these areas for other potential COCs.
Response
By continuing discussion, US EPA, OEPA, DOE, and BWXTO reached agreement on a different approach that uses the VSAP as the vehicle for establishing the list of COCs.
13. Section 5.1.1
Page 10 of 21, Second Bullet (from top of page)
Verification – delete the last sentence and replace it with: “As the removal progresses, other COCs may be identified. Cleanup objectives will be consistent with the most recent 10^{-6} Risk Based Guideline Values. The cleanup objective will be adjusted for background concentrations as appropriate.”
Response
By continuing discussion, US EPA, OEPA, DOE, and BWXTO reached agreement on a different approach that uses 10^{-5} risk based guideline values.
14. Section 5.1.1
Page 10 of 21, Third Bullet (from top of page)
Site Restoration – it should be stated that the restoration will meet all construction requirements and that MMCIC will be consulted as per the future use of the site and vegetation.
Response
In the course of the discussions about this action memo, this section was not revised. As the update on PRS 276 at the FFA meeting on September 26 demonstrated, there are communication mechanisms in place for consultation with MMCIC on site restoration.
15. Table 5.1 Cleanup Objectives
Page 11 of 21
This table will need to be modified as per comment #12 above.
Response
The table was modified extensively.
16. Section 5.1.13

Page 11 of 21

Are not the "other locations" an uncertainty?

Response

Although the total number of "other locations" is an uncertainty, this was not included in the Public Review Draft

17. Section 5.1.2

Page 12 of 21, First Paragraph

In the first sentence (third printed line), a space should be inserted between the words "contamination" and "remaining;" also, "excavavtion" is misspelled.

Response

The space was inserted and the spelling corrected.

18. Section 5.1.4

Page 12 of 21

More information is needed concerning the EE/CA. Elaborate as to how the evaluation led to the presented cost analysis: what is the basis for the analysis as presented herein?

Response

The cost estimates presented are the average for the listed PRSs.

19. Section 5.1.5.2

Page 13 of 21

Include the appropriate surface water and construction standards, e.g., surface water runoff controls and fugitive dust controls.

Response

These standards were added.

20. Section 5.1.7

Page 14 of 21

The fifth sentence presents the same concerns as discussed in comment #10. Are we really giving sufficient notice if the first the public knows about the location is in the public notice and the notice is being published at the same time as the fieldwork is starting?

Response

See response #10.

21. Section 5.2 and Table 5.2

Pages 14 and 15 of 21

Please provide more information as to how the estimated costs were determined. Are the costs presented for all the PRSs, or for each? With the discussed uncertainties, what level of confidence does DOE-MEMP and BWXTO have in the numbers presented? Is it possible that the costs are underestimated? Based on the geographic size alone, the volume of contaminated soil varies from PRS to PRS. How

is this taken into account? Also, do the costs take into account the latest efficiencies?

Response

The cost estimates presented are the average for the listed PRSs.

22. Section 8

Page 19 of 21, Fourth Sentence

Please remove the word "the" between "per" and "CERCLA."

Response

The text was changed as requested.

23. Appendix A

PRS 75 Recommendation

This PRS was differed until near the end of site restoration due to the need for staging and shipping. Please remove from the document. All PRS recommendations other than PRS 276 and PRS 421 should be removed.

Response

PRS 75 was removed. By continuing discussion, US EPA, OEPA, DOE, and BWXTO reached an agreement that included the other PRSs listed in Appendix A.

**ACTION MEMORANDUM
ENGINEERING EVALUATION/COST ANALYSIS**

**CONTINGENT REMOVAL ACTION FOR
CONTAMINATED SOIL**

**MOUND PLANT
MIAMISBURG, OHIO**

SEPTEMBER 2001

Public Review Draft



Department of Energy



BWXT of Ohio, Inc.

**ACTION MEMORANDUM
ENGINEERING EVALUATION/COST ANALYSIS**

CONTINGENT REMOVAL ACTION FOR CONTAMINATED SOIL

**MOUND PLANT
MIAMISBURG, OHIO**

SEPTEMBER 2001

**PREPARED FOR:
U.S. DEPARTMENT OF ENERGY
MIAMISBURG ENVIRONMENTAL MANAGEMENT PROJECT
MIAMISBURG, OHIO 45343**

**BY:
BWXT of Ohio, Inc.
P.O. BOX 3030
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UNDER CONTRACT #DE-AC24-97OH20044**

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APPENDIX

Appendix A	Core Team Recommendations for PRSs 153, 266, 273, 276, 412, and 421	
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Appendix B Background information for PRSs 153, 266, 273, 276, 412,
and 421

Appendix C Calculation of Risk-Based Guideline Values

ACRONYMS

AM	Action Memorandum
AM/EE/CA	Action Memorandum/Engineering Evaluation/Cost Analysis
ARARs	Applicable or Relevant and Appropriate Requirements
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	Contaminant of Concern
CRA	Contingent Removal Action
DOE	Department of Energy
DOT	Department of Transportation
EE/CA	Engineering Evaluation/Cost Analysis
ER	Environmental Restoration
FFA	Federal Facilities Agreement
MEMP	Miamisburg Environmental Management Project
MMCIC	Miamisburg Mound Community Improvement Corporation
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
OAC	Ohio Administrative Code
OEPA	Ohio Environmental Protection Agency
OSC	On-Scene Coordinator
OSHA	Occupational Safety and Health Administration
pCi/g	picoCuries per gram
PRS	Potential Release Site
RA	Removal Action
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
RSE	Removal Site Evaluation
SARA	Superfund Amendments and Reauthorization Act
USEPA	United States Environmental Protection Agency

1. PURPOSE

The U.S. Department of Energy (DOE) is the designated lead agency under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and removal actions at the Mound Plant are implemented as non-Superfund, federal-lead actions. DOE provides the On-Scene Coordinator (OSC). Non-Superfund, federal-lead removal actions are not subject to United States Environmental Protection Agency (USEPA) limitations on the OSC (\$50,000 authority) and are not subject to National Oil and Hazardous Substances Pollution Contingency Plan (NCP) limitations on removal actions (i.e., \$2,000,000 in cost and 12 months in duration).

This Action Memorandum (AM) Engineering Evaluation/Cost Analysis (EE/CA) has been generated to document the general site conditions that would justify application of a Contingent Removal Action (CRA) consistent with CERCLA, to propose the CRA described herein, and to allow public input (USEPA 1990).

2. SITE CONDITIONS AND BACKGROUND

2.1 SITE DESCRIPTION

This section describes the physical site location, site characteristics, release of contaminants into the environment, and the site's National Priorities List (NPL) status.

2.1.1 Physical Location

The Mound Plant is located on the southern border of the city of Miamisburg in Montgomery County, Ohio. The site is located approximately 10 miles south-southwest of Dayton and 45 miles north of Cincinnati. This CRA is proposed for the Potential Release Sites (PRSs) identified in Table 2.1 and shown in Figure 2.1. This CRA is also proposed for similar PRSs designated for Removal Action (RA) by the Core Team as well as similar sites not yet discovered.

2.1.2 Site Characteristics

The PRSs to be addressed under this Action Memorandum have the following characteristics:

- simple removal action,
- easily verified, and
- small number of contaminants of concern.

PRSs that meet the above criteria and have been designated for RA are identified in Table 2.1.

2.1.3 Release or Threatened Release into the Environment

The potential release of radionuclides and/or hazardous chemicals (including petroleum hydrocarbons) prompted this removal action.

2.1.4 National Priorities List Status

The USEPA placed the Mound Plant in Miamisburg, Ohio on the NPL by publication in the Federal Register on November 21, 1989.

2.2 OTHER ACTIONS TO DATE

The Mound Plant initiated a CERCLA program in 1989, now guided by the agreement among, the DOE, Ohio Environmental Protection Agency (OEPA), and USEPA. A Federal Facilities Agreement (FFA) under CERCLA Section 120 was executed between DOE and USEPA Region V on October 12, 1990. It was revised on July 15, 1993.

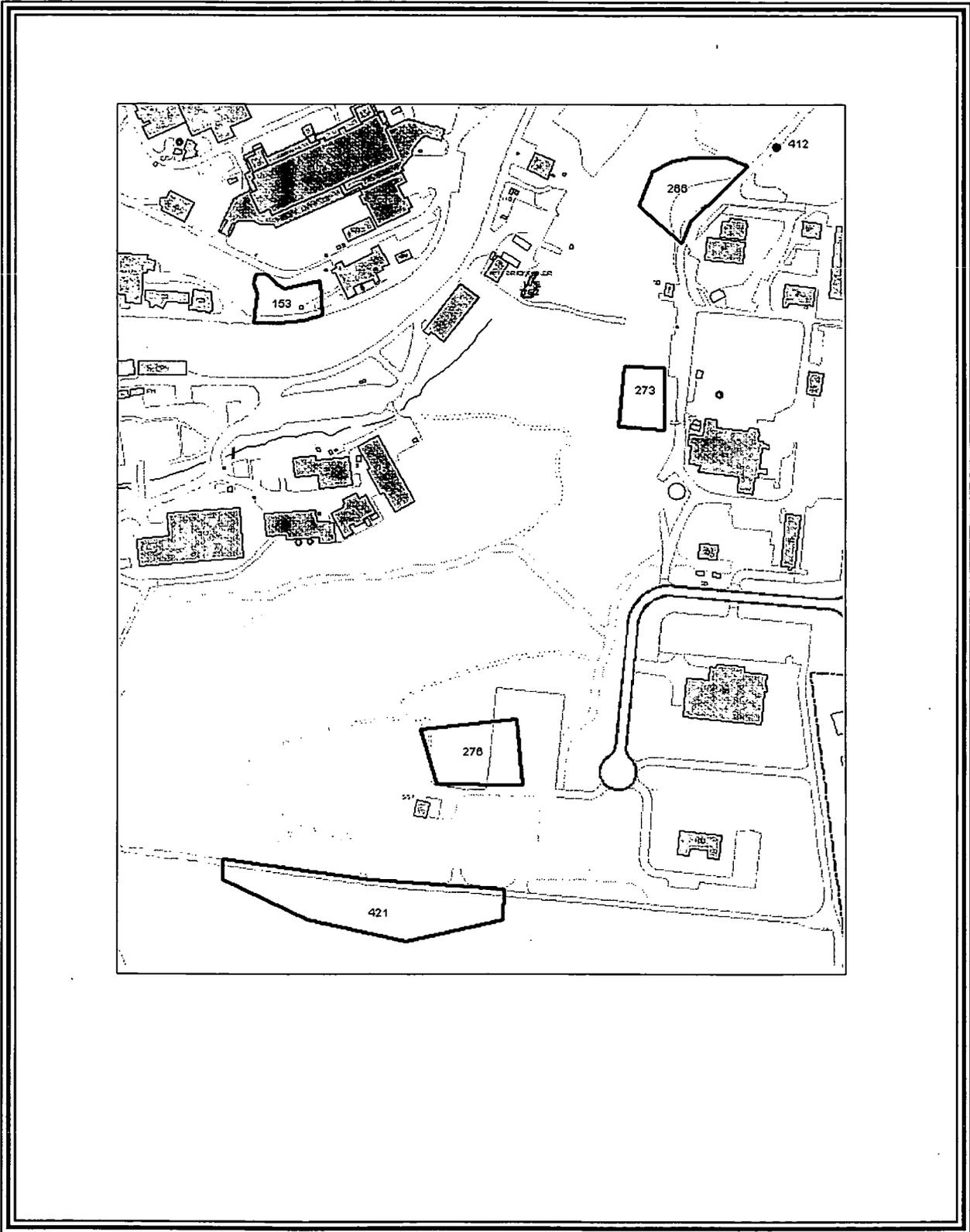


Figure 2.1 Location of Identified PRSs for this Contingent Removal Action
(PRS 153, 266, 273, 276, 412, and 421 - Outlined in Red)

(EPA Administrative Docket No. OH 890-008984) to include OEPA as a signatory. The general purposes of the FFA are to:

- ensure that the environmental impacts associated with past and present activities at the site are thoroughly investigated and appropriate remedial actions taken as necessary to protect the public health, welfare, and the environment,
- establish a procedural framework and schedule for developing, implementing, maintaining, and monitoring appropriate response actions at the site in accordance with CERCLA, Superfund Amendments and Reauthorization Act (SARA), the NCP, Superfund guidance and policy, and Resource Conservation and Recovery Act (RCRA) guidance and policy, and
- facilitate cooperation, exchange of information, and participation of the parties in such actions.

On the dates indicated in Table 2.1, the Core Team (consisting of representatives of DOE/Miamisburg Environmental Management Project (MEMP), USEPA, and OEPA) recommended these PRSs be addressed as Removal Actions. These recommendations (included in Appendix A) were available for public review and comment during the dates indicated in Table 2.1.

2.2.1 Previous Removal Actions

No previous removal actions have been performed at the PRSs identified in Table 2.1.

2.2.2 Current Actions

Currently, no action is underway at the PRSs in Table 2.1.

2.3 STATE AND LOCAL AUTHORITIES' ROLES

2.3.1 State and Local Action to Date

In 1990, as a result of Mound Plant's placement onto the NPL, DOE and USEPA entered into an FFA that specified the manner in which Mound CERCLA-based Environmental Restoration (ER) was to be implemented. In 1993, the FFA was amended to include the OEPA as a signatory. DOE remains the lead agency.

Table 2.1 Initial PRSs Identified for this Contingent Removal Action

PRS	Date of Core Team Removal Action Recommendation	Dates of Public Review
153	July 17, 1996	January 9, 1997 - February 13, 1997
266	August 28, 1996	October 2, 1996 - February 15, 1996
273	April 17, 1996	January 30, 1997 - March 6, 1997
276	July 22, 1999	October 13, 1999 - November 13, 1999
412	March 17, 1998	April 15, 1998 - May 15, 1998
421	July 12, 2000	May 10, 2001 - June 10, 2001

2.3.2 Potential for Continued State and Local Response

Eventual release of the Mound Plant for industrial/commercial use is planned. Periodic environmental monitoring of the area may be required until a final Record of Decision (ROD) is implemented for the entire Mound site. This monitoring would require coordination with local, state, and federal authorities. Current plant-wide environmental monitoring programs will continue until such time as remediation is completed. OEPA will continue its oversight role until all terms of the FFA have been completed.

3. THREAT TO PUBLIC HEALTH OR WELFARE OR THE ENVIRONMENT

3.1 THREATS TO PUBLIC HEALTH OR WELFARE

The potential release of radionuclides and/or hazardous chemicals (including petroleum hydrocarbons) may create a potential threat to the public health or welfare.

3.2 THREATS TO THE ENVIRONMENT

The potential release of radionuclides and/or hazardous chemicals (including petroleum hydrocarbons) may create a potential threat to the environment.

3.2.1 Removal Site Evaluation

The Removal Site Evaluation (RSE) requirements, as outlined under EPA's NCP regulations in 40 Code of Federal Regulations (CFR) 300.415, are presented throughout this AM/EE/CA. The source and nature of the potential release are described in the PRS Data Packages for the PRSs listed in Table 2.1. On the basis of this information, the Core Team recommended Removal Actions for these PRSs. An evaluation by public health agencies has not been performed for these PRSs, and, therefore, is not included in this AM/EE/CA. The determination of the need for a removal action is outlined in this section in Table 3.1.

The NCP identifies eight factors that must be considered in determining the appropriateness of a removal action [40 CFR 300.415(b)(2)]. These criteria are evaluated in Table 3.1.

**Table 3.1 Evaluation of Removal Action Appropriateness Criteria
[40 CFR 300.415(b)(2)]**

Criteria		Evaluation
(i)	"...potential exposure to nearby human populations, animals, or the food chain..."	There is potential exposure to nearby human populations, animals, or the food chain from the radionuclides and/or hazardous chemicals (including petroleum hydrocarbons) when present institutional controls are relaxed.
(ii)	"Actual or potential contamination of drinking water supplies..."	There is potential for contamination of onsite drinking water supplies from the radionuclides and/or hazardous chemicals (including petroleum hydrocarbons). The contaminants could migrate to the groundwater that is the source for the plant drinking water.
(iii)	"Hazardous substances or pollutants or contaminants in drums, barrels, tanks, or other bulk storage containers, that may pose a threat of release;"	This CRA does not address hazardous substances, pollutants, or contaminants in drums, barrels, tanks, or other bulk storage. However, remnants of drums, barrels, tanks, or other bulk storage may be encountered during this CRA.
(iv)	"High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface, that may migrate;"	There is the potential to encounter high levels of hazardous substances, pollutants, or contaminants in soils largely at or near the surface that may migrate.
(v)	"Weather conditions that may cause hazardous substances to migrate or be released;"	These sites are exposed to weather conditions. The effects of stormwater runoff might cause the associated hazardous substances to migrate.
(vi)	"Threat of fire or explosion;"	N/A.
(vii)	"The availability of other appropriate federal or state response mechanisms to respond to the release;" and	There are no other state or federal mechanisms to respond. The FFA established a combined state and federal mechanism to respond under CERCLA. DOE is the designated lead agency at Mound under CERCLA.
(viii)	"Other situations or factors that may pose threats to public health or welfare or the environment."	N/A.

N/A - Not applicable

4. ENDANGERMENT DETERMINATION

As these locations are currently configured and access controlled, actual or threatened releases of pollutants and contaminants from this site do not pose an endangerment to public health or welfare or to the environment. However, to eliminate the possibility of endangerment, as the site transfers from DOE ownership and control, DOE has determined that removal of the contaminants is appropriate.

5. PROPOSED ACTION AND ESTIMATED COSTS

5.1 PROPOSED ACTION

The proposed action is the excavation and disposal of contaminated soil and associated material/debris that meet the criteria in Section 2.1.2. This CRA is proposed for PRSs identified in Table 2.1. This proposed action also includes locations/PRSs that exhibit properties similar to those of the PRSs in Table 2.1 (i.e., type of contaminant, contaminant concentration, isolated areas of contamination).

Since the proposed action is within the site boundaries, it is not expected to have a disproportionate impact on low income or minority populations.

5.1.1 Proposed Action Description

The proposed action is expected to result in multiple fieldwork efforts during the remainder of the Mound Exit Project. Components of the proposed action include the following:

- **Project Planning**

This step includes among other objectives: identifying/confirming the limits of excavation, identifying disposal site(s) and methods for containerization of contaminated soil, identifying real or near-real time monitoring techniques for contaminant(s) of concern, developing and gaining approval of an appropriate Removal Action Work Plan, and training personnel as appropriate.

- **Public Notification**

The public review of the AM/EE/CA constitutes the public notification for the PRSs specifically listed in Table 2.1. For other, similar locations/PRSs that are addressed by this CRA, public notification will have several elements. First, a public notice will be published in a local newspaper. The public notice will indicate the location, nature of the contaminant, and refer to this AM/EE/CA. The notice may be published concurrent with the start of fieldwork.

A fact sheet will be developed. The fact sheet will include a brief description/history of the PRS, contaminants of concern (COCs), risk criteria, background levels, cleanup objectives, dust controls, surface water controls, environmental surveillance measures, verification sampling, and schedule of key activities (public review period, excavation, shipping, On-Scene Coordinator Report publication), estimated cost, where to find

additional information, etc. The fact sheet will be provided to the regulators for review with the VSAP and work plan. The facts sheet will be available in the public reading room and referenced in the newspaper notification discussed above. Stakeholders / public can provide comments for thirty days; this opportunity for comment is concurrent with field work. The VSAP will not be implemented until stakeholders have had an opportunity to comment on the fact sheet. The fact sheet will also be provided to the members of the MAC and MRC.

- Site Preparation

This step includes among other activities: review activities and safety issues with workforce, obtain appropriate permits, establish control of access and egress to construction site, locate and clearly mark underground utilities, establish soil erosion controls, make provisions for excavation equipment, make provisions for containment (as needed) for contaminated material, and make provisions for monitoring equipment.

- Excavation

This step may include among other activities: removal of trees or shrubs that interfere with work activities, establishing a staging area for waste and contaminated material, removal of small structures, and excavation of soil and debris. Progression and extent of excavation will be determined in the field.

- Verification

This step includes among other activities, sampling and analysis of soil in and at the edges of excavation to determine the residual contaminant concentration and verifying that the residual contaminant concentration is within acceptable limits. An Ohio EPA and USEPA approved Verification Sampling and Analysis Plan (VSAP), as detailed in the approved work plan, will further define the verification sampling and analysis process, which will include COCs and cleanup objectives. The most common COCs and accompanying cleanup objectives for the PRSs targeted by this document are listed in Table 5.1 (Calculations of the Risk-Based Guideline Values listed in Table 5.1 are included in Appendix C). The list of COCs may be expanded for each PRS and added PRSs, based upon additional information and characterization. The cleanup objectives will be based upon the established background levels and the most recent 10^{-5} risk-based guideline value for the more conservative scenario (construction or office worker). New or modified toxicological factors will also be taken into account for any PRSs that have not been cleaned up. Dependent on the contaminants, leaching to groundwater may need to be addressed.

Table 5.1 Cleanup Objectives (pCi/g)

Contaminant	Background Level	10-5 Risk Level ⁽²⁾	Cleanup Objective*
Actinium-227+ decay products in secular equilibrium to Lead-207	0.11	4.5	4.7
Americium-241		63	63
Cesium-137+D	0.42	3.4	3.8
Cobalt-60		0.7	0.7
Lead-210+ decay products in secular equilibrium to Lead-206	1.2 ⁽¹⁾	6.2	7.4
Protactinium-231+ decay products in secular equilibrium to Lead-207	0.11 ⁽¹⁾	3.9	4
Plutonium-238	0.13	61	55
Radium-226+ decay products in secular equilibrium to Lead-210	2.0	0.9	2.9
Thorium-230+ decay products in secular equilibrium to Lead-206	1.9	0.9	2.8
Thorium-232+ decay products in secular equilibrium to Lead-208	1.4	0.7	2.1

*Objective is sum of 10⁻⁵ Risk-Based Guideline Value and background.

⁽¹⁾ These radionuclides have comparatively short half-lives and are deduced to be in secular equilibrium with the parent nuclide. Thus the background value measured for the parent is considered to be the appropriate value for these as well. The validity of using this method for background determination for other radionuclides will be assessed on a case by case basis if not available.

⁽²⁾ More conservative scenario (construction or office worker)

Additional cleanup objectives for non-radioactive COCs in soil will also take into consideration leaching to groundwater, as well as the risk from contaminated soil. Additional characterization could identify additional COCs or could indicate that one or more of the primary COCs are not present. This will be addressed and documented in the VSAP. The VSAP may also include isolated hot spot criteria; i.e., a verification result that exceeds the cleanup objective by a factor of three indicates a hot spot and the need for further excavation at that location. For PRSs with small areas of contamination (for example less than 1000 ft²), hot spot criteria will not be applied. In that case, all samples shall not exceed the agreed upon cleanup objective. If exceedances occur, additional cleanup will occur. Exceptions to the above would require review and approval by the Core Team.

The complete list of COCs for each PRS and any additional PRSs addressed under this action memorandum EE/CA will be documented in the VSAP and approved by the Core Team. To avoid the potential for elevated risk (greater than 1×10^{-4}) due to multiple contaminants, cumulative risk within a parcel will be considered by the Core Team in establishing the list of COCs and associated cleanup objectives. Additional information to be used in developing the VSAP may become available through additional data, historical review, PRS characterization before or during excavation, etc. Any changes will be presented to the public at the monthly Mound Action Committee and Mound Reuse Committee meetings by DOE/MEMP and BWXTO.

- Site Restoration

Equipment, materials, waste containers, and barricades will be removed. The site will be backfilled and compacted to original contours and elevation unless otherwise specified. The area will be seeded as needed.

- Documentation of Completion

Completion of the CRA will be documented by either a PRS-specific OSC Report or a series of annual OSC Reports. Each annual OSC Report will address the previous fiscal year's efforts. The draft OSC Report for each year is due to USEPA and OEPA three months after the end of the fiscal year. If this CRA is not applied to a location/PRS during a fiscal year, USEPA and OEPA will be notified in the monthly project managers meeting. In addition, this will be documented by letter.

5.1.1.1 Rationale, Technical Feasibility, and Effectiveness

The removal action chosen is necessary for the removal of known contamination to ensure that migration of the contamination does not occur.

The situations addressed by this CRA involve straightforward tasks including

excavation of soil/debris, containerization and disposal of soil/debris, followed by verification sampling. Typical methods used to accomplish these tasks are described in the work plan.

Verification sampling detailed in the work plan will be employed to confirm the effectiveness of the CRA. Verification sampling results will be documented in the OSC Report.

5.1.1.2 Monitoring

Health and safety monitoring will be performed throughout the removal action according to standard Mound procedures.

5.1.1.3 Uncertainties

The major uncertainties are the concentration levels of the contaminants and the extent of contamination (lateral and depth). The minor uncertainties include location of utilities that may exist in the area of excavation.

5.1.1.4 Institutional Controls

DOE will remain in control of the locations/PRSSs addressed by this CRA until transfer of ownership of the parcel(s) they are in. If necessary, enforceable deed restrictions will be in place at the time of transfer in order to ensure future protection of human health and the environment.

5.1.1.5 Post-Removal Site Control

Post-removal site control will be provided by DOE/MEMP. See Institutional Controls above.

5.1.1.6 Cross-Media Relationships and Potential Adverse Impacts

The potential cross-media impact associated with the removal action is the potential for unintended release of contaminated materials into the atmosphere or surface water. Careful monitoring and control will be implemented during the removal action.

No potential adverse impacts of the removal action have been identified.

5.1.2 Contribution to Future Remedial Actions

To facilitate further assessments and removal actions in or near the site of this removal action, the exact dimensions of the excavation and the levels of contamination remaining at the base of excavation will be documented. The

excavation will be documented by utilizing photographs, record drawings, the OSC Report, and other information collected during the removal action.

The Mound Plant is anticipated to be cleaned up by removal actions. This removal action is planned to be the final clean-up for the locations at which it is applied. The information obtained, as a result of this removal, will be used in determining the availability for the final disposition of the Mound site and will be subject to review in the subsequent risk evaluation.

5.1.3 Description of Alternative Technologies

Alternative technologies frequently evaluated for CERCLA remediation include institutional controls, containment, collection, treatment, and disposal. Based on the prevailing conditions, the following alternatives (in addition to the proposed alternative of excavation and offsite disposal) were developed.

1. No Action
2. Institutional Controls

The performance capabilities of each alternative with respect to the specific criteria is discussed below.

5.1.3.1 No Action

The "No Action" approach was eliminated. The Core Team determined that a Removal Action is warranted for the PRSs in Table 2.1.

5.1.3.2 Institutional Controls

Implementing institutional controls for these PRSs was eliminated from further consideration. This option was not feasible for future site plans. Removal Action is warranted for these locations/PRSs.

5.1.4 Engineering Evaluation/Cost Analysis

This document serves as the action memo and the EE/CA.

5.1.5 Applicable or Relevant and Appropriate Requirements (ARARs)

Mound ARARs for the ER Program have been identified (DOE 1993). CERCLA regulations require that removal actions comply with ARARs.

The following have been identified as applicable, or relevant and appropriate to this removal action:

- 49 CFR 172, 173: Department of Transportation (DOT) hazardous material transportation and employee training requirements.

5.1.5.1 Air Quality

- 40 CFR Part 61 Subpart H: National Emissions Standards for Emissions of Radionuclides other than Radon from Department of Energy Facilities.
- Ohio Administrative Code (OAC) 3745-15-07(A): Air Pollution Nuisances Prohibited.
- OAC 3745-17-02 (A,B,C): Particulate Ambient Air Quality Standards.
- OAC 3745-17-05: Particulate Non-Degradation Policy.
- OAC 3745-17-08: (A)(1), (A)(2), (B),(D): Emission Restrictions for Fugitive Dust.

5.1.5.2 To Be Considered

- EPA/230/02-89/042: Methods for Evaluating the Attainment of Cleanup Standards.

5.1.5.3 Worker Safety

- 29 CFR Part 1910: Occupational Safety and Health Act (OSHA) - General Industry Standards.
- 29 CFR Part 1926: OSHA - Safety and Health Standards.
- 29 CFR Part 1904: OSHA - Record Keeping, Reporting, and Related Regulations.

5.1.5.4 Storm Water Runoff

- National Pollutant Discharge Elimination System (NPDES) Permit No. 11O00005*HD, June 1998.

5.1.6 Other Standards and Requirements

Other standards or requirements related to the actual implementation of the removal action may be identified subsequently during the design phase and will be incorporated into the Work Plan and/or its revisions.

5.1.7 Project Schedule

The schedule established for planning and implementing the removal action is illustrated in Figure 5.1. It is expected (but not required) that the PRSs identified in Table 2.1 will be addressed in the first field applications of this removal action. The schedule illustration indicates four fieldwork campaigns for these PRSs (FY02-1, FY03-1, FY03-2, and FY03-3). The actual numbers and duration of these campaigns may differ from the schedule illustration. When this CRA is applied to a PRS not listed in Table 2.1, there will be a public notice in the local newspaper concurrent with the start of fieldwork. This is shown in the schedule illustration for the remaining fieldwork campaigns. Because of the flexible nature of this CRA, the numbers, duration, and timing of these fieldwork campaigns may differ from Figure 5.1.

5.2 ESTIMATED COSTS

The cost estimate to perform the removal action is shown in Table 5.2. Costs include the construction activities, all engineering and construction management, waste disposal, and site restoration. The estimate is based on the average of the estimates for the PRSs in Table 2.1; additional locations are expected to have similar costs.

Table 5.2 Removal Action Cost Estimate

ESTIMATE TOTALS	
Planning	35,000
Fieldwork	315,000
Report	28,000
TOTAL	\$378,000

Project Name: Contingent Removal Action

Task Name	2001		2002				2003				2004				2005				
	Q1	Q4	Q1	Q2	Q3	Q4													
Develop Action Memorandum	■																		
Public Review of Action Memorandum	■																		
Field Work FY02-1			■																
Field Work FY02-2				■															
FY02 OSC Report					■														
Field Work FY03-1							■												
Field Work FY03-2								■											
Field Work FY03-3									■										
Public Notice										■									
Field Work FY03-4											■								
FY03 OSC Report												■							
Public Notice FY04-1													■						
Field Work FY04-1														■					
Public Notice FY04-2															■				
Field Work FY04-2																■			
FY04 OSC Report																	■		
Public Notice FY05-1																		■	
Field Work FY05-1																			■
Public Notice FY05-2																			
Field Work FY05-2																			■
Public Notice FY05-3																			
Field Work FY05-3																			■
Public Notice FY05-4																			
Field Work FY05-4																			■
FY05 OSC Report																			■

Figure 5.1 Planning and Implementation Schedule

6. EXPECTED CHANGE IN THE SITUATION SHOULD ACTION BE DELAYED OR NOT TAKEN

There is the potential for the contaminants to migrate if action is delayed or not taken.

7. OUTSTANDING POLICY ISSUES

There are currently no outstanding policy issues affecting performance of this removal action.

8. ENFORCEMENT

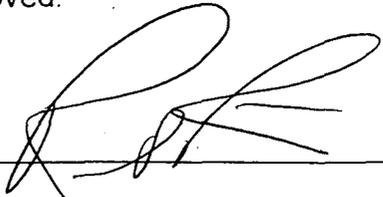
The Core Team consisting of DOE, USEPA, and OEPA has agreed on the need to perform the removal. The work described in this document does not create a waiver of any rights under the FFA, nor is it intended to create a waiver of any rights under the FFA. The DOE is the sole party responsible for implementing this cleanup. Therefore, DOE is undertaking the role of lead agency, per CERCLA and the NCP, for the performance of this removal action. The funding for this removal action will be through DOE budget authorization and no Superfund monies will be required.

9. RECOMMENDATION

This decision document represents the selected removal action for the specific PRSs listed in Table 2.1 and similar locations/PRSs developed in accordance with CERCLA as amended by SARA, and consistent with the NCP. This decision is based on the administrative record for the site.

Conditions at the site meet the NCP Section 300.415 (b)(2) criteria for a removal and we recommend initiation of the removal action(s).

Approved:



Robert S. Rothman, Remedial Project Manager DOE/MEMP

9/26/01

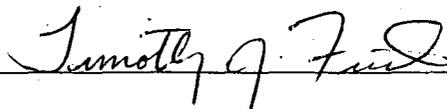
Date



Brian K. Nickel, Project Manager OEPA

9/26/01

Date



Timothy J. Fischer, Remedial Project Manager USEPA

9/26/01

Date

10. REFERENCES

USEPA 1990. Superfund Removal Procedures Action Memorandum Guidance. Office of Emergency and Remedial Response. US Environmental Protection Agency. December 1990.

DOE 1993. Draft Comprehensive Listing of State of Ohio ARARs, Letter from Hatcher to Kleinrath, May, 1993.

APPENDIX A
Core Team Recommendations for PRSs 153, 266, 273, 276, 412, and 421

**MOUND PLANT
PRS 153
RADIOACTIVE WASTEWATER SEWER PIPELINE BREAK
AREA 20**

RECOMMENDATION:

Potential Release Site (PRS) 153 is a soil area on the hillside west of the Hydrolysis House (HH) Building and bounded on the south by a roadway. This soil area, also known as Area 20, was designated a PRS because of contamination by leaks of wastewater from the 3-inch underground pipeline that transversed the northern boundary of this soil area. During the removal of the underground pipeline and surrounding soils in 1994, a localized area of contamination in the northwest corner of PRS 153 was discovered. The remediated soil had maximum concentrations of 678 pCi/g Th-232 (5 pCi/g Th-232 guideline level) and 7,694 pCi/g Pu-238 (25 pCi/g Pu-238 guideline level).

Therefore, a RESPONSE ACTION is recommended for the remainder of the contamination.

CONCURRENCE:

DOE/MB:

Arthur W. Kleinrath 11/26/96
Arthur W. Kleinrath, Remedial Project Manager (date)

USEPA:

Timothy J. Fischer 12/3/96
Timothy J. Fischer, Remedial Project Manager (date)

OEPA:

Brian K. Nickel 12/17/96
Brian K. Nickel, Project Manager (date)

SUMMARY OF COMMENTS AND RESPONSES:

Comment period from 1/9/97 to 2/13/97

No comments were received during the comment period.

Comment responses can be found on page _____ of this package.

MOUND PLANT
PRS 266/395
SOIL CONTAMINATION
Supersedes October 18, 1995 Recommendation

RECOMMENDATION:

PRS 266 was identified as a potential release site as a result of historical information and the Radiological Site Survey performed in October 1983. The 25,000 square foot area has three sets of data indicating high levels of thorium-232 (greater than 200 pCi/g). Therefore, a RESPONSE ACTION is recommended for PRS 266, as previously recommended on October 18, 1995.

PRS 395 was identified as a potential release site in June 1994 due to qualitative PETREX soil gas results during the Operable Unit 5, Operational Area Phase I Investigation. On October 18, 1995 further assessment for halogenated hydrocarbons was recommended for PRS 395. A subsequent quantitative *Soil Gas Confirmation Investigation* sample taken within 50 feet of PRS 395 showed that all concentrations of volatile (including halogenated hydrocarbons), semivolatile, PCBs, pesticides, metals, radionuclides, and explosives in the soils were below their respective ALARA, regulatory or 10^{-6} Risk Based Guideline Criteria. Therefore, NO FURTHER ASSESSMENT is recommended for PRS 395.

CONCURRENCE:

DOE/MEMP:

Arthur W. Kleinrath 12/18/96
Arthur W. Kleinrath, Remedial Project Manager (date)

USEPA:

Timothy J. Fischer 12/18/96
Timothy J. Fischer, Remedial Project Manager (date)

OEPA:

Brian K. Nickel 12/18/96
Brian K. Nickel, Project Manager (date)

SUMMARY OF COMMENTS AND RESPONSES:

Comment period from 4/3/97 to 5/8/97



No comments were received during the comment period.



Comment responses can be found on page _____ of this package.

MOUND PLANT
PRS 266/395

RECOMMENDATION:

Complete removal or encapsulation of soil in the area is recommended. The 25,000 square foot area has three sets of data indicating high levels of Thorium-232 (greater than 100 pCi/g). Upon completion of the Thorium-232 removal, the verification sampling plan, associated with PRS 266, will include sampling for Halogenated Hydrocarbons. This will insure that PRS 395 will be adequately characterized or removed from the area.

CONCURRENCE:

DOE: Arthur J. Bennett 10/12/95
USEPA: Scott J. Fitch 10/18/95
ORPA: Bob Hill 10/12/95

SUMMARY OF COMMENTS AND RESPONSES:

Comment period from 3/15/96 to 4/15/96

- No comments were received during the comment period.
 Comment responses can be found on page _____ of this package.

**MOUND PLANT
PRS 273
SOIL CONTAMINATION - AREA 12 (SM/PP HILLSIDE)**

RECOMMENDATION:

This soils area was identified as a PRS due to historic use as a disposal site for radiologically contaminated soil.

Plutonium exists at 12 times the Mound ALARA goal of 25 pCi/g and thorium exists at 40 times the regulatory standard of 5 pCi/g. No other contaminants have been identified at levels of concern. Because this area is heavily vegetated, there is no immediate threat for migration of the contamination. However, there would be unacceptable exposure to a construction worker.

Therefore, since plutonium and thorium exist in the soil of PRS 273 at levels which present an unacceptable risk to potential future construction activities a **RESPONSE ACTION** is recommended.

CONCURRENCE:

DOE/MB:

Arthur W. Kleinrath 11/26/96
Arthur W. Kleinrath, Remedial Project Manager (date)

USEPA:

Timothy J. Fischer 12/3/96
Timothy J. Fischer, Remedial Project Manager (date)

OEPA:

Brian K. Nickel 12/17/96
Brian K. Nickel, Project Manager (date)

SUMMARY OF COMMENTS AND RESPONSES:

Comment period from 1/30/97 to 3/6/97

- No comments were received during the comment period.
- Comment responses can be found on page _____ of this package.

**MOUND PLANT
PRS 276
Contaminated Soil**

RECOMMENDATION:

PRS 276 is a soils location approximately 300 feet northeast of Building 21 (since demolished) and is also known as Area 22. PRS 276 is located on the south part of the SM/PP Hill and has the approximate dimensions of 75 ft by 150 ft. This area consists of many piles of soil excavated from other areas at Mound Plant, including Area 20 (PRS 153). It is also called the "orphan soils" area because it was created when construction projects did not have funding for disposal of unexpected contaminated soil. The soil was placed at PRS 276 while waiting for funding. PRS 276 was not part of the original compilation of radioactively contaminated areas but was identified by the initial gamma surveys conducted when the Site Survey Project began.

The Core Team originally recommended Further Assessment for PRS 276. Subsequently, the cost of further investigation versus the cost of removing the potentially contaminated soils was evaluated. Cost estimates indicate that the cost of removal is not significantly greater than the cost of further assessment at PRS 276. Additionally Further Assessment findings may indicate the need for a Response (removal) Action, resulting in costs associated with both Further Assessment and Response Action. Therefore, the Core Team recommends a RESPONSE ACTION as a more cost-effective course of action for PRS 276

CONCURRENCE:

DOE/MEMP:	<u>Arthur W. Kleinrath</u>	<u>7/25/99</u>
	Arthur W. Kleinrath, Remedial Project Manager	(date)
USEPA:	<u>Timothy J. Fischer</u>	<u>7/28/99</u>
	Timothy J. Fischer, Remedial Project Manager	(date)
OEPA:	<u>Brian K. Nickel</u>	<u>7/29/99</u>
	Brian K. Nickel, Project Manager	(date)

SUMMARY OF COMMENTS AND RESPONSES:

Comment period from 10/13/99 to 11/13/99

No comments were received during the comment period

Comment responses can be found on page at front of this package

**MOUND PLANT
PRS 412
Contaminated Soil**

RECOMMENDATION:

PRS 412 (hot spot C0033) was identified as a result of the Radiological Site Survey Project. Thorium was found at 42 pCi/g at this location.

The Core Team originally recommended Further Assessment for PRS 412. Subsequently, the cost of further investigation versus the cost of removing the potentially contaminated soils was evaluated. Cost estimates indicate that the cost of removal is not significantly greater than the cost of further assessment at PRS 412. Additionally Further Assessment findings may indicate the need for a Response (removal) Action, resulting in costs associated with both Further Assessment and Response Action. Therefore, the Core Team recommends a RESPONSE ACTION as a more cost-effective course of action for PRS 412.

CONCURRENCE:

DOE/MEMP:	<u>Arthur W. Kleinrath</u>	<u>3/14/98</u>
	Arthur W. Kleinrath, Remedial Project Manager	(date)
USEPA:	<u>Timothy J. Fischer</u>	<u>3/19/98</u>
	Timothy J. Fischer, Remedial Project Manager	(date)
OEPA:	<u>Brian K. Nickel</u>	<u>3/19/98</u>
	Brian K. Nickel, Project Manager	(date)

SUMMARY OF COMMENTS AND RESPONSES:

Comment period from 4/15/98 to 5/12/98

No comments were received during the comment period.

Comment responses can be found on page C1 - C8 of this package.

**MOUND PLANT
PRS 421
"The Ridge"
Contaminated Soil**

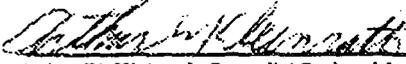
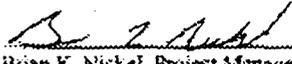
RECOMMENDATION:

Potential Release Site (PRS) 421 was identified as a PRS when historical sampling data indicated the presence of contaminated soil in the "Ridge" area. This was confirmed during the verification sampling for PRS 407. Elevated readings were also observed during a 1999 Health Physics survey to support locating power line poles for DP&L. This PRS is a subpart of PRS 406.

The magnitude of contamination for PRS 421 as indicated by historical sampling data revealed levels of Plutonium-238 up to 396.4 pCi/g (5.5 pCi/g 10⁻⁶ risk based guideline value), Thorium-232 up to 32.6 pCi/g (0.11 pCi/g 10⁻⁶ risk based guideline value), and Thorium-228 up to 15.6 pCi/g (0.11 pCi/g 10⁻⁶ risk based guideline value).

Therefore, since PRS 421 contains unacceptable levels of contaminants above guideline values, a REMOVAL ACTION is recommended.

CONCURRENCE:

DOE/MEMP:	 _____ Arthur W. Kleiman, Remedial Project Manager	October 18, 2000 _____ (date)
USEPA:	 _____ Timothy J. Fischer, Remedial Project Manager	11/16/00 _____ (date)
OEPA:	 _____ Brian K. Nickel, Project Manager	12/18/00 _____ (date)

SUMMARY OF COMMENTS AND RESPONSES:

Comment period from _____ to _____

- No comments were received during the comment period.
- Comment responses can be found on page _____ of this package.

Appendix B
Background information for PRSs 153, 266, 273, 276, 412, and 421

PRS 153

Background Information: PRS 153 is a soil area on the hillside west of the Hydrolysis House (HH) Building and bounded on the south by the roadway. This soil area, also known as Area 20, was contaminated by leaks of wastewater from the 3-inch underground pipeline that transverses the northern boundary of this soil area. HH to WD underground line was removed in 1994 along with soil in the immediate area of the waste line. Surveys were conducted in mid-1980's, 1985, 1992 (Soil Gas Survey), 1994 and 1995.

Information from previous investigations:

- (a). Mid-1980s: Radiological Site Survey study of PRS 153 found; Plutonium-238 (1.9 pCi/g), Cesium-137 (1.0 pCi/g), Radium-226 (0.9 pCi/g), Americium-241 (>0.5 pCi/g) and Thorium-232 (4.0 pCi/g) (All were less than guideline criteria).
- (b). 1985 (During installation of a sanitary sewer line, routine surface soil sampling found)
 - (1). Cobalt-60 (800 pCi/g), Bismuth-207 (70 pCi/g), Cesium-137 (200 pCi/g).
 - (2). The above contamination was reportedly removed from PRS 153 (Area 20) to PRS 276 (Area 22) but no verification sampling was provided.
- (c). 1992 (Soil Gas Survey was Performed)
 - (1). Toluene (213 ppb/Guideline Criteria: 414,600 ppb)
- (d). 1994 (In 1994, the HH to WD underground radiological waste line (transverses PRS 153) was removed)
 - (1). Contaminated soil was discovered. Some of this area was excavated, but the remediation was discontinued because of utility interference and the depth of excavation. Area was backfilled.
 - (2). Thorium-232 (678 pCi/g) and Plutonium-238 (7,694 pCi/g).
- (e). 1995: Further assessment of PRS 153 area was performed in 1995. This investigation, Other Soils Characterization, divided up PRS 153 into 15 foot by 15 foot grids and analyzed soil samples for organics (by organic vapor analyzer and organic vapor meter), metals radionuclides. Samples were collected every four feet until a depth of 12 feet or refusal was reached. However, the presence of utilities prevented sampling the extent of the contamination.
 - (1). Thorium-232 (>5pCi/g) and Plutonium-238 (38 pCi/g).
 - * All metal detection were below the 10⁻⁶ Risk Base Guideline Criteria for soil.
 - * Volatile Organic Compounds (VOCs) were detected in twenty-nine samples (no quantitative data is available).

PRS 266/395

Background Information: Radiological data from the Site Survey in 1983 identified thorium-232 contamination at a maximum value of 254.3 pCi/g in the subsurface sample at a depth of 80 inches. Plutonium-238 levels were slightly elevated in the same area. PRS 395, which is at the western edge of PRS 266, indicated elevated levels of "Total Halogenated Hydrocarbons."

Information from previous sampling:

- (a). Thorium-232 and Total Halogenated Hydrocarbons.
- (b). December 18, 1996 Core Team Recommendation : Response Action for PRS 266, NO Further Assessment is recommend for PRS 395. Verbal communication with John Price, BWXT and earlier with Felix Spittler, BWXT indicates organic contamination may be present.

PRS 273

Background Information:

An area of soil located west of Building 38 and the Special Metallurgical Building on the SM/PP (special

Metallurgical Building/Plutonium Processing Building) hillside. In 1965, thorium-232 contaminated soil was scraped from Area 1 and placed in PRS 273. Also in 1965, plutonium-238 and thorium-232 contaminated soil from the SM Building was placed in PRS 273. The Waste Transfer System pipeline (now removed) which carried radioactive waste from Building 38 to the Waste Disposal Building (WD) passed through the west side of PRS 273.

Information from previous sampling:

- (a). 1983 Radiological Site Survey: Plutonium 238 (313 pCi/g) and Thorium-232 (190 pCi/g).
- (b). 1995 Other Soil Characterization: Plutonium 238 (301 pCi/g) and Thorium-232 (212 pCi/g (subsurface)).

Special Notes:

- * All metal detection were below the 10^{-6} Risk Base Guideline Criteria for soils.
- * Volatile Organic Compounds (VOCs) were detected in twenty-nine samples (no quantitative data is available).

PRS 276

Background Information: PRS 276 is a soils location approximately 300 feet northeast of Building 21 and is also known as Area 22. This area consists of many piles of soil excavated from other areas at the Mound Plant, including Area 20 (PRS 153). It is also called the "Orphan Soils" area because it was created when construction projects did not have funding for disposal of unexpected contaminated soil.

Information from previous sampling:

- (a). 1988 Radiological Site Survey: Plutonium 238 (8.33 pCi/g), Thorium-232 (7.73 pCi/g), Cobalt-60 (143 pCi/g), Cesium-137 (7 pCi/g), Radium-226 (0.7 pCi/g), Americium-241 (not detected), Tritium (990 pCi/l (soil distillate)).

Special Note: Neither Bismuth-207 nor Bismuth-210m were analyzed for even though they may be expected in association with Cobalt-60 & Since Cesium-137 was identified, it is possible that Strontium-90 may also be present.

- (b). COCs 1994 Screening Investigation at Area 22: 72 soil samples were collected and analyzed from area 22 at the Mound Soil Screening Facility for plutonium-238 and thorium-232. Soil screening detected plutonium-238 above the Mound Plant ALARA goal of 25 pCi/g in 21 samples. Thorium-232 was detected in one sample.
**Plutonium-238 (81 pCi/g)
**Thorium-232 (3.1 pCi/g)

PRS 412

Background Information: PRS 412 previously known as PRS 393, is identified as a radiological hot spot located near the eastern boundary of the Mound plant on the SM hill.

Information from previous sampling:

- (a). 1983 Radiological Site Survey: Plutonium-238 (0.97 pCi/g) and Thorium-232 (42.4 pCi/g at 3 feet (C0033)). (Note: Four samples were taken: 2-Surface & 2- Subsurface)
- (b). 1994 OU5 Operational Area Phase I Investigation: Plutonium 238 (9 pCi/g) and Thorium-232 (0.5 pCi/g).
- (c). No detection of VOCs or SVOCs (Further Assessment : Soil Gas Confirmation Sampling).
- (d). PRS 308 Further Assessment, July 2000. Based on a radiological survey conducted during the PRS 308 investigation, two samples were collected in the vicinity of PRS 412. Thorium 232 was detected at 4.43 pCi/g for sample #004618 and 20.21 pCi/g for sample #004619. It was agreed that these elevated areas would be addressed with the PRS 412 removal.

PRS 421

Background Information: PRS 421 was identified after the completion of the Building 21 (PRS 284) & Associated Soils (PRS 407 and PRS 281) Decontamination & Decommissioning (D&D) Project. It is felt that PRS 421 contamination is the result of contaminant migration from PRS 407 and PRS 284. Five storm drains from the PRS 407 and PRS 284 areas discharged into the area of PRS 421. There is no process history associated with PRS 421; no incidents, spills, or leaks are noted to have occurred here.

Information from previous sampling:

	Maximum Level	10 ⁻⁶ Guideline Value (at the time of the sampling event). Background level is not included.
Benzo(a)pyrene	1.0 mg/kg	0.41 mg/kg
Beryllium	1.4 mg/kg	0.70 mg/kg
Cesium-137+D	1.15 pCi/g	0.46 pCi/g
Thorium-228+D	15.6 pCi/g	0.41 pCi/g
Thorium-230+D	2.59 pCi/g	0.13 pCi/g
Thorium-232+D	32.6 pCi/g	0.11 pCi/g
Plutonium-238	396.4 pCi/g	55.0 pCi/g (10 ⁻⁵)
Uranium-234+D	6.6 pCi/g	0.13 pCi/g

APPENDIX C
Calculation of Risk-Based Guideline Values

Construction Worker - Soil/Sediment Exposure Pathway

Variables defined in Table 4.1.3 p93 RBGV Report 3/97
Equations listed in Table 4.1.3 p92 RBGV Report 3/97

Enter the following:

Series Ac-227 to Pb-207			Cancer Slope Factors HEAST Table 4 (April 2001)				
	Target Risk	1.00E-05	Series Segment	Ingestion	Inhalation	External Exp	
	Oral Cancer Slope Factor	1.16E-09 risk/pCi	Ac-227	Pb-207	1.16E-09	2.09E-07	1.47E-06
	Inhalation Cancer Slope Factor	2.09E-07 risk/pCi					
	External Cancer Slope Factor	1.47E-06 risk/pCi					
Ingestion			Total		1.16E-09	2.09E-07	1.47E-06
Target Risk	TR	1.00E-05					
Exposure Duration 1	ED ₁	5 yrs					
Exposure Frequency	EF	250 days/yr					
Oral Cancer Slope factor	SF ₀	1.16E-09 risk/pCi					
Conversion Factor 1	CF ₁	0.001 g/mg					
Ingestion rate - Soil	IR _{soil}	480 mg/day					
Radionuclide Concentration in Soil (Ingestion)	CS _{ing}	14.37 pCi/g					
Inhalation							
Inhalation Cancer Slope factor	SF ₁	2.09E-07 risk/pCi					
Conversion Factor 2	CF ₂	1000 g/kg					
Inhalation Rate	IR _{air}	20 m ³ /day					
Soil to Air Volatilization Factor	VF	1 m ³ /kg					
Particulate Emission Factor	PEF	4.28E+09 m ³ /kg					
Radionuclide Concentration in Soil (Inhalation)	CS _{inh}	8.19E+03 pCi/g					
External							
External Cancer Slope Factor	SF _e	1.47E-06 risk/pCi					
Exposure Duration 2	ED ₂	3.425 yrs					
Gamma Shielding Factor	S _e	0.1					
Gamma Exposure Time factor	T _e	0.33					
Radionuclide Concentration in Soil (External Exposure)		6.63 pCi/g					
Total							
	CS _{TOTAL}	4.54E+00 pCi/g					

Construction Worker - Soil/Sediment Exposure Pathway

Variables defined in Table 4.1.3 p93 RBGV Report 3/97
 Equations listed in Table 4.1.3 p92 RBGV Report 3/97

Enter the following:

	Series Am-241	
Target Risk		1.00E-05
Oral Cancer Slope Factor		2.17E-10 risk/pCi
Inhalation Cancer Slope Factor		2.81E-08 risk/pCi
External Cancer Slope Factor		2.76E-08 risk/pCi

Series Segment
 Am-241

Cancer Slope Factors HEAST Table 4 (April 2001)		
Ingestion	Inhalation	External Exp
2.17E-10	2.81E-08	2.76E-08

Ingestion					
Target Risk	TR	1.00E-05		Total	2.17E-10 2.81E-08 2.76E-08
Exposure Duration 1	ED ₁	5 yrs			
Exposure Frequency	EF	250 days/yr			
Oral Cancer Slope factor	SF ₀	2.17E-10 risk/pCi			
Conversion Factor 1	CF ₁	0.001 g/mg			
Ingestion rate - Soil	IR _{soil}	480 mg/day			
Radionuclide Concentration in Soil (Ingestion)	CS _{ing}	76.80 pCi/g			
Inhalation					
Inhalation Cancer Slope factor	SF ₁	2.81E-08 risk/pCi			
Conversion Factor 2	CF ₂	1000 g/kg			
Inhalation Rate	IR _{air}	20 m ³ /day			
Soil to Air Volatilization Factor	VF	1 m ³ /kg			
Particulate Emission Factor	PEF	4.28E+09 m ³ /kg			
Radionuclide Concentration in Soil (Inhalation)	CS _{inh}	6.09E+04 pCi/g			
External					
External Cancer Slope Factor	SF _e	2.76E-08 risk/pCi			
Exposure Duration 2	ED ₂	3.425 yrs			
Gamma Shielding Factor	S _e	0.1			
Gamma Exposure Time factor	T _e	0.33			
Radionuclide Concentration in Soil (External Exposure)		352.97 pCi/g			
Total					
	CS _{TOTAL}	6.31E+01 pCi/g			

Commercial/Office Worker - Soil/Sediment Exposure Pathway (Radionuclides)

Variables defined in Table 5.1.3 p110-111 RBGV Report 3/97

Equations listed in Table 5.1.3 p109 RBGV Report 3/97

Enter the following:

Cancer Slope Factors

HEAST Table 4 (April 2001)

Ingestion	Inhalation	External Exp
4.33E-11	1.19E-11	2.55E-06

Series Cs-137+D			Series Segment Cs-137+D		
Target Risk		1.00E-05			
Oral Cancer Slope Factor		4.33E-11 risk/pCi			
Inhalation Cancer Slope Factor		1.19E-11 risk/pCi			
External Cancer Slope Factor		2.55E-06 risk/pCi			
Ingestion			Total	4.33E-11	1.19E-11 2.55E-06
Target Risk	TR	1.00E-05			
Exposure Duration 1	ED ₁	25 yrs			
Exposure Frequency	EF	250 days/yr			
Oral Cancer Slope factor	SF ₀	4.33E-11 risk/pCi			
Conversion Factor 1	CF ₁	0.001 g/mg			
Ingestion rate - Soil	IR _{soil}	50 mg/day			
Radionuclide Concentration in Soil (Ingestion)	CS _{ing}	739.03 pCi/g			
Inhalation					
Inhalation Cancer Slope factor	SF ₁	1.19E-11 risk/pCi			
Conversion Factor 2	CF ₂	1000 g/kg			
Inhalation Rate	IR _{air}	20 m ³ /day			
Soil to Air Volatilization Factor	VF	1 m ³ /kg			
Particulate Emission Factor	PEF	4.28E+09 m ³ /kg			
Radionuclide Concentration in Soil (Inhalation)	CS _{inh}	2.88E+07 pCi/g			
External					
External Cancer Slope Factor	SF _e	2.55E-06 risk/pCi			
Exposure Duration 2	ED ₂	17.125 yrs			
Gamma Shielding Factor	S _e	0.2			
Gamma Exposure Time factor	T _e	0.08			
Radionuclide Concentration in Soil (External Exposure)		3.43 pCi/g			
Total					
	CS _{TOTAL}	3.42E+00 pCi/g			

Commercial/Office Worker - Soil/Sediment Exposure Pathway (Radionuclides)

Variables defined in Table 5.1.3 p110-111 RBGV Report 3/97

Equations listed in Table 5.1.3 p109 RBGV Report 3/97

Enter the following:

Cancer Slope Factors

HEAST Table 4 (April 2001)

Ingestion	Inhalation	External Exp
4.03E-11	3.58E-11	1.24E-05

Series Co-60		Series Segment	Cancer Slope Factors		
Target Risk		Co-60	Ingestion	Inhalation	External Exp
Oral Cancer Slope Factor	1.00E-05		4.03E-11	3.58E-11	1.24E-05
Inhalation Cancer Slope Factor	4.03E-11 risk/pCi				
External Cancer Slope Factor	3.58E-11 risk/pCi				
	1.24E-05 risk/pCi				
Ingestion			Total		
Target Risk	TR	1.00E-05	4.03E-11	3.58E-11	1.24E-05
Exposure Duration 1	ED ₁	25 yrs			
Exposure Frequency	EF	250 days/yr			
Oral Cancer Slope factor	SF ₀	4.03E-11 risk/pCi			
Conversion Factor 1	CF ₁	0.001 g/mg			
Ingestion rate - Soil	IR _{soil}	50 mg/day			
Radionuclide Concentration in Soil (Ingestion)	CS _{ing}	794.04 pCi/g			
Inhalation					
Inhalation Cancer Slope factor	SF ₁	3.58E-11 risk/pCi			
Conversion Factor 2	CF ₂	1000 g/kg			
Inhalation Rate	IR _{air}	20 m ³ /day			
Soil to Air Volatilization Factor	VF	1 m ³ /kg			
Particulate Emission Factor	PEF	4.28E+09 m ³ /kg			
Radionuclide Concentration in Soil (Inhalation)	CS _{inh}	9.56E+06 pCi/g			
External					
External Cancer Slope Factor	SF _e	1.24E-05 risk/pCi			
Exposure Duration 2	ED ₂	17.125 yrs			
Gamma Shielding Factor	S _e	0.2			
Gamma Exposure Time factor	T _e	0.08			
Radionuclide Concentration in Soil (External Exposure)		0.71 pCi/g			
Total					
	CS _{TOTAL}	7.06E-01 pCi/g			

Construction Worker - Soil/Sediment Exposure Pathway

Variables defined in Table 4.1.3 p93 RBGV Report 3/97
Equations listed in Table 4.1.3 p92 RBGV Report 3/97

Cancer Slope Factors
HEAST Table 4 (April 2001)
Ingestion Inhalation External Exp
2.66E-09 1.39E-08 4.21E-09

Enter the following:

Series Pb-210+D			Series Segment		Cancer Slope Factors		
Target Risk			Pb-210	Pb-206	Ingestion	Inhalation	External Exp
Oral Cancer Slope Factor		1.00E-05			2.66E-09	1.39E-08	4.21E-09
Inhalation Cancer Slope Factor		2.66E-09 risk/pCi					
External Cancer Slope Factor		1.39E-08 risk/pCi					
		4.21E-09 risk/pCi					
Ingestion			Total		2.66E-09	1.39E-08	4.21E-09
Target Risk	TR	1.00E-05					
Exposure Duration 1	ED ₁	5 yrs					
Exposure Frequency	EF	250 days/yr					
Oral Cancer Slope factor	SF ₀	2.66E-09 risk/pCi					
Conversion Factor 1	CF ₁	0.001 g/mg					
Ingestion rate - Soil	IR _{soil}	480 mg/day					
Radionuclide Concentration in Soil (Ingestion)	CS _{ing}	6.27 pCi/g					
Inhalation							
Inhalation Cancer Slope factor	SF ₁	1.39E-08 risk/pCi					
Conversion Factor 2	CF ₂	1000 g/kg					
Inhalation Rate	IR _{air}	20 m ³ /day					
Soil to Air Volatilization Factor	VF	1 m ³ /kg					
Particulate Emission Factor	PEF	4.28E+09 m ³ /kg					
Radionuclide Concentration in Soil (Inhalation)	CS _{inh}	1.23E+05 pCi/g					
External							
External Cancer Slope Factor	SF _e	4.21E-09 risk/pCi					
Exposure Duration 2	ED ₂	3.425 yrs					
Gamma Shielding Factor	S _e	0.1					
Gamma Exposure Time factor	T _e	0.33					
Radionuclide Concentration in Soil (External Exposure)		2314.04 pCi/g					
Total							
	CS _{TOTAL}	6.25E+00 pCi/g					

Construction Worker - Soil/Sediment Exposure Pathway

Variables defined in Table 4.1.3 p93 RBGV Report 3/97
 Equations listed in Table 4.1.3 p92 RBGV Report 3/97

Enter the following:

Cancer Slope Factors HEAST Table 4 (April 2001)		
Ingestion	Inhalation	External Exp
3.74E-10	4.55E-08	1.39E-07
1.16E-09	2.09E-07	1.47E-06

Series Pa-231 to Pb-207	
Target Risk	
Oral Cancer Slope Factor	1.53E-09 risk/pCi
Inhalation Cancer Slope Factor	2.55E-07 risk/pCi
External Cancer Slope Factor	1.61E-06 risk/pCi

Series Segment	
Pa-231	Ac-227
Ac-227	Pb-207

Ingestion			Total	1.53E-09	2.55E-07	1.61E-06
Target Risk	TR	1.00E-05				
Exposure Duration 1	ED ₁	5 yrs				
Exposure Frequency	EF	250 days/yr				
Oral Cancer Slope factor	SF ₀	1.53E-09 risk/pCi				
Conversion Factor 1	CF ₁	0.001 g/mg				
Ingestion rate - Soil	IR _{soil}	480 mg/day				
Radionuclide Concentration in Soil (Ingestion)	CS _{ing}	10.86 pCi/g				
Inhalation						
Inhalation Cancer Slope factor	SF ₁	2.55E-07 risk/pCi				
Conversion Factor 2	CF ₂	1000 g/kg				
Inhalation Rate	IR _{air}	20 m ³ /day				
Soil to Air Volatilization Factor	VF	1 m ³ /kg				
Particulate Emission Factor	PEF	4.28E+09 m ³ /kg				
Radionuclide Concentration in Soil (Inhalation)	CS _{inh}	6.73E+03 pCi/g				
External						
External Cancer Slope Factor	SF _e	1.61E-06 risk/pCi				
Exposure Duration 2	ED ₂	3.425 yrs				
Gamma Shielding Factor	S _e	0.1				
Gamma Exposure Time factor	T _e	0.33				
Radionuclide Concentration in Soil (External Exposure)		6.05 pCi/g				
Total						
	CS _{TOTAL}	3.89E+00 pCi/g				

Construction Worker - Soil/Sediment Exposure Pathway

Variables defined in Table 4.1.3 p93 RBGV Report 3/97
Equations listed in Table 4.1.3 p92 RBGV Report 3/97

Enter the following:

Cancer Slope Factors
HEAST Table 4 (April 2001)
Ingestion Inhalation External Exp
2.72E-10 3.36E-08 7.22E-11

Series Pu-238		Series Segment	Cancer Slope Factors		
Target Risk		Pu-238	Ingestion	Inhalation	External Exp
Oral Cancer Slope Factor		1.00E-05	2.72E-10	3.36E-08	7.22E-11
Inhalation Cancer Slope Factor		2.72E-10 risk/pCi			
External Cancer Slope Factor		3.36E-08 risk/pCi			
		7.22E-11 risk/pCi			
Ingestion			Total		
Target Risk	TR	1.00E-05	2.72E-10	3.36E-08	7.22E-11
Exposure Duration 1	ED ₁	5 yrs			
Exposure Frequency	EF	250 days/yr			
Oral Cancer Slope factor	SF ₀	2.72E-10 risk/pCi			
Conversion Factor 1	CF ₁	0.001 g/mg			
Ingestion rate - Soil	IR _{soil}	480 mg/day			
Radionuclide Concentration in Soil (Ingestion)	CS _{ing}	61.27 pCi/g			
Inhalation					
Inhalation Cancer Slope factor	SF ₁	3.36E-08 risk/pCi			
Conversion Factor 2	CF ₂	1000 g/kg			
Inhalation Rate	IR _{air}	20 m ³ /day			
Soil to Air Volatilization Factor	VF	1 m ³ /kg			
Particulate Emission Factor	PEF	4.28E+09 m ³ /kg			
Radionuclide Concentration in Soil (Inhalation)	CS _{inh}	5.10E+04 pCi/g			
External					
External Cancer Slope Factor	SF _e	7.22E-11 risk/pCi			
Exposure Duration 2	ED ₂	3.425 yrs			
Gamma Shielding Factor	S _e	0.1			
Gamma Exposure Time factor	T _e	0.33			
Radionuclide Concentration in Soil (External Exposure)		1.35E+05 pCi/g			
Total					
	CS _{TOTAL}	6.12E+01 pCi/g			

Commercial/Office Worker - Soil/Sediment Exposure Pathway (Radionuclides)

Variables defined in Table 5.1.3 p110-111 RBGV Report 3/97

Equations listed in Table 5.1.3 p109 RBGV Report 3/97

Enter the following:

Cancer Slope Factors

HEAST Table 4 (April 2001)

	Ingestion	Inhalation	External Exp
Ra-226 Pb-210	7.30E-10	1.16E-08	8.49E-06
Pb-210 Pb-206	2.66E-09	1.39E-08	4.21E-09

	Series Ra-226+D	
Target Risk	1.00E-05	
Oral Cancer Slope Factor	3.39E-09 risk/pCi	
Inhalation Cancer Slope Factor	2.55E-08 risk/pCi	
External Cancer Slope Factor	8.49E-06 risk/pCi	

Series Segment	
Ra-226 Pb-210	
Pb-210 Pb-206	

Ingestion Total 3.39E-09 2.55E-08 8.49E-06

Target Risk	TR	1.00E-05
Exposure Duration 1	ED ₁	25 yrs
Exposure Frequency	EF	250 days/yr
Oral Cancer Slope factor	SF ₀	3.39E-09 risk/pCi
Conversion Factor 1	CF ₁	0.001 g/mg
Ingestion rate - Soil	IR _{soil}	50 mg/day

Radionuclide Concentration in Soil (Ingestion) CS_{ing} 9.44 pCi/g

Inhalation		
Inhalation Cancer Slope factor	SF ₁	2.55E-08 risk/pCi
Conversion Factor 2	CF ₂	1000 g/kg
Inhalation Rate	IR _{air}	20 m ³ /day
Soil to Air Volatilization Factor	VF	1 m ³ /kg
Particulate Emission Factor	PEF	4.28E+09 m ³ /kg

Radionuclide Concentration in Soil (Inhalation) CS_{inh} 1.34E+04 pCi/g

External		
External Cancer Slope Factor	SF _e	8.49E-06 risk/pCi
Exposure Duration 2	ED ₂	17.125 yrs
Gamma Shielding Factor	S _e	0.2
Gamma Exposure Time factor	T _e	0.08

Radionuclide Concentration in Soil (External Exposure) 1.03 pCi/g

Total

CS_{TOTAL} 9.30E-01 pCi/g

Construction Worker - Soil/Sediment Exposure Pathway

Variables defined in Table 4.1.3 p93 RBGV Report 3/97
Equations listed in Table 4.1.3 p92 RBGV Report 3/97

Enter the following:

Cancer Slope Factors

HEAST Table 4 (April 2001)

Series Th-230+D			Series Segment			Ingestion	Inhalation	External Exp
Target Risk		1.00E-05	Th-230	Ra-226	2.02E-10	2.85E-08	8.19E-10	
Oral Cancer Slope Factor		3.59E-09 risk/pCi	Ra-226	Pb-210	7.30E-10	1.16E-08	8.49E-06	
Inhalation Cancer Slope Factor		5.40E-08 risk/pCi	Pb-210	Pb-206	2.66E-09	1.39E-08	4.21E-09	
External Cancer Slope Factor		8.50E-06 risk/pCi						
					Total	3.59E-09	5.40E-08	8.50E-06
Ingestion								
Target Risk	TR	1.00E-05						
Exposure Duration 1	ED ₁	5 yrs						
Exposure Frequency	EF	250 days/yr						
Oral Cancer Slope factor	SF ₀	3.59E-09 risk/pCi						
Conversion Factor 1	CF ₁	0.001 g/mg						
Ingestion rate - Soil	IR _{soil}	480 mg/day						
Radionuclide Concentration in Soil (Ingestion)	CS _{ing}	4.64 pCi/g						
Inhalation								
Inhalation Cancer Slope factor	SF ₁	5.40E-08 risk/pCi						
Conversion Factor 2	CF ₂	1000 g/kg						
Inhalation Rate	IR _{air}	20 m ³ /day						
Soil to Air Volatilization Factor	VF	1 m ³ /kg						
Particulate Emission Factor	PEF	4.28E+09 m ³ /kg						
Radionuclide Concentration in Soil (Inhalation)	CS _{inh}	3.17E+04 pCi/g						
External								
External Cancer Slope Factor	SF _e	8.50E-06 risk/pCi						
Exposure Duration 2	ED ₂	3.425 yrs						
Gamma Shielding Factor	S _e	0.1						
Gamma Exposure Time factor	T _e	0.33						
Radionuclide Concentration in Soil (External Exposure)		1.15 pCi/g						
Total								
	CS _{TOTAL}	9.20E-01 pCi/g						

Construction Worker - Soil/Sediment Exposure Pathway

Variables defined in Table 4.1.3 p93 RBGV Report 3/97
Equations listed in Table 4.1.3 p92 RBGV Report 3/97

Enter the following:

Cancer Slope Factors

HEAST Table 4 (April 2001)

Ingestion Inhalation External Exp

Series Th-232+D			Series Segment		
Target Risk		1.00E-05	Th-232	Ra-228	2.31E-10
Oral Cancer Slope Factor		3.33E-09 risk/pCi	Ra-228	Th-228	2.29E-09
Inhalation Cancer Slope Factor		1.92E-07 risk/pCi	Th-228	Pb-208	8.09E-10
External Cancer Slope Factor		1.23E-05 risk/pCi			1.43E-07
					7.76E-06

Ingestion

Target Risk	TR	1.00E-05
Exposure Duration 1	ED ₁	5 yrs
Exposure Frequency	EF	250 days/yr
Oral Cancer Slope factor	SF ₀	3.33E-09 risk/pCi
Conversion Factor 1	CF ₁	0.001 g/mg
Ingestion rate - Soil	IR _{soil}	480 mg/day

Total 3.33E-09 1.92E-07 1.23E-05

Radionuclide Concentration in Soil (Ingestion)

CS_{ing} 5.01 pCi/g

Inhalation

Inhalation Cancer Slope factor	SF ₁	1.92E-07 risk/pCi
Conversion Factor 2	CF ₂	1000 g/kg
Inhalation Rate	IR _{air}	20 m ³ /day
Soil to Air Volatilization Factor	VF	1 m ³ /kg
Particulate Emission Factor	PEF	4.28E+09 m ³ /kg

Radionuclide Concentration in Soil (Inhalation)

CS_{inh} 8.94E+03 pCi/g

External

External Cancer Slope Factor	SF _e	1.23E-05 risk/pCi
Exposure Duration 2	ED ₂	3.425 yrs
Gamma Shielding Factor	S _e	0.1
Gamma Exposure Time factor	T _e	0.33

Radionuclide Concentration in Soil (External Exposure)

0.79 pCi/g

Total

CS_{TOTAL} 6.84E-01 pCi/g