Department of Energy
Oak Ridge Operations
Paducah Site Office
P.O. Box 1410
Paducah, KY 42001

May 5, 1999

Mr. Carl R. Froede Jr., P. G.
United States Environmental Protection Agency
Region IV
DOE Remedial Section
Federal Facilities Branch
Waste Management Division
61 Forsyth Street
Atlanta, Georgia 30303

Mr. Michael V. Welch, P.E.
Manager
Hazardous Waste Branch
Kentucky Department for Environmental Protection
14 Reilly Road, Frankfort Office Park
Frankfort, Kentucky 40601

Dear Mr. Froede and Mr. Welch:

WASTE AREA GROUPING 6 (C-400 AREA) REMEDIAL INVESTIGATION REPORT (DOE/OR/07-1727&D2), PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY

Enclosed for your approval is the subject document along with the Comment Response Summary for comments received on the D1 version of the Waste Area Grouping (WAG) 6 Remedial Investigation (RI) Report. As you are aware, once this document is approved, the WAG 6 RI will be incorporated into the Groundwater Operable Unit (GWOU) Feasibility Study (FS), which is due for submittal June 18, 2000. In addition to incorporation into the GWOU FS, the WAG 6 data will also be incorporated into the other operable units as appropriate. Consistent with the Federal Facilities Agreement, we request that you provide notification of your approval of the WAG 6 D2 RI Report by June 10, 1999. If you have any questions or require additional information, please call David W. Dollins at (502) 441-6819.

Sincerely,

Jimmie C Hodges

Jimmie C. Hodges, Site Manager
Paducah Site Office

I-00810-0050

Enclosure

cc w/enclosure:
S. Hampson, KDEP/Frankfort
G. T. Mullins, KDEP/Frankfort
T. M. Taylor, KDEP/Frankfort
J. A. Volpe, KDEP/Frankfort

COMMENT RESPONSE SUMMARY

for Review Comments from
The United States Environmental Protection Agency
and the
Commonwealth of Kentucky Department of Environmental Protection

for the
August 1998

Remedial Investigation Report for Waste Area Grouping 6 at the Paducah Gaseous Diffusion Plant Paducah, Kentucky
DOE/OR/07-1727&D1

Prepared by
CH2M HILL, Inc.
Paducah, Kentucky
under General Order 18B-99345C

for the
U.S. Department of Energy
Office of Environmental Management

Environmental Management Activities at the
PADUCAH GASEOUS DIFFUSION PLANT
Paducah, Kentucky 42002
managed by
BECHTEL JACOBS COMPANY LLC
for the
U.S. DEPARTMENT OF ENERGY
Under contract DE-AC05-98OR22700

Remedial Investigation Report for the Waste Area Grouping 6 at the Paducah Gaseous Diffusion Plant, Paducah Kentucky
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Comment No.	Section/Page/Para.	State Comment	Response
1	General	Given the amount of TCE present in UCRS soil at SWMU 11, it is likely that DNAPL exists beneath the southeast corner of the C-400 Building. DNAPL may also be present beneath the southwest corner of the building. Samples collected from borings 400-015 and 400-142 would tend to support this assumption. It will be necessary to further characterize these two areas in order to support a full evaluation of remedial alternatives. Further characterization could be undertaken as a part of the Treatability Study for WAG 6. A discussion of additional characterization as a part of the Feasibility Study should be included in the D2 WAG 6 RI Report.	We agree that a considerable amount of TCE exists both at the southeast and southwest corners of the C-400 Building. However, the DOE and project team are comfortable that sufficient data exist to put bounds and develop sensitivities on the areas and volumes of material that would require treatment in a remedial action situation. To that end, we propose to do no further characterization at this time. We do, however, suggest that we should look at the implementation of remedial design borings during the design phase following the Record of Decision to assist in isolating the area to be treated and thus conserve resources for treatment.

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Comment No.	Section/Page/Para.	State Comment	Response
2	General	Waste Area Grouping 6 represents a source of contamination that is contributing to risks above 1×10^{-6} to current industrial workers on-site, as well as current off-site receptors. The modeling used by DOE (MEPAS) does not indicate that future concentrations of radionuclides migrating within the TCE plume will be above a level of concern for several hundred years. Technetium-99 was not modeled as it is currently present in off-site groundwater above a level of concern. We have serious reservations about the tendency to rely on modeled predictions which assume that the fate and transport of each contaminant present is independent of the presence of other chemicals in the soil and aquifer.	Comment noted. Please see responses to specific comments for additional discussion about modeling concerns. DOE recognizes that MEPAS modeling results are screening level. In addition please recognize that DOE did not prepare the model in order to declare that monitoring was not needed at WAG 6 or in the groundwater plumes. Furthermore, the modeling was not intended to show that contaminants were not migrating from source areas at WAG 6. In fact, existing offsite monitoring shows that TCE and Tc-99 are migrating from the site in concentrations of concern. Currently, since modeling and monitoring are the only means available for determining what is leaving or may leave the site, we must model. The DOE recognizes that migration characteristics of a contaminant may be impacted by a co-contaminant(s) present in the source area. However, modeling to integrate all possible contaminant combinations is very expensive, and would provide results that are very uncertain. Therefore, DOE believes that such modeling would be of little benefit in this RI Report.

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Comment No.	Section/Page/Para.	State Comment	Response
3	General	Include a table that contains the ground surface or floor surface elevations for all sampling locations.	Agreed. Appendix F in Volume 2 of this report presents the surveyed elevations for all WAG 6 sampling locations.
4	General	Include a figure that depicts the location of all buried utility lines and building drains, past and present.	Agreed. A figure depicting the location of all buried utility lines and building drainage systems in the vicinity of WAG 6 has been compiled from available data and added to Section 3 of Volume 1.
5	General	For completeness it is suggested that this chapter include a table listing the metals and radioisotope PRGs similar to Tables 4.1 and 4.2 which list the metals background values and radioactive-isotope background values respectively.	Agreed. A new table (Table 4.2) presenting the PRGs for selected metals and radioisotopes has been added to Section 4.

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Comment No.	Section/Page/Para.	State Comment	Response
6	General	The lack of documentation of the source of Technetium-99 leaves unresolved a significant issue that may be necessary for remediation.	Agreed. The DOE concurs that additional characterization is needed of the Tc-99 source area. The DOE has identified the North-South Diversion Ditch to be a source of the Tc-99 contamination. The limited sampling results that are available from the Phase II Investigation provide information supporting the N-S Ditch being the source. We further believe that additional characterization is needed to identify it as the source and to identify the additional contaminants that may be present and which must be handled as part of a remedial action. To that end, we are evaluating and reprioritizing the resources available to us this fiscal year to determine whether we can perform a limited number of borings this calendar year. After prioritization, if the resources are not available, we commit to attempting to obtain additional resources to perform these additional borings. With the inclusion of the limited number of borings discussed above, an additional drilling program may be needed as part of the remedial design to focus resources based on the remedial technology chosen for implementation. This information will be incorporated into the Groundwater Operable Unit Feasibility Study.

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Comment No.	Section/Page/Para.	State Comment	Response
1	Section 2.3; Page 2-2; 2nd para	Using radioactivity meters to scan for twice background can be problematic when working in close proximity to the cylinder yards. A new method has recently been employed at the PGDP in which soil samples are encased in lead prior to performing gamma scans.	Comment noted. The new sampling procedure using a sodium iodide detector and lead-shielded samples was employed during the WAG 27 RI fieldwork (Spring 1998).
2	Section 2.4; Page 2-4; 2nd para	This paragraph indicates that 12 groundwater samples were collected from piezometers for volatile organic analysis. Please indicate whether these piezometers were of PVC or stainless steel construction. PVC wells might adversely affect VOC results.	All piezometers were constructed using schedule 40 PVC. Construction details are contained in Section 2.5, Piezometer and Monitoring Well Installation, and Sampling. The piezometers were not originally planned to be sampled for groundwater. However, to collect additional groundwater data, a field decision was made near the end of the project to collect a round of UCRS water samples from the piezometers. The potential effect on the VOC content of the groundwater collected from monitoring wells constructed of PVC is minimal and will not affect risk management.
3	Section 2.8.5.3; Page 2-17	Lines 3 through 5 state that sample results "...judged to be significantly impacted were assigned an assessment flag." Please clarify what is meant by "significantly impacted."	Any VOA sample in which the holding time exceeded fourteen days was considered "significantly impacted" and assigned a BL-T data assessment flag. This clarification has been added to the text in Section 2.8.5.3.

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Comment No.	Section/Page/Para.	State Comment	Response
4	Section 4.1.1; Page 4-2	Lines 2 through 5 state that certain known laboratory contaminants were "...determined to represent laboratory contamination and not site contamination." Please explain how these compounds were eliminated from further consideration as possible site contaminants. Was their elimination based upon a comparison of blank and sample results or were they simply eliminated because there are known lab contaminants?	Laboratory contaminants were identified using protocol set forth in the U.S. EPA's National Functional Guidelines for Organic Compounds. This protocol is based on a comparison of field or method blanks to environmental results. Compounds identified as laboratory contaminants were assigned an "In-Lab" assessment qualifier in the database and were removed from consideration in Section 4, Nature and Extent of Contamination. A statement will be added to the text in Section 2.8.5.3, Final Review, that clarifies this process.
5	Section 4.2.8.2; Page 4-26	Lines 15 and 16 state that the majority of subsurface samples collected from beneath the SWMU 26 pipeline were collected from no deeper than 15-feet bgs. However, lines 21-22 on the previous page state that subsurface samples were collected from a depth of 48.5-feet bgs. These two statements appear to contradict each other. Please clarify.	Agreed. Subsurface samples were collected beneath the SWMU 26, C-401 Transfer Line at depths of up to 48.5 feet below ground surface (bgs). Most of the samples that were collected along the pipeline were from a depth of less than 15 feet bgs. However, at selected locations in Sector 8, samples were collected down to a depth of 48.5 feet bgs to help determine the nature, extent, and origin of contaminants that might be present at depth. The text on page 4-25, lines 21-22 has been changed to read "...(collected from a depth of up to 48.5 ft bgs)...".

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Comment No.	Section/Page/Para.	State Comment	Response
6	Section 4.3.3; Page 4-37; 2nd para	Line 18 lists 1.82 pCi/L as the maximum Tc-99 activity from boring 400-041. Table 4.65 lists this result as 1.88 pCi/L. Which figure is correct?	Agreed. The correct value for the Tc-99 concentration in groundwater at a depth of 120-feet bgs in boring 400-041 is 1.88 pCi/L. The numerical value in the text on page 4-37 has been corrected from 1.82 pCi/L to 1.88 pCi/L.
7	Figure 4.9	Volatile organic compounds were detected at high concentrations within this sector. Please revise the map so that points where VOC contamination exists can be easily identified.	Agreed. Figure 4.9 has been revised to show which boring locations contained VOA contaminants.
8	Figure 4.10c	The panel at the top of this figure shows a large area of contamination (i.e., blue and green) located just south of the C-400 Building. There does not appear to be enough sample density in this area to justify including the blue contoured region in the figure. Please explain how this data was contoured.	Agreed. The series of maps included in Figures 4.10a, 4.10b, and 4.10c were intended to graphically depict the approximate location of the contaminant plume at Sectors 4 and 5 as it appears at different depths below the ground surface. Unfortunately, the perspective used to illustrate the plume location at depth is misleading. This apparent shift in the actual location of the plume has been corrected so that plume placement as depicted on the depth slices now corresponds to contaminant concentrations reported from boring locations. Revisions of Figures 4.10a, 4.10b, and 4.10c are included in the D2 report.
9	Figure 4.11a	In this figure, the soil sample collected at boring 400-200 from 30-feet bgs contained 2,759,000 ppb TCE. The top panel in Figure 4.10c gives no indication that such high levels of TCE exist in the vicinity of 400-200. Please explain and revise Figure 4.10c as necessary.	Agreed. Figure 4.10c has been revised to reflect the levels of TCE reported from boring 400-200. Please also see response to Comment #8 above.

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Comment No.	Section/Page/Para.	State Comment	Response
10	Figure 4.11b	In this figure, the soil sample collected at boring 400-015 from 24-feet bgs contained 168,200 ppb TCE. The top panel in Figure 4.10c gives no indication that such high levels of TCE exist in the vicinity of 400-015. Please explain and revise Figure 4.10c as necessary.	Agreed. Figure 4.10c has been revised to reflect the levels of TCE reported from boring 400-015. Please also see response to Comment #8 above.
11	Figure 4.12	This map does not indicate the presence of any TCE contamination in the vicinity of boring 400-195 or boring 400-178. However, Figure 4.10c shows high levels of TCE in this area. Explain and revise the figures as necessary.	Agreed. Figure 4.10c has been revised accordingly. Please also see response to Comment #8 above.
12	Figure 4.39	TCE concentrations for RGA groundwater at boring 400-034 are not listed below 60-feet. Include the RGA groundwater concentrations on the figure. Also, the inset map at the bottom of this figure is somewhat misleading. Several boring locations have been adjusted so that all borings fall along a straight line. The figure makes it appear as if numerous McNairy borings were drilled beneath the C-400 building. Please revise this figure.	Agreed. TCE concentrations for the RGA groundwater at boring 400-034 have been posted on Figure 4.39. Also, the inset map showing the line of section has been revised to show the actual spatial relations of the wells and how these individual borings were *projected* into the cross section.

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Comment No.	Section/Page/Para.	State Comment	Response
13	Section 2.2; Page 2-1	It is unclear as to how the soil gas sampling was utilized in the Remedial Investigation (RI) of WAG 6. It appears that the sampling was focused along utility bed corridors, but that problem with the integrity of the sampling equipment prevented obtaining reliable results from a number of samples. Discuss how the results of this sampling were used in the RI. Appendix D is incorrectly referenced in the text as containing a discussion of the sampling problems.	A discussion of the soil gas sampling effort during the WAG 6 project, as well as the problems encountered, can be found in Volume 2, Appendix D, pages D-1 through D-4, of the RI. For the WAG 6 RI, soil gas sampling was conducted within and adjacent to the utility corridors in order to collect real time screening data that would help focus the soil and groundwater sampling effort. Unfortunately, there were technical problems associated with the soil gas sampling effort that caused the reliability of the screening data to be questioned. However, due to the high density of soil samples which were being collected in conjunction with the soil gas sampling and the associated analyses at the on-site Close Support Lab, it was determined that real time definitive data were already available at most of the soil gas sampling locations. Therefore, adequate coverage for characterization was available even if the soil gas screening data were invalid. As a result, due to the problems in the collection of soil gas screening data, the results of the soil gas survey were not used to draw any conclusions concerning the nature and extent of contamination or to make any risk-related decisions during the WAG 6 project.

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Comment No.	Section/Page/Para.	State Comment	Response
14	Section 2.4	Provide discussion whether these groundwater samples were filtered prior to analysis. For risk assessment purposes, analytical data from unfiltered samples are required.	Agreed. Both filtered and unfiltered groundwater sample data were used in the WAG 6 RI. The following text will be added to Section 2.4, <u>Borehole Groundwater Samples</u>, to clearly define the use of filtered and unfiltered sample data: "**<u>Filtered and Unfiltered Groundwater Sampling Rationale</u>.** Groundwater samples collected during the WAG 6 RI were submitted for laboratory analyses in both a filtered and unfiltered condition. This was accomplished by collecting a sufficient volume of groundwater at each sampling point to divide the sample into separate aliquots for analyses. As discussed in Section 4, <u>Nature and Extent of Contamination</u>, for metals the filtered results were primarily used to preclude biased-high results that are inherent to groundwater that percolates through clay-rich soils. Results from both the filtered and unfiltered samples for metals were assessed in the baseline risk assessment as discussed in the Section 6 summary and in Vol. 3a."

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Comment No.	Section/Page/Para.	State Comment	Response
15	Section 2.5; Section 4.3	According to the text in this section, the analytical data from groundwater samples used in the risk assessment is based on filtered samples. However, in Volume 3a (Section 1.6.1.4, page 1-171), the RI states "In this BHHRA, all analyte concentrations in water came from and analyses of unfiltered or total samples". Please clarify and correct these conflicting statements. The calculation of risk from exposure to groundwater must be based on the total metals present (unfiltered samples), according to guidance from the United States Environmental Protection Agency (USEPA 1998).	The discussion of filtered versus unfiltered groundwater results in section 4.3, Groundwater, is specific to the Nature and Extent section of the RI report. In keeping with the procedures in the regulatory agency-approved *Methods for Conducting Human Health Risk Assessment and Risk Evaluations at the Paducah Gaseous Diffusion Plant*, results from unfiltered groundwater samples were used when characterizing the risk reported in the main part of the risk assessment, and the results from filtered groundwater samples were used when examining the uncertainties inherent in unfiltered samples (i.e., separate assessment run). As noted in the aforementioned document, this approach is consistent with all EPA guidance.

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Comment No.	Section/Page/Para.	State Comment	Response
16	Section 2.7	When the sump was sampled, was consideration given toward the potential for preferential settling of contaminants of potential concern (COPCs) in the waste liquid? The description of the sampling method used indicated that it is appropriate for sampling a relatively homogenous waste liquid. However, heavy or insoluble contaminants, if present, may not have been adequately characterized through this method.	Internal characterization of the C-403 Neutralization Tank was not part of the original scope of the WAG 6 RI. Indeed, the tank was believed to be dry at the start of the field investigation. However, during the field effort liquid was observed in the tank and a field decision was made to collect a sample of the liquid for analyses. As discussed in Section 2, Field Investigation, a grab sample was collected using a disposable bailer. Additional sampling has been conducted at the tank based on the results of this initial analyses. Please also see response to Comment No. 30.

Comment No.	Section/Page/Para.	State Comment	Response
17	Section 4.1.1; Page 4-1	Numerous inorganic elements in the background data set for soil and groundwater exceed a risk-based level of concern, some by several orders of magnitude (e.g., thallium in groundwater). Screening COPCs against background when some background levels are elevated will underestimate the risks present. Regardless of whether the contaminants are related to the site or are naturally occurring "ambient" concentrations, the exposures are to the total contaminant mass present. The estimation of risk should reflect the total risk present, and ambient, or background risk should be considered in the risk management process.	As discussed in the introductory material in Section. 4, Nature and Extent of Contamination, the data were screened against background data to develop a list of analytes that deserved additional attention in the discussion of the nature and extent of contamination. This screening is totally unrelated to the approach followed in the baseline risk assessment. In the baseline risk assessment, a background screen is included per the regulatory agency-approved *Methods for Conducting Human Health Risk Assessment and Risk Evaluations at the Paducah Gaseous Diffusion Plant*. However, to address the issue of high background concentrations for some metals, additional discussions of the risk that may be caused by exposure to soils containing metals at the background concentrations are included in the uncertainty section of the risk assessment. Hence, all information necessary to make appropriate risk management decisions is present in the baseline risk assessment.

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Comment No.	Section/Page/Para.	State Comment	Response
18	Section 4.2.4.2; Page 4-14	Please explain why the sample quantitation limit (SQL) was 20 times greater than the PGDP background value for antimony in soils. We would expect the SQL to be near or below the background value reported in Table 4.1 (0.21 mg/kg).	Agreed. As you expected, a review of the BG data shows that in most cases the SQLs are lower than, or equal to, BG. The exception is antimony. However, the laboratory Instrument Detection Limit for antimony was low enough to capture the antimony analytical results. These results were used to evaluate Nature and Extent, Fate and Transport, and Risk from exposure to antimony.
19	Section 4.3.2; Page 4-35	Although no trend in the inorganic analyses suggests that the C-400 Building was the source of the widespread metals contamination found in groundwater below WAG 6, the building was used for metal-plating, and numerous elevated detections were found associated with waste storage areas and transfer conduits. The activities within the C-400 Building and surrounding areas have obviously impacted surface and subsurface soils and should be considered as a significant contributor to the contamination found in the underlying groundwater resource. The acidic soils found over WAG 6 would tend to facilitate the mobility of many inorganic compounds through soils to groundwater.	Comment noted. The limiting factors controlling metals migration in subsurface soils are discussed in Section 5, Fate and Transport, Subsection 5.3.3, Metals. As a further note, pH is one of the transport parameters used in the MEPAS model.
20	Figure 4.16	The mapped sample locations and the analytical data do not appear to agree. The sample locations also do not agree with other maps of Sector 5. Please clarify this discrepancy.	Agreed. During the final plotting of this figure for the D1 report, the electronic layer containing the data boxes was inadvertently shifted to the right in relation to the base figure. This shift has been corrected and the revision of Figure 4.16 is presented in the D2 as requested.

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Comment No.	Section/Page/Para.	State Comment	Response
21	Section 5.2.2.1; Page 5-5	Additional explanation of the justification and rationale behind the estimation of the groundwater recharge rate from precipitation is needed. It is unclear how the estimate (8% of total rainfall) was determined. It appears that the estimate is based on average rainfall, which does not account for the variation often seen in annual precipitation levels. A conservative estimate, which represents an upper-bound annual rainfall amount, would ultimately indicate the potential upper-bound migration, rather than the central tendency.	The recharge rate was derived from the 1992 Geotrans modeling simulations that accounted for the physical conditions of the PDGP facility. Since the facility is covered with industrial structures including pavement, buildings, and product storage areas, a recharge rate of 8% is a very realistic estimation of the total rainfall available for recharge. For a comparable site in an area with much lower industrial usage, a published ratio of recharge to annual rainfall of 12% has been reported. A difference of 4% in total recharge for the PGDP facility would appear justified by the high industrial land usage. It should be noted that this recharge rate was provided to give general information concerning the water balance at the PGDP and was not used in the MEPAS modeling conducted for this RI. The water balance for MEPAS is computed using long-term meteorologic data (including monthly estimates of precipitation, potential evapotranspiration, snowmelt, temperature, and runoff) as well as WAG 6 site information and so does account for variation in precipitation.

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22	Section 5.3.3; Page 5-12	a) Chromium should also be considered to be one of the metals used at the C-400 Building, based on the analytical data from sampling the residual waste within the Technetium-99 Storage Tank (SWMU 47). Widespread chromium detections in surface soils, subsurface soils, and groundwater support this assertion. b) "Generally reported literature values" for metals are not relevant to the PGDP site, or the WAG 6 RI.	a) Chromium has been added to the text of the first bullet listed under Abundant Metals on page 5-12. This will provide consistency with the source description of SWMU 47 provided under Section 5.2.1, Sector 6 (SWMU 47). b) The published values for metals are relevant and may be useful to future decision-making by risk managers. The suggested use of published data should be noted in the text.
23	Section 5.4.1.2; Page 5-16	Please provide the method for the estimation of the advection velocity.	Agreed. The advection (seepage) velocity,v = ki/n; and the variables are defined as k (the hydraulic conductivity), i (the hydraulic gradient), and n (the effective porosity).
24	Section 5.5; Page 5-20; line 19	a) Please identify the criteria used to identify "analyte concentrations that did not greatly exceed a screening level". b) It is unclear how the concentration (source) term for each sector used in the model was determined. It appears that all detections plus one-half the value of non-detections were averaged. The source term	a) Agreed. The following sentence will be added to the text for clarification: "Analyte concentrations that did not greatly exceed a screening level were determined by site experts based on the range of observed contaminant levels and the closeness of the screening level to the sample quantification level". b) Agreed. A reference will be added in the text indicating that the procedures used to define each source term are detailed in Table 5.8 (Sector 1), 5.11 (Sector 2), 5.14 (Sector 3),

Comment No.	Section/Page/Para.	State Comment	Response
24	Cont.	should be based on the 95% UCL or the maximum. Please explain the procedure used for this process.	5.17 (Sector 4), 5.20 (Sector 5), 5.23 (Sector 6), 5.26 (Sector 7), and 5.29 (Sector 8). The revised text will further state that the procedures used to characterize the contaminant levels for each source term are dependent upon the distribution of data. Default to either the maximum observed concentration or the 95% UCL is appropriate where the data distribution is inadequate to define a source term. In most cases, the WAG 6 data are sufficient, in combination with knowledge of site processes, to model a source term. The maximum observed concentration was used when data were insufficient to define the source term.
		c) The RI states "Modelers identified RGA sources for two sectors: 5 and 7.". Please explain what is meant by "RGA sources". It would appear that several other sectors are sources of contamination to the RGA (e.g., Sector 2 (SWMU 40), Sector 8 (SMWU 26)).	c) Agreed. "RGA sources" refers to sources of undissolved contaminant within the lower Continental Deposits (primary host formation of the Regional Gravel Aquifer). You are correct that other sectors contain sources within the topsoil and upper Continental Deposits (host formation of the Upper Continental Recharge System) - these are the MEPAS sources defined as Surface Soil and Subsurface Soil. The text will be revised to clarify the sources being discussed.

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24	Cont.	d) How does the modeling account for the effect of the presence of highly acidic soils on the rate of migration of COPCs through soils?	d) MEPAS accounts for soil pH. The pH of the soils is one of the input parameters used to select the K_d values for inorganics. See Table 5.6 for the pH values used in the WAG 6 model. (The soils are not highly acidic.)
25	Figure 5.3	The Division will not accept the "2X" background approach to screen potential chemicals of concern. This approach, although supported by Region 4 USEPA, is not scientifically based. It is a "rule of thumb" which attempts to accommodate the typical CERCLA site with a limited degree of background sampling. The approach that KYDEP supports is one in which chemicals of concern are screened against health-based preliminary remediation goals (PRGs) for residential use. Contaminants which are not related to site activities yet exist above health-based levels are accounted for in the estimate of pathway and total risk. Risks above the de minimus which can be attributed to "background" are discussed in the risk characterization portion of the risk assessment. The nature of the site, potential for exposure, and characteristics of the contaminants (e.g., fate and transport) and presence of other site-related contaminants will dictate if risk management is required.	Agreed. It would not be appropriate to use the 2X background rule in risk assessments at PGDP where we have developed an approved set of background values for soil. In keeping with this conclusion, this approach was not used in the baseline risk assessment. The risk assessment uses only those screening criteria approved in *Methods for Conducting Human Health Risk Assessment and Risk Evaluations at the Paducah Gaseous Diffusion Plant.* However, the 2X background screen was used in the fate and transport section of the WAG 6 RI report (i.e., Section 5) in order to identify those contaminants in soil which deserve further attention in the fate and transport discussion, and not to define COCs. Text will be added to clarify the intent of the screening steps outlined in Figure 5.3.

Comment No.	Section/Page/Para.	State Comment	Response
26	Figures and Tables	Many of the references cited in support of information found in several figures and tables (e.g., Table 5.1, Physical and Chemical Properties of COPCs at WAG 6; Table 5.2, List of Distribution Coefficients; Table 5.3, Radioactive Half-lives, etc) are not listed in the references found in Section 8.	Agreed. The references cited in the text have been added to Section 8.
27	Table 5.4	The biodegradation half-life estimates for PAH compounds in this table represent the lowest estimate (maximum biodegradation rate) in the range published in Howard et. al. (1991). There is no reason to believe that site conditions at WAG 6 will support either the minimum or maximum biodegradation rates. A reasonable compromise is using half-life data for PAHs which represent the average of the range of estimated half-lives. The chlorinated hydrocarbons are correctly assumed to resist biodegradation as they migrate from WAG 6 through the RGA, as confirmed through previous monitoring data.	Comment noted. The table is presented for general reference and to provide information for Risk Management Personnel and was not used for calculating quantitative results of PAH biodegradation at WAG 6.
28	Figure 3.6	Building C-410 and the C-402 Lime House should be identified. The north-south diversion ditch should be included as SWMU-98. Expand the label of SWMU 40 to include the phrase "C-403 Neutralization Tank", SWMU 47 to include "Tc-99 Storage Tank", SWMU 203 to include "Waste Discard Sump", and SWMU 11 to include "TCE Leak Site".	Agreed. Figure 3.6 has been revised to include designations for Building C-410 and for the C-402 Lime House. Also, SWMU labels have expanded as requested and the north-south diversion ditch (SWMU 59) has been delineated on the map.

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Comment No.	Section/Page/Para.	State Comment	Response
29	Section 4.2.1.2; Page 4-5	Figure 5.2 indicates that the water table at WAG 6 is less than 40-feet bgs. Explain how the soil sample from boring 400-020 taken at a depth of 44-48 feet could be at the base of the UCRSs vadose zone.	The UCRS water level in Figure 5.2 was approximated from several water level measurements in borings or monitoring wells. The figure has been revised using water level elevations (42-45' bgs) as determined from the potentiometric map in Figure 3.18.
30	Section 4.2.2.1; Page 4-7	Explain the source of Technetium-99 in the area of the C-403 Neutralization Tank when water entered the tank from an adjacent water line break during the WAG 6 investigation. Table 4-11 provides radiation data for samples from this sector; however, activities of radionuclides in the UCRS adjacent to C-403 cannot account for the levels of radionuclides in the tank subsequent to the water line break. Indicate the location of the water line break on Figure 4.4 and provide data for any soil samples taken from the area or adjacent areas. Explain the decrease in activity from 43,750 pCi/L to 4430 pCi/L from November 1997 to January 1998. Did the volume of water increase in the tank? Explain loss of activity since decay cannot be the cause of the decrease in activity?	Agreed. The location of the broken water line in the area of the C-403 Tank is now shown on Figure 4.4, and soil samples that were collected from the area around the C-403 Tank during a post-WAG 6 supplemental work scope have been included as an addendum to Appendix J. The high Tc-99 activities of up to 43,750 pCi/L represent historical sampling of the tank contents. The scope of the WAG 6 investigation did not include the internal characterization of the C-403 Tank. However, based on stratified sampling of the contents of the tank in July 1998, the levels of Tc-99 and TCE were found to increase significantly with depth. This suggests that the source for the TCE and Tc-99 is the layer of bricks and interstial pore water within these bricks that line the base of the tank.

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Comment No.	Section/Page/Para.	State Comment	Response
31	Section 4.4.4; Page 4-9	The last paragraph reports results for water samples. Since this section deals with surface and subsurface soils, this paragraph appears out of place. Furthermore, no sampling locations and no procedure for handling samples is provided with the data. Explain the information provided in this last paragraph.	Agreed. The comment correctly notes that the water radioactivity was reported within the soils evaluation section. The paragraph containing the water radioactivity results has been moved to the subsection immediately following and is now the last paragraph before Section 4.2.3, Sector 3. The water samples discussed in the subject paragraph were collected from six borings located around the perimeter of the C-403 Neutralization Tank. These locations have been added to Figure 3.6 as an inset map. A description of this additional sampling effort has been added to the Sector 2 text on page 3-13: "Six additional soil borings were drilled in the UCRS to a depth of 10-30 feet bgs in April 1998 to determine if a release had or was occurring from the C-403 tank". The drilling and sampling of the six borings was conducted using the same field operations procedures described in Section 2, Field Investigation.

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Comment No.	Section/Page/Para.	State Comment	Response
32	Section 4.2.6.2; Page 4-22	Technetium-99 activities do not appear excessively elevated and the uranium appears to be naturally occurring and not depleted. Explain the data and include the activity of Technetium-99 and uranium isotopes.	Agreed. The activities for these samples were described as "high" based on a comparison with BG. Admittedly, it is a subjective judgment as to whether an activity that is four or twenty times higher than background should be described as "high". The text on page 4-22 in the Radionuclides section has been revised to simply indicate that radioisotopes in the 047-002 soil sample from 4.5-feet bgs were detected at activities that exceeded background.
33	Section 4.3; Page 4-30	Indicate whether the exclusion of metals also applies to radionuclides.	In Section 4, both filtered and unfiltered radionuclide results were considered in assessing the nature and extent of radionuclide constituents detected at WAG 6.
34	Section 4.3.1; Page 4-33	Identify the Sector(s) associated with sample locations 400-009 and 400-018. Tables 4.4 through 4.50: Samples of sludge should be identified as sludge and not listed as "soil".	Agreed. Sample locations 400-009 and 400-018 are assigned to Sector 5. Appendix A provides a list of each sampling station and its associated sector for the WAG 6 RI. Agreed. Sludge samples were not differentiated from soil samples within the unique sample identifier used during the WAG 6 RI. Tables 4.4 through 4.50 have been revised to clearly indicate sludge samples by placing the word "Sludge" in column 1, Sample Type, where appropriate.

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35	Section 5.2.2; Page 5-5	Line 7 states that the UCRS is not perennially saturated where as line 29 states that the saturated zone is the UCRS; resolve this conflict.	The text on line 7 refers to one of the MEPAS modeling (leachability analysis) assumptions. The text on line 29 refers to one of the assumptions made by Geotrans (1992) to simulate the water balance at the PGDP. Different models require different types of assumptions, and although they may appear to be limiting, the modeling results afford the technology to evaluate several physical processes simultaneously and to help predict future tends in fate & transport analyses.
36	Section 5.3.4; Page 5-13; lines 34 and 35; 2nd para	The text indicates that decay chains, etc. are provided in Table 5.3. Either include decay chains in Table 5.3 or modify statement.	Agreed. The sentence has been revised to state that "the decay products and half-lives" are presented in Table 5.3.
37	Section 5.3.4; Page 5-14; last para	Include the background activities for the radionuclides mentioned. Describe the calculations and any conversion factors that are alluded to in the text.	Agreed. The background activities available for radionuclides at the PGDP are provided in Table 4.1 of the report. The reference statement concerning radioactive conversion calculations is given as general information only. The calculations were not performed as part of the WAG 6 RI work scope and would not add significant value to the report.

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38	Section 5.4.1.1; Page 5-16; line 2	The velocity of infiltrating water should be based on the effective porosity which can be very closely approximated by the field capacity, especially in the fine grained soils like those of the UCRS.	The velocity of infiltrating water was conservatively estimated using a water filled porosity because of the theory that preferential flow paths have developed in the upper 20 feet of material, material known to have been borrowed during the construction of PGDP. Underground utilities and other structures also increase the rate at which water infiltrates. A published value for specific yield (effective porosity) of 0.2 can be used.
39	Section 5.4.1.1; page 5-15; lines 10-11	The Division does not concur with the assessment that the dominant driving force in the UCRS is diffusion. Investigations of the UCRS groundwater flow system and investigations of the structure of the loess (C. Petersen, Masters thesis, University of Kentucky, 1996) indicate that the loess can have an abundance of macropores and vertical fractures that facilitate the rapid vertical transport of groundwater.	At the PGDP fluvial sediments comprise the bulk of the UCRS strata, and neither vertical fractures nor macropores have been typically described from the samples studied. Macropores and fractures can, in many rock types, enhance the physical process that drives contaminant transport and probably plays some role in the overall dispersion of contamination from the UCRS to the RGA.
40	Section 5.5; Page 5-17	Supply the results of the calibration and verification runs for the MEPAS model.	Because the MEPAS model does not utilize potential past source terms, it is not possible to calibrate the model to existing conditions. In fact, the goal of the MEPAS model is to estimate potential future concentrations of contaminants in groundwater at the exposure points given the current source terms at WAG 6.

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Comment No.	Section/Page/Para.	State Comment	Response
41	Section 5.5.4; Page 5-23	Lines 7 and 8 state that cis-1,2-DCE and trans-1,2-DCE could not be modeled because they are absent from the MEPAS database. Both of these contaminants were detected in Sector 4 at levels above established residential PRGs. In particular, trans-1,2-DCE was detected at a maximum level of 1200 µg/L. The residential PRG for this compound is 4 µg/L. These compounds should not be discounted as contributors to off-site risk and therefore should be modeled.	The WAG 6 risk assessment accounts for cis-1,2-DCE and trans-1,2-DCE in Sector 4. However, the MEPAS model was unable to model future contaminant levels. Because we expect the source to deplete over time, the current risk posed by these volatile organics provides a boundary to the problem.
42	Section 5.5; Page 5-18; lines 24 through 30	The source of Technetium-99 has not been identified. Therefore, how can the statement be made that the activity of Technetium-99 is declining? Provide data documenting that the activity of Technetium-99 is decreasing at the source.	Agreed. A plot of measured Tc-99 activity for well MW-66 (completed in the Northwest Plume near the PGDP security fence) will be added to the RI Report to document the trend of declining levels over time. Because the Northwest Plume originates from the C-400 technetium source, the dissolved phase trends reflect the change in the remaining source mass.
43	Section 5.5; Page 5-18; 3rd & 4th para	The following two statements: "...modeling is not required for assessing current or future levels of contaminant exposure originating from the DNAPL zone." and "...modeling is unnecessary for assessing current or future levels of contaminant exposure originating from the Technetium-99 source," are contradicted by the modeling described in Sections 5.5.1 through 5.5.8. Revise the text to eliminate this apparent contradiction.	Agreed. The text will be revised. The modeling in Sections 5.5.1 through 5.5.8 is required to assess the need for remedial action in each of the independent sectors. However, it remains true that empirical data are sufficient to demonstrate, without modeling, that the cumulative impact of contamination in the shallow soils (upper Continental Deposits) and aquifer (lower Continental Deposits) requires a remedial action.

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Comment No.	Section/Page/Para.	State Comment	Response
44	Table 5.6	Include references for bulk density, total porosity, and field capacity.	The table documents the calculation of bulk density (no other reference is applicable). There has been no measurement of field capacity of PGDP soils. The value is based on MEPAS guidance, which provides estimates of field capacity based on soil texture, and the professional judgment of site hydrogeologists (a reference to the MEPAS guidance will be added). A reference will be included for total porosity (WAG 6 measurements).
45	Volume 3a; Section 1.2.2; Page 1-15	The comparison to background procedure outlined in this section differs from the methodology outlined in Volume 1 (Figure 5.3). Our (KYDEP) recommendations for screening contaminants were outlined in Specific Comment #15.	Comment noted. Please recognize that the recommendations in Specific Comment #15 do not match the procedure contained in the approved *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant*. As agreed when that document was prepared, a screen against background is to be performed as part of the risk assessment, and the uncertainties inherent in this screen are to be discussed. This is the procedure followed in the WAG 6 Baseline Risk Assessment.

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Comment No.	Section/Page/Para.	State Comment	Response
46	Volume 3a; Section 1.2.3.2; Page 1-22	In addition to several deficiencies noted within these comments, the groundwater model does not take into account the presence of multiple contaminants and the associated potential enhancement of migration through the UCRS and the RGA. Based on the historical success of modeled predictions at PGDP, we (KYDEP) recommend that remedial decisions should not be based on modeled predictions. Continuous monitoring of the groundwater plumes originating from WAG 6 is necessary to track the migration of contaminants. This monitoring program must start near (downgradient) of WAG 6 and consist of sampling points within the Northwest and Northeast Plumes, with the distance between the sampling points sufficient to approximate the location of migrating contaminants. It is our concern that off-site concentrations above health-based levels of concern will, because the models predicted that the WAG 6 contribution is insignificant, be attributed to "upgradient" or "other" sources which will remain unknown and not addressed until the groundwater integrator unit is considered. Meanwhile, impacts to the RGA and to potential off-site receptors will continue unabated.	Agreed. DOE recognizes that the MEPAS modeling results are screening level results at best. In addition, the DOE did not prepare the model in order to declare that monitoring was not needed at WAG 6 or that contaminants were not migrating from sources in WAG 6 leading to concentrations of contaminants at the points of exposure that are of concern. Additionally, DOE recognizes in Sect. 5 of Vol. I and in Vol. 3a that the TCE and Tc-99 concentrations at WAG 6 are such that modeling was not needed to show if a problem may exist, since empirical evidence shows that a problem does exist. DOE also recognizes that migration characteristics of a contaminant may be impacted by co-contaminants present in a source. Unfortunately, modeling to integrate all possible combinations of co-contaminants is very expensive and leads to results that are very uncertain (i.e., consider propagation of error). Therefore, DOE believes such modeling would be of little net benefit in the RI report.
47	Volume 3a; Section 1.3.1.7; Page 1-35	Please correct the sentence describing the respective percentages of the surface area of Sector 6 that is covered by concrete, gravel and grass. The total, as written, is 155%.	Agreed. The correct proportions are 10% covered by concrete, 0% covered by asphalt, 65% covered by gravel, and 25% covered by grass. The appropriate change has been made in the D2 revision of the RI report.

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Comment No.	Section/Page/Para.	State Comment	Response
48	Volume 3a; Page 1-44	The residential scenario should also include the consumption of wild game, since the proximity of wildlife habitat would be near the residential area. In addition, the recreational visitor will come in contact with surface soils; incidental ingestion, inhalation of volatiles and particulates from soils, dermal, and external (radioactive) exposures under this scenario should be evaluated.	If the consumption of wild game is of concern to the decision makers, then the risk from consumption of game can be combined with the risk from the other rural residential exposure routes. Note that, as discussed in the baseline human health risk assessment, the individual assumed to harvest wild animals at the PGDP is, in fact, a local resident. It is noted that a recreational user may be exposed to contaminants in the soil through incidental ingestion, dermal contact, inhalation of particles and vapors, and direct irradiation; however, because a flat open area such as WAG 6 could contain little of interest that would prolong exposure, the doses expected would be minimal. Also, please be aware that the exposure assessment and its results presented in the WAG 6 baseline human health risk assessment are consistent with the regulatory agency-approved *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant.*
49	Volume 3a; Section 1.3.2.3; Page 1-45	a) The evaluation of contact with groundwater-filled ponds by residents was deferred to when the groundwater operable unit is considered as a whole. The area downgradient of WAG 6 and within the contaminated plume migrating off-site appears to contain numerous ponds and surface water sources.	a) As noted in the cited material, the decision to defer the evaluation is consistent with the regulatory agency-approved *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant.* In addition, current

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49	Cont.	It is not apparent whether current impacts from WAG 6 and other contaminated soils and groundwater to distant surface water bodies have been evaluated by sampling; this potential exposure pathway has been assumed to be insignificant based on fate and transport modeling. The model should be verified by sampling before the significance of the pathway is discounted. If the investigation of this potential exposure route is deferred as intended, current uncontrolled exposures will continue to take place perhaps at or above levels of concern. The surface water bodies potentially impacted by PGDP in general and WAG 6 in particular should be evaluated and appropriate risk management procedures initiated, if required, to prevent additional exposures.	groundwater controls restrict or prevent use of contaminated groundwater at PGDP; therefore, uncontrolled exposures are not occurring.
		b) Consumption of livestock products were not evaluated for the future resident due to the industrial nature of the WAG 6 area and the fact that if livestock production occurs in the area, it will be far into the future, making the current contaminant levels meaningless. For volatile organic compounds in soils, this may be true. However, the radioactive compounds will not appreciably degrade for thousands of years. Inorganic compounds also will not appreciably degrade. Additionally, the groundwater is currently	b) Please recognize that the WAG 6, as it currently stands, is not suitable for livestock production. Although the area is rather large, a significant portion of the surface area is currently covered by buildings, gravel, concrete, or asphalt. In addition, not quantifying the risk through the livestock and livestock products consumption exposure routes at a source unit like WAG 6 is consistent with the regulatory agency-approved *Methods for Conducting Risk Assessments and Risk Evaluations at the*

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49	Cont.	contaminated with TCE and radioactive compounds to the degree that the water used will remain contaminated at high levels far into the future. Thus, it appears the persistence of the waste present in WAG 6 will remain after the industrial use of this site is finished, requiring an evaluation of potential consumption of livestock products.	*Paducah Gaseous Diffusion Plant.* Finally, please note that the uncertainty inherent in not quantifying the livestock and livestock product consumption exposure routes is discussed in the uncertainty section of the risk assessment; therefore, the pertinent information concerning these routes of exposure is available for consideration by risk managers.
50	Volume 3a; Section 1.4; Page 1-51	The toxicity equivalent factors (TEFs) for two furan congeners listed in Exhibit 1.21 are incorrectly noted in the Region 4 guidance (1995) cited in this section. According to USEPA's *Interim Procedures for Estimating Risks Associated Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and –Dibenzofurans (CDDs and CDFs) and 1989 Update, EPA/625/3-89/016, March, 1989)* which was used as the source for the Region 4 guidance, the TEF for 1,2,3,7,8-Pentachloro-p-dibenzofuran (1,2,3,7,8-PeCDF) is actually 0.05, and the TEF for 2,3,4,7,8,-PeCDF is 0.5.	Comment noted. Because the TEFs listed here are those which we are required to use per the approved *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant*, they cannot be changed based on this comment alone. This change will need to be discussed by DOE, EPA, and the Commonwealth. In any event, dioxins and furans are not COCs in WAG 6.

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51	Volume 3a; Table 1.62	Numerous COCs in this table are not listed with all of the appropriate toxicity criteria. In Kentucky, unless data indicates otherwise, route-to-route extrapolation from oral slope factors to inhalation slope factors are used to evaluate the toxicity associated with the inhalation of carcinogenic chemicals. Table 1.62 should be updated to reflect the following criteria, and the risk calculations should also reflect these changes. *Table attached at the end of this document.*	The COCs are listed with the toxicity criteria which were correct and appropriate at the time the document was produced (i.e., Spring 1998). Also, as noted in the approved *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant*, DOE recognizes the preference of the Commonwealth for extrapolation from oral toxicity criteria to inhalation toxicity criteria. To address this preference, DOE agreed to examine the potential impact of such extrapolation as an uncertainty to the risk assessment. This was done in the WAG 6 risk assessment and demonstrates that the increases in the level of risk are insignificant given the risks from other exposure routes. Note, Table 1.62 will not be updated with the extrapolated criteria because this would invalidate the agreements made in the approved *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant.*
52	Volume 3a; Table 1.63	Several toxicity values listed in Table 1.63 are not in keeping with values recognized as appropriate by KYDEP, or are missing. Please add the following values to Table 1.63 and incorporate them into the assessment of risk from exposure to WAG 6 contamination. *Table attached at the end of this document.*	Please see response to Comment #51.

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53	Volume 3a; Section 1.4.6; Page 1-126	This section should be updated to reflect the modifications to Tables 1.62 and 1.63 outlined in the previous comments.	Please see response to Comment #51.
54	Volume 3a; Section 1.75; Pager 1-188	The dermal absorption rates recommended by KYDEP are based on the range of values seen in various peer-reviewed studies. Numerous references to dermal absorption can be found in the toxicological profiles published by the Agency for Toxic Substance and Disease Registry (ATSDR), Washington D.C. Most dermal absorption studies evaluate the degree of absorption of a single contaminant; exposures in the "field" are likely to consist of exposure to multiple contaminants simultaneously, which may increase the degree of absorption over that seen in the laboratory.	Agreed.

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Comment No.	Section/Page/Para.	State Comment	Response
55	Volume 3a; Section 2.1.2.1; Page 2-3	Chemicals of potential concern should be removed from consideration only if they are below a No Observed Effects Level (NOEL) for the most sensitive ecological receptor. Screening against background is inappropriate. Likewise, the sample quantitation limits should be below or equal to the NOEL for the most sensitive ecological receptor that could potentially be present.	The procedure contained in the approved *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant* includes screening contaminant concentrations against background as part of the risk assessment. This is the procedure followed in the WAG 6 baseline risk assessment. The purpose is to focus the assessment on site-related contaminants. The sample quantitation limits used for the project were those of standard EPA analytical methods and are as presented in the work plan for WAG 6. The sample quantitation limits were approved by the regulatory agencies prior to initiating work.

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Comment No.	Section/Page/Para.	State Comment	Response
56	Volume 3a; Section 2.6; Page 2-41	As mentioned in the assessment, although current use of the WAG 6 does not provide significant habitat for ecological receptors due to the industrial nature of the site, current concentrations are present at sufficient levels to cause adverse impacts to ecological receptors. As long as the site remains active, the potential for significant impact is minimized. Future use of the site (i.e. abandonment) could result in more attractive habitat and increased impacts to ecological receptors. Off-site impacts to surface water resources have not been evaluated. It is likely that the WAG 6 contribution to the contamination found in the RGA and McNairy Formation is several miles off-site, and is causing significant impacts (e.g., Ohio River). These impacts should be assessed.	Agreed. A future use of the site which results in higher quality habitat would lead to greater use by ecological receptors. This is the scenario addressed in the assessment as the current industrial nature of the site precludes it from being a significant area for wildlife. Potential off-site impacts to surface water resources are beyond the scope of the WAG 6 RI. Potential impacts to ecological endpoints in off-site aquatic habitats will be assessed as part of the Surface Water OU.

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Comment No.	Section/Page/Para.	EPA Comment	Response
1	General	The report addresses all radionuclides that have the potential to be COCs and important contributors to risk.	Comment noted.
2	General	The characterization of the contaminants appears to be complete except that greater care is needed in distinguishing between background levels of radionuclides in the environment and elevated levels of radionuclides in the environment attributed to the operation of the facility. For many of the sectors, radionuclides are reported as being present above background, when in fact they appear to be present within the expected variability of background.	Screening of the radionuclide data discussed in the WAG 6 RI Report was accomplished by comparing data collected during the WAG 6 RI field investigation with background values derived from historical data that are representative of naturally occurring conditions and concentrations in the surface soil, subsurface soil, and groundwater at PGDP. The background values used for comparison with the WAG 6 data were obtained from the following reports: 1) *Baseline Risk Assessment and Technical Investigation Report for the Northwest Dissolved Phase Plume, Paducah Gaseous Diffusion Plant (DOE.OR.07-1286&D1), July 1994* and 2) *Background Levels of Selected Radionuclides and Metals in Soils and Geologic Media at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE/OR/07-1586&D2), June 1997.* Please recognize that DOE has agreed to utilize background concentrations that were developed as parts of other projects and to identify potential contamination when these values are exceeded.

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Comment No.	Section/Page/Para.	EPA Comment	Response
3	General	The radiological risk characterization appears to be complete and in accordance with EPA guidance and standards of good practice. However, the regulatory level (1E-6, background, or PRGs) selected for screening is in some cases confusing. Summary tables that include the limiting concentrations that correspond to 1E-6, any ARARs, the variability in background, and the minimum detectable concentration should be provided.	Comment noted. Summary tables containing ARARs and 1E-6 values are contained in the Risk Section (Volume 3) of the RI. These values were used to screen the data to assess impacts to human health and the environment. Minimum Detectable Concentrations (MDCs) for radionuclides have not been routinely requested from the contract analytical laboratory in the past, and were not provided for the WAG 6 project. However, MDCs have been added as a requirement for future projects to be conducted at the PGDP. Due to the fact that background values used in the WAG 6 report are set as the 95% upper tolerance bound, consideration of the variability of background concentrations would not be appropriate. A table of Preliminary Remediation Goals (PRGs), Table 4.2, has been added to the Section 4 of Volume 1 for comparative purposes.
4	General	DOE does not provide any information to support their source term release rates. Their current assumptions lead to dilution/attenuation factors of about 9 orders of magnitude, which appears highly unrealistic. A more detailed discussion of this issue is provided in Appendix B.	The following discussion demonstrates that the WAG 6 RI MEPAS model is reasonably approximating dissolved contaminant concentrations. As in the U.S. EPA model effort, Sector 7 technetium levels are used for the derivation. In the following discussion, both English and metric units are used, depending upon the units of coefficients. <u>Derivation of dissolved Tc-99 activity in the source term</u>

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4	Cont.		For Sector 7, the Tc-99 activity of the soil is modeled as 3.16 pCi/g. The K_d for Tc-99 used in the MEPAS model of WAG 6 is 20 ml/g. Thus, the derived Tc-99 activity dissolved in the source zone water should be 1.58 x 10^{-1} pCi/ml or 1.58 x 10^2 pCi/L (derived by dividing 3.16 pCi/g by 20 ml/g). Redistribution of Tc-99 activity in the unsaturated zone The modeled source extends to a depth of 34 ft. The unsaturated zone is 49 ft thick. Thus, 15 ft (457.2 cm) of unsaturated zone is present below the source zone in which the Tc-99 activity will be reduced. The unsaturated zone has a bulk density of 1.86 g/cm^3. Assuming a 1 cm^2 area vertical flow cell, a soil mass of 850.4 g exists between the base of the source zone and the top of the aquifer. The K_d for Tc-99 of 20 ml/g defines the amount of Tc-99 that will remain in the dissolved phase after partitioning to the soil in the flow of water downward to the aquifer. The resulting dissolved phase Tc-99 activity is 9.29 pCi/L. (1.58 x 10^2 pCi/L divided by 20 l/kg x 0.8504 kg). Dilution of Tc-99 activity in the aquifer

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4	Cont.		To assess the effect of dilution, consider the input of a 1 ft^2 area at the top of the aquifer below the source zone. From the conceptual model for WAG 6 (page 5-5 of the RI report), net groundwater recharge is 8% of 50.28 in/yr (rainfall is 4.19 in/month). This equates to a daily net recharge of 0.011 in/day (4.02 in/yr divided by 365.25 days/yr). However, only 93% (0.010 in/day) of the groundwater recharge enters the aquifer. This equates to 8.53×10^{-4} ft/day per unit area which is equal to 8.53×10^{-4} ft^3/day. The aquifer has an effective porosity of 0.3, a hydraulic conductivity of 1,500 ft/day, and a gradient of 0.0004. The Darcy velocity of the aquifer is 2 ft/day. With an aquifer thickness of 45 ft, the amount of aquifer water flowing beneath the source zone unit area is 27 ft^3/day (2 ft/day flow rate x 0.3 x 45 ft thickness x 1 ft width). Thus, the dilution factor is 8.53×10^{-4} ft^3/day divided by 27 ft^3/day (3.2×10^{-5}). The Tc-99 activity in the aquifer immediately below the source zone is 9.29 pCi/L multiplied by 3.2×10^{-5} (2.97×10^{-4} pCi/L). <u>Assessment of Dispersion in the Aquifer</u> The modeled dispersion of Tc-99 activity in the aquifer can be derived by an iterative trial and

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4	Cont.		error procedure using the given modeled Tc-99 activity at the security fence (distance = 1,005 m/ 3,297 ft) and at the DOE property boundary (distance = 1,680 m/5,512 ft). The modeled Tc-99 activities are 5.35×10^{-6} pCi/L at the security fence and 3.37×10^{-6} pCi/L at the DOE property boundary. For the iteration, we will use the size of your model cell (15 m). This iterative analysis determines that the Tc-99 activity is depleted by 1/0.9898 for each 15 m of the flow path between the security fence and the DOE property boundary (refer to Attachment 1). The reduction factor of 1/0.9898 is an approximation of the modeled dispersion. <u>Comparison of estimates of Tc-99 activity in the aquifer at the source zone derived from K_d and dilution functions versus dispersion</u> Using the dispersion estimate and the modeled Tc-99 activity at the security fence, the estimated Tc-99 activity in the aquifer at the source zone is 1.06×10^{-5} pCi/L. This estimate is one order of magnitude less than the estimate derived from the source zone and represents a negligible error. There is some error in the approximations of the model processes.

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Comment No.	Section/Page/Para.	EPA Comment	Response
	SPECIFIC COMMENTS ON VOLUME I		
1	Page 2-3, line 27	This sentence refers to free release criteria pertaining to the radionuclide content of subsurface samples. Is this statement referring to contamination levels that are below concern from a radiation protection perspective for radiation workers, for transport of samples, or does it refer to clearance criteria for soil contaminated with radioactivity? Whichever the case, reference should be made to that section of the report that addresses free release criteria. This comment also applies to other sections of the report, such as page 2-7, line 31.	Agreed. The purpose of the referenced screening was to ensure that radioactive contaminated material and supplies that were used to collect environmental samples were not released off-site. All tools and equipment that were used to collect samples of environmental media were considered to be contaminated until a Health and Safety staff member scanned the items for the presence of radioactivity. The results of the radiological screening survey were compared to DOE established limits to determine if the material was acceptable for unrestricted or "free release" from the site, or if the equipment and material required decontamination to remove radiation contamination before being allowed off-site. Paducah Operations Work Instruction P202, Appendix A in the *Radiation Protection Program Manual* for WAG 6, contains a table listing the Free Release Criteria Values. Reference to these documents will be added to Section 2 of the RI report.
2	Section 2.8 (pages 2-8 to 2-10)	This section describes the analytical methods, DQOs, QA, data verification and data management used on the project and is consistent with EPA guidance and standards of good practice.	Comment noted.

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Comment No.	Section/Page/Para.	EPA Comment	Response
3	Page 2-9, lines 28-42	This section refers to the radiological procedures used in the program. The procedures are consistent with EPA guidance and standards of good practice.	Comment noted.
4	Table 2.8	Table 2.8 refers to a detection limit of 10 pCi/L gross alpha and 20 pCi/L gross beta for liquid samples, and 12 pCi/L gross alpha for solid samples. Reference should be made to sections of the report or procedures that establish why this lower limit of detection is acceptable. For example, is the specified detection limit sufficiently sensitive to ensure that the MCLs or the 15 mrem/yr dose limit for contaminated soil are not exceeded? Clearly these detection limits are not sufficient to detect contaminants in the environment that are associated with a lifetime risk of 1E-6. This subject requires some discussion.	The radioactivity detection limits listed in Table 2.8 of the RI are for the Close Support Laboratory (CSL) and were established based on the type of instruments used and the radiological scanning procedure that was followed. The methods for calculating the MDCs for the CSL are contained in the document titled *"WAG 6 Quality Assurance Project Plan -CSL"*. The CSL detection limits were set so that they would be below the screening levels outlined in Section 10.1.1, Characterization Strategy, of the approved WAG 6 Work Plan. These screening levels were used to determine which environmental samples would be shipped to an off-site laboratory for selected isotopic analyses.
5	Table 4.2	This table defines discrete values for background contamination. What is the variability associated with these values? In addition, there appears to be a need to demonstrate that twice background is a defensible approach for screening in light of the variability of natural background for these radionuclides.	The source for the background values contained in Table 4.2 are: 1) *Baseline Risk Assessment and Technical Investigation Report for the Northwest Dissolved Phase Plume, Paducah Gaseous Diffusion Plant (DOE/OR/07-1286&DF1, July 1994* and 2) *Background Levels of Selected Radionuclides and Metals in Soils and Geologic Media at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE/OR/07-1586&D2) June 1997*. Because the background values used in the

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5	Cont.		WAG 6 report are defined as the 95% upper tolerance bound, consideration of the variability of background concentrations would not be appropriate, and the "twice background argument" would not be viable.
		a) Section 4.1.1 refers to the Screening process used to identify COCs. Table 4.2, referred to in Section 4.1.1, presents the background radionuclide concentrations used to assess whether the contaminants identified in WAG 6 are above natural background or above ubiquitous levels of radionuclides in the environment due to fallout. Inspection of Table 4.2 reveals that, except for Pb-210 and Tc-99, the values appear reasonable. In the case of Pb-210, the table indicates N/A (Not Available). The levels of Pb-210 in soil should be comparable to those of U-238 and Ra-226, Eisenbud (1997)[1] cites work that shows that the Pb-210 concentrations in soil is about twice that of U-238, and rainwater contains about 1 to 10 pCi/L of Pb-210. Later in the report, Pb-210 is reported as an important COC and contributor to risk associated with the site. This appears to be an artifact associated with not considering Pb-210 as part of natural background.	a) Agreed. The information concerning Pb-210 contained in this comment will be added to the uncertainty discussion in Vol. 3a, to the observations made in Vol. 3a, and in Sect. 6 of Vol. 1. It is agreed that excess cancer risk associated with Pb-210 may not be real; however, the final decision in that regard will need to be made by the appropriate risk managers.
		b) The Tc-99 level or 2.5 pCi/L does not seem to be appropriate (i.e., it should be zero) since it is not	b) The background value for Tc-99 was drawn from a regulatory agency-approved report

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5	Cont.	normally present in soil. (See Section 1.4.3.8 of Volume 3 of the report, which explains why Tc-99 is not naturally present in the environment.)	entitled *Background Levels of Selected Radionuclides and Metals in Soils and Geologic Media at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-1586&D2) *June 1997*. In that document, the background concentrations of Tc-99 in surface soil is reported as being 2.8 pCi/g. (This value is a 95% upper tolerance bound.) Generally, the range given for Tc-99 in surface soil across the A and B horizons and three soil types was 0 to 3.1 pCi/g (15 samples total), and the mean concentrations were 0.151 and 0.395 pCi/g for the A and B horizons, respectively, across three soil types. Hence, the value used for Tc-99 background is correct.
		c) Np-237 is reported as present in natural background at 0.1 pCi/g. Please cite the basis for this value.	c) The background value for Np-237 was drawn from a regulatory agency-approved report entitled *Background Levels of Selected Radionuclides and Metals in Soils and Geologic Media at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-1586&D2) *June 1997*. In that document, the background concentration of Np-237 in surface soil is reported as being 0.1 pCi/g.

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Comment No.	Section/Page/Para.	EPA Comment	Response
6	Table 4.6	Table 4.6 presents the isotopes detected in Sector 1. It appears that all radionuclides are at the background level except for Np-237, where the background level is reported as zero. However, Table 4.2 reports that Np-237 is present in background surficial soils at 0.1 pCi/g. It is not apparent that any radionuclide contamination is present in the Section 1 analysis above background. Table 4.6 does not include the values for Tc-99. If any radionuclide is expected to be present it would be Tc-99. Some discussion of this matter is needed.	Table 4.6 provides concentrations of radioisotopes in subsurface soil. The background concentration for Np-237 in the subsurface is 0. (See *Background Levels of Selected Radionuclides and Metals in Soils and Geologic Media at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-1586&D2) *June1997.* There were no detections of Tc-99 at concentrations above background levels from UCRS soils at Sector 1. The general lack of elevated radionuclide activity, including Tc-99, below the thick concrete floor of the C-400 building is not unexpected.

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Comment No.	Section/Page/Para.	EPA Comment	Response
7	Table 4.12, 4.17, and the other summary level Upper Continental Recharge System (UCRS) soil tables	Table 4.12 indicates that uranium, thorium, and Tc-99 are present in soil above background. However, it is not apparent whether these levels are above the levels corresponding to ARARs, 1E-6, or 1E-4. It is not until the reader reviews other chapters that the significance (or lack thereof) of the measured values becomes apparent. These tables should include the limiting concentrations that correspond to 1E-6, 1E-4, any ARARs, the variability in background, and the minimum detectable concentration. This comment applies to all the summary level tables. It appears that the site related radionuclide concentrations in soil at most sectors are relatively low, often close to background, and within the 1E-4 risk range. The main exception to this observation is Sector 8, where the Tc-99 and uranium levels are clearly of concern. This observation is obscured by the enormous amount of information provided. It should be mentioned in the Executive Summary.	It was the intent of the Nature and Extent section (Section 4) to document the distribution and occurrence of all the constituents that may represent possible contamination at the site. For this reason, only limited screening of the data set was preformed. However, as discussed in Section 4.1.1, Screening Process, emphasis was placed on those contaminants that were identified as most likely to be drivers for remedial actions. Additional screens of the data set against risk-based parameters were performed as part of the Baseline Risk Assessment, which is contained in Volume 3 of the report. It is during the BRA process that the constituent concentrations are compared to HI and ELCR values for various scenarios to assess impact to human health and the environment. However, for comparative purposes, a comprehensive list of risk-based Preliminary Remediation Goals (PRGs) has now been included in Section 4 as Table 4.2. Inclusion of this table in the Nature and Extent section should allow the reader to assess the relative significance of the quantitative results that are reported in this section.

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Comment No.	Section/Page/Para.	EPA Comment	Response
8	Page 4-30, line 38	This line states that the peak Tc-99 concentration observed in the upper portion of the Regional Groundwater Aquifer (RGA) during the Site Investigation (SI) was 177 pCi/L. It should be pointed out that this is well below the MCL for Tc-99. Reference is also made to high levels of Tc-99 (i.e., 1200 and 1735 pCi/L). Again these concentrations should be placed into perspective with respect to the MCLs.	Agreed. The significance of these historical detections of TCE and Tc-99 will be placed in perspective by adding text to the discussion that compares the reported values to risk-based PRGs.
9	Page 4-36,line 8	This line refers to Bi-212, Pb-210 and Pb-214 detected above screening levels. These are likely naturally occurring. Some discussion regarding this issue is needed.	Agreed. The text has been revised to state that the three referenced isotopes were each detected in only one sample. Natural groundwater typically contains trace amounts of Bi and Pb, and it is probable that the reported constituents are naturally occurring. However, there is no site specific background data at PGDP for the specific isotopes that were identified. For this reason, and because the risk from these isotopes is evaluated in the BRA, a decision to report the occurrences of these isotopes without additional comment appears appropriate.

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Comment No.	Section/Page/Para.	EPA Comment	Response
10	Page 4-37, line 7	This section identifies a long list of radionuclides detected above screening levels (as described in Section 4.1). Many of these are naturally occurring and appear to be present at naturally occurring levels. The screening criteria provided in Section 4.1 need to be revisited with regard to the natural levels of uranium decay series radionuclides and K-40 in soil and water.	Agreed. Many of the identified radionuclides referenced are likely present at levels which are naturally occurring. Unfortunately, no site-specific background data on these radionuclides are available at the PGDP to support this assumption. Therefore, the distribution and concentration of these radioactive isotopes is reported without further comment. The potential impact due to exposure to these isotopes has been evaluated as part of the BRA.
11	Table 4.50	The radionuclide concentrations in RGA/McNairy soil all appear to be within background levels. By adding additional columns to the table, giving the variability of background, the MDCs, and the 1E-4 to 1E-6 levels, all the reported concentrations could be quickly placed into perspective.	Agreed. Many of the radionuclide concentrations identified within the RGA/McNairy soil are likely within the range of background concentrations for naturally occurring isotopes. Unfortunately, background data for many of the identified constituents are not available for the PGDP. The goals and objectives of the Nature and Extent section was to document the distribution and occurrence of all the constituents that may represent possible contamination at the site. For this reason only limited screening of the data set was preformed. However, for comparative purposes, a table containing a comprehensive list of risk-based PRGs has now been included in Section 4 (Table 4.2). This table will help the reader to place the reported concentrations in perspective with regards to potential health-based risk.

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Comment No.	Section/Page/Para.	EPA Comment	Response
12	Tables 4.55, 4.60, 4.65, and 4.66	The radionuclide concentration in water could be placed into better perspective by comparing the values to the MCLs.	Agreed. However, Maximum Contaminant Levels (MCLs) are not available for most of the radionuclides contained in the referenced tables and would be of limited value. Therefore, for comparative purposes, a table containing a comprehensive list of calculated risk-based PRGs has now been included in Section 4 (Table 4.2). This table will help the reader to place the reported concentrations in perspective with regards to potential health-based risk.

Comment No.	Section/Page/Para.	EPA Comment	Response
13	Section 5.2 General Comment	It is not apparent, according to the conceptual site model, whether the origin of the contaminants in the aquifers down gradient from the site (see Figure 5.1) are from WAG 6 sources or from other onsite sources. Some discussion is needed of the results of this study within the context of the overall site.	Agreed. Figure 5.1 is a schematic site conceptual model. One of the primary functions of this figure was to illustrate the migration pathway for contaminants derived from the WAG 6 SWMUs. Additional labeling of the figure with respect to the location of WAG 6 and to identify the contaminated plume as originating from sources at WAG 6 have been placed on the figure. Additionally, the following text has been added to Section 5.2, Conceptual Site Model: "As illustrated in Figure 5.1, extensive areas of soil surrounding WAG 6 have been impacted by releases of high concentrations of TCE and lower concentrations of other contaminants into the shallow subsurface UCRS soil. Due to the DNAPL characteristics of the TCE, the dominant dispersal pattern through the vadose soil to the top of the RGA is gravity driven. Within the RGA, where spill volumes were sufficiently large, vertical DNAPL migration has penetrated to the base of the RGA. Lateral transport of dissolved phase contaminants within the RGA follows groundwater flow paths established by the regional groundwater gradient. Releases of TCE at WAG 6 are the source for the downgradient, off-site Northwest Plume and may be related to the smaller Northeast Plume."

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Comment No.	Section/Page/Para.	EPA Comment	Response
14	Section 5.3.4	This section provides an overview of the radionuclides that may be present at the site based on process knowledge. The section indicates that it is unlikely that the longer lived progeny of the U-238 series are present because the site only processed uranium, which was separated from the ore. As such, Th-230 and Ra-226 and their progeny are not expected to be seen at the site. The results of the sampling and analysis program confirm this because Ra-226 does not appear to be present above natural background. Nevertheless, the report identifies Pb-210 as a COC and an important contributor to risk. This appears to be an incorrect conclusion.	Agreed. The occurrence of Pb-210 in natural soils and groundwater has been added to the uncertainty discussion in the Risk section of Volume 3 of the RI. See associated responses to EPA comments #5a and #19.
15	Page 5-14, line 42	This section states that "Due to the very long half-lives of U-238 and U-235, relatively little daughter activity is produced until periods of time approaching the half life have expired. Once the half life has expired, most of the uranium activity is due to U-238". These statements are incorrect and reflect a lack of understanding of basic health physics principles. The presence of any progeny is a function of the half life of the progeny not the parent. For example, the short-lived, immediate progeny of U-238, i.e., Th-234 T1/2=24.1 days; and Pa-234 T1/2=1.7 months, are almost always present along with U-238 in equilibrium. Within a few half lives of the progeny, the progeny approach full equilibrium of the parent; i.e., they approach the same concentration of the parent, given the branching fraction.	The referenced statements have been removed from the text and replaced with: "Radioisotopes such as U-235 and U-238 decay over relatively long time periods and produce daughter products. However, because the presence of any daughter product is a function of the half-life of the progeny, the parent and progeny can approach equilibrium within a few half-lives of the progeny"

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16	Figure 5.3	The figure indicates that radionuclides that exceeded 2 times background or the PRGs were modeled. The PRGs are usually set at the ARARs or at a concentration that falls within the risk range. PRGs for radionuclides are not presented in the report. In addition, it appears that all analyses key into a lifetime risk of 1E-6. Finally, the background levels provided in Section 4, appear to require correction (i.e., the Pb-210 problem). There appear to be some problems with the screening process that need to be resolved. For radionuclides, it appears that only U-238 and Tc-99 in Section 8 are above the PRGs.	The screening summarized in Figure 5.3 was used only to pare the list of contaminants for fate and transport modeling (the PRGs are keyed to a 10^{-6} risk level). This is not the screening procedure used in the quantitative risk assessment.
17	Page 5-23, line 16	This line discusses plutonium contamination in the soils at Sector 4. Inspection of Table 4.22 indicated that there is no plutonium present above 0.2 pCi/g. This is well below any concentration that would be considered a PRG. As a rule of thumb, any concentration of Pu-239 in soil below a few pCi/g could not result in a lifetime risk in excess of 1E-4. In addition, given that all the reported values are at 0.2 pCi/g, is 0.2 pCi/g the MDC? Table 2.8 addresses MDCs but does not provide the MDC for specific radionuclides. a) This section reveals that there are some problems with the screening process. Much more attention must be given to background and the variability in background, the difference between PRGs and screening at 1E-6, the ARARs, and minimum detectable concentrations for radionuclides. In	As a conservative measure in screening contaminants for fate and transport modeling, a plutonium source was modeled at the level of quantification in the absence of a background value or PRG. a) The screening process for the quantitative risk assessment is that outlined in *Methods for Conducting Human Health Risk Assessment and Risk Evaluations at the Paducah Gaseous Diffusion Plant.*

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17	Cont.	general, it appears that only Sector 8 contains radionuclide contamination in soils that requires modeling because the concentrations are clearly above PRGs. According to the tables in Section 4, all other sectors have insignificant levels of radionuclides, well below possible PRGs. If the authors of the report are using 1E-6 as a PRG, that would explain some of the conclusions. If the authors are using 1E-6 levels as the basis for decision making, this should be made clear, and reference to PRGs deleted. It should be noted that using 1E-6 as a decision point for radionuclides is problematical because natural background and ubiquitous manmade levels of radionuclides in the environment are above or comparable to the levels corresponding to a risk of 1E-6.	
18	Table 5.31	As a check on the MEPAS modeling, the Tc-99 results were reviewed for Sector 8. According to Table 5.31, the peak Tc-99 concentration in groundwater at the fencepost is 1.14E-3 pCi/L and occurs at year 2213. The starting point for this calculation is the concentration of Tc-99 in subsurface soil in Sector 8, which is given in Table 4.42 as an average of 1281 pCi/g with a max of 4840 pCi/g. Since the Kd of Tc-99 is about 0.1 (i.e., it moves at about the same velocity as the groundwater), it can be assumed that the Tc-99 concentration in the soil pore water in Sector 8 is about 1000 pCi/ml or 1E6 pCi/L. This means that between the source and the fencepost, which appears to be about 1 mile, the Tc-99 is diluted by about a factor	See response to EPA General Comment # 4. The source term concentrations used for the MEPAS modeling of Sector 8 contaminants are provided in Table 5.29 and differ from the concentrations provided in Table 4.42 that were used in your calculations. A source concentration of 265 pCi/g Tc-99 was input to MEPAS, as it was the maximum detected in UCRS soils (the higher values listed in Table 4.42 represent concentrations in sludge). The MEPAS model selected a K_d value of 20 ml/g, based on the soil properties of the UCRS. Using these values, the Tc-99 activity in the water released from the

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18	Cont.	of 1E9 and takes 2000 years to travel the 1 mile. This is an extremely large dilution factor. A discussion is needed explaining conceptually why it is reasonable to expect such a large dilution factor between the source and the fencepost. a) It is also unclear how the existing plume concentrations have been factored into the modeling analysis. Do the models assume that the modeled results are superimposed on the preexisting plume?	source into the vadose zone is 1.325 x 10^{4} pCi/L. Additional dilution occurs upon entry into the saturated zone. If an approximate dilution factor of 3.2 x 10^{-5} is applied within the RGA (see Comment # 4), dilution within the aquifer would reduce the Tc-99 activity to 4.2 x 10^{-1} pCi/L, which is approximately 2 orders of magnitude greater than the result (1.14 x 10^{-3} pCi/L). The approximations provided above have a high degree of uncertainty. It also is recognized that there are uncertainties in the input parameters used in MEPAS that can lead to results that differ by orders of magnitude. For this reason, the model is used just as a screening tool, not to provide quantitative data for input to the risk assessment. The mathematical formulations used by MEPAS can be found in the Battelle document *MEPAS: Multimedia Environmental Pollutant Assessment System Formulations*. This reference will be added to the document. In addition, the K_d values used in the MEPAS model will be added to Table 5.6 for clarification.

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19	Section 6	The risk assessment appears to be comprehensive in that it addresses all the radionuclides of concern, a broad range of current and future use scenarios, and the important exposure pathways. However, Page 6-4, line 8 concluded that exposure to Pb-210 is a major contributor to risk from the site. For the reasons discussed above, the Pb-210 present at the site is likely a natural background and not due to the operation of the facility.	Agreed. The information concerning Pb-210 will be included in the revised risk assessment so that the information is available for consideration by risk managers; a reference to the information will be inserted in Section 6 of the RI report.
20	Section 7	The conclusion section should indicate that, except for Sector 8, the observed radionuclide concentrations are either within the normal range of natural background or well within the MCLs or potential PRGs.	Disagree. A comparison of the radionuclide data to the PRGs in Table 4.2 indicates several radionuclides were present in WAG 6 at concentrations greater than the MCL or PRGs.
21	Volume 3a-Baseline Risk Assessment for Radionuclides	Given schedule and resource limitations, it was not possible to perform a separate detailed review of the BRA. However, a cursory review was performed of the radiological portions of Volume 3, the Baseline Risk Assessment.	Comment noted.
	REVIEWER TWO COMMENTS		

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22	General	The BRA presents a comprehensive analysis of all plausible scenarios and pathways for both present and future use of the site, both on and offsite. All potentially significant radionuclides are addressed. MEPAS was used as the dose and risk assessment model. Previous reviews of MEPAS have revealed that it is an excellent multi-media model for performing offsite dose and risk assessments for both toxic chemicals and radionuclides.	Comment noted.
23	Page 1-115, line 21	Line 21 attributes the elevated risk of lung cancer from smoking to the alpha emitters in tobacco. It is more likely that the chemical carcinogens present in tobacco smoke are primarily responsible for the cancer risks associated with smoking.	Agreed. The sentence "In addition, the cancer incidence in smokers may be directly attributed to the naturally occurring alpha emitter, polonium-210, in common tobacco products" will be modified to "In addition, the cancer incidence in smokers may be attributed, in part, to the naturally occurring alpha emitter, polonium-210, in common tobacco products."
24	Page 1-116, line 16	The statement is made that stochastic effects are related to dose and acute effects are not related to dose. This statement is incorrect. The severity of a stochastic effect is unrelated to dose, but the probability of a stochastic effect is related to dose. The severity of nonstochastic effects are related to dose above the same threshold.	Agreed. The appropriate revisions will be made.
	GENERAL COMMENTS ON GROUNDWATER		

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	General	The greatest concerns we have identified, with respect to DOE's prediction of the fate and transport of radionuclides in groundwater, are associated with DOE's failure to provide relevant information with respect to their contaminant source terms. The information that is usually necessary to describe the source term can be divided into four general areas and include 1) data availability; 2) conceptual model; 3) mathematical model, and 4) verification of results.	Comment noted.
25	Data Collection	Although we performed only relatively cursory review of the available data, it appears that DOE has collected a reasonable amount of data from which the dimensions of the source terms and existing contaminant plumes can be roughly delineated. As noted below, however, data associated with contaminant partitioning and release rates appear to be almost non existent.	Comment noted.

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26	Conceptual Model	DOE's conceptual model for explaining the mechanisms by which radionuclides are mobilized and transported is restricted to a very brief discussion of page 5-19, and indicates that the sources were modeled as depleting over time and degrading within the environment. To evaluate the adequacy of their approach, DOE needs to present the means by which the radionuclides are depleted. For example, on p. 5-7, the text indicates that the distribution coefficient (K_d) is useful in determining retardation, but that K_d does not relate the total metal concentration in the solid to a dissolved concentration. DOE is correct in asserting that the K_d concept is not very accurate in predicting the partitioning between the soil and the water phase, but the fact remains that it is commonly used for this purpose. DOE needs to explain how they explain how they have arrived at pore-water concentrations of radionuclides since apparently they have not used the K_d concept.	Agreed. Although asserting that the K_d concept is not very accurate, the WAG 6 RI uses K_d values in the model to derive pore-water concentrations. Text will be added to clarify that K_d values were used.

Comment No.	Section/Page/Para.	EPA Comment	Response
27	Mathematical Model	The most comprehensive discussion pertaining to the mathematical model is found on pages 5-18 and 5-19. The presentation shows that DOE is predicting the migration of contaminants in groundwater by one-dimensional advective and three-dimensional dispersive equations that account for sorption and radioactive decay. This discussion does not, however, present the mathematical formulations for the source-leaching term, which are necessary for a technical adequacy review. Another concern with the mathematical model used to support the RI is that the authors of MEPAS only intended MEPAS to be used as a screening level tool, as is clearly indicated in the code's User's Manuals. This fact is also acknowledged on page 5-19 of the Paducah RI. Therefore, it is not clear how DOE is justifying the use of a tool designed to provide qualitative estimates to support a quantitative risk assessment.	For the WAG 6 model, the RI uses the MEPAS model source-term release module, relying upon K_d values, to derive pore-water concentrations. The MEPAS model is only being used in a qualitative manner to support the risk assessment.

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Comment No.	Section/Page/Para.	EPA Comment	Response
28	Model Verification	It is difficult to see that DOE has done anything to verify that their modeling results are providing reasonable approximations of the actual field conditions. As will be shown below in our independent modeling section, the most critical aspects of their fate and transport analyses are the assumptions regarding radionuclide release rates from the source term. At a minimum, DOE should support their release rates with leaching studies that are performed with actual site media (i.e., soil and groundwater), and under prevailing geochemical conditions (e.g., Eh, pH). Although DOE indicates that they do not use K_d to predict the concentrations of radionuclides in groundwater, it is difficult to see how they could support a more sophisticated approach since even the most basic data (i.e., K_ds) for the radionuclides have not been measured at the site. Furthermore, if they did use a more defensible means for deriving radionuclide pore-water concentrations, the same methodology should have been used to predict rates of transport. The K_d approach that they use to predict transport rates has many of the same limitations that are associated with predicting pore-water concentrations. The facilitative transport associated with plutonium in Sector 4 suggests that, at least in some cases, the current conceptual model describing transport may not adequately predict radionuclide migration rates and concentrations.	Agreed. Leaching studies with PGDP soils are unavailable for reference. In the absence of the data, the WAG 6 RI has defaulted to K_d values to approximate pore-water contaminant levels derived from the sources. Additional text will be added to the report to discuss the source-release mechanisms. Please also see response to Comment # 4.

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Comment No.	Section/Page/Para.	EPA Comment	Response
	COMPUTER MODEL VERIFICATION		
	MODFLOW/ SURFACT Modeling	As a reality check on the DOE modeling results, and to illustrate the importance of the contaminant source term assumptions, we performed an independent modeling analysis. Since DOE does not provide any information on the pore-water concentrations of radionuclides reaching the water table, we used our analysis to back out intermediate concentrations along the flow path in order to assess whether DOE's leaching rates and concentrations appear reasonable. Our analysis consists of three major steps as identified below: • Assess how much dilution could potentially occur in the saturated zone as radionuclides travel from the contaminant source to the DOE property boundary. • Use potential dilution rates calculated for the saturated zone, in conjunction with DOE's predictions of Tc-99 concentrations at the DOE property boundary, to determine concentrations of Tc-99 reaching the water table. • Use DOE's assumed contaminant source concentrations in conjunction with estimates of radionuclide concentrations reaching the water table to assess the appropriateness of dilution/attenuation rates that DOE is taking credit for in the unsaturated zone. *Computer Code Selection* - The computer codes that	As shown in our response to EPA General Comment #4, the results obtained by MEPAS are reasonable approximations. An explanation of how source leaching terms are derived by MEPAS is too extensive to include in the RI report, as the formulas used depend on the location of the source and the contaminant type. However, a reference to the Battelle document "MEPAS: Multimedia Environmental Pollutant Assessment System Formulations" will be added to direct the reader to the needed information.

Comment No.	Section/Page/Para.	EPA Comment	Response
	Cont.	were selected for the analysis are MODFLOW, for the flow aspects of the analysis, and SURFACT for the transport simulations. MODFLOW was developed by the US Geological Survey, and SURFACT was developed by HydroGeoLogic Inc. *Model Setup* - The model domain is shown in Figure 1, and consists of an area of 6000 by 3000 feet. Constant head boundaries were imposed on the up and downgradient edges of the model in order to impose a hydraulic gradient identical to that used by DOE (i.e., 0.0004). The grid spacing was uniformly set to 15 m, and the domain was divided into 5 layers (i.e., top layer is 5 feet thick, remaining layers are each 10 feet thick). This discretization results in a total of 400,000 nodes. As in Sector 7, the source term dimensions are 290 ft by 195 ft and are set 3300 feet from the security fence and 5500 feet from the DOE property boundary. The source concentration was set to a unit concentration of 1.0, and was assumed to be constant and non decaying. The aquifer properties were also assigned to those used by DOE as identified in DOE's Table 5.6. The hydraulic conductivity (i.e., 1500 ft/day) was assumed to be homogeneous and isotropic. The effective porosity was set to 0.3, and the aquifer thickness was assigned a value of 45 feet (Table 5.6). Contaminant transport properties were also assigned values used by the DOE and include 50, 5, and 0.1 ft. for longitudinal, transverse and vertical	

Comment No.	Section/Page/Para.	EPA Comment	Response
	Cont.	dispersivities, respectively; and a distribution coefficient (K_d) of 0.1 L/kg, which DOE assumed was appropriate for Tc-99. *Saturated Zone Dilution* - The results from the modeling are shown in Figures 1, 2, and 3 Figure 1 depicts the steady-state relative concentrations of the areal plume. It should be kept in mind that these concentrations are relative to a unit concentration of 1.0. Therefore, dilution rates are only applicable after the radionuclides have reached the water table. Insofar, as the model does not simulate leaching within the partially saturated zone. Figures 2 and 3 show that relative dilution rates at the fence line and DOE property, respectively. These graphs indicate that the saturated zone could be responsible for reducing radionuclide concentrations by approximately a factor of four. *Concentration of Tc-99 Reaching the Water Table* - To estimate the Tc-99 concentrations that MEPAS would have predicted to reach the water table we have used DOE's model predictions of Tc-99 concentrations at the fence line and DOE property boundary, in conjunction with our knowledge of potential dilution rates in the saturated zone. For the Sector 7 source term, DOE currently predicts that Tc-99 concentrations at the fence line and DOE property boundary will be 5.35×10^{-6} pCi/L, and 3.37×10^{-6} pCi/L, respectively (Table 5.28). Our modeling results,	

Comment No.	Section/Page/Para.	EPA Comment	Response
	Cont.	presented above, have shown that dilution in the saturated zone will only decrease contaminant concentrations by a factor of 4. Therefore, DOE must be assuming that concentrations of Tc-99 reaching the water table from the partially saturated zone are approximately 1.685 x 10^{-6} pCi/L (i.e., 3.37 x 10^{-6} divided by 0.2). *Leaching Concentrations* - To assess whether DOE's assumed concentration of Tc-99 (i.e., 1.685 x 10^{-5} pCi/L) reaching the water table is reasonable, we have used Tc-99 concentration data from Sector 7. The initial source concentration presented in Table 5.26 indicates a Tc-99 concentration in the soil of 3.16 pCi/g. As mentioned above, DOE does not discuss their means for deriving pore-water concentrations. This approach, albeit with a high-degree of uncertainty, results in a port water concentration of 3.16 x 10^{-4} pCi/L for Tc-99, as shown below: $Conc_{Water} = Conc_{Soil}/K_d$ $Conc_{Water} = 3.16$ pCi/gr (1000 gr/kg)(1/0.1 L/kg) $Conc_{Water} - 3.16 \times 10^{-4}$ pCi/L This calculation indicates that the processes DOE has assumed are occurring in the unsaturated zone, in conjunction with the initial mixing of the radionuclides introduced to the groundwater, reduces the pore-water concentrations of Tc-99 from 3.16 x 10^{4} pCi/L to 1.685 x 10^{-05} pCi/L or by approximately nine orders of magnitude.	

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Comment No.	Section/Page/Para.	EPA Comment	Response
	Cont.	*Conclusions* - At face value, a concentration reduction due to dilution/attenuation in the immediate vicinity of the source on nine orders of magnitude appears unrealistically high. However, since DOE has not provided a discussion of the source-release mechanisms it is not possible to identify specific assumptions that seem unreasonable. Perhaps this subject matter can be incorporated within the revised report?	

DOE/OR/07-1727/V1&D2
PRIMARY DOCUMENT

Remedial Investigation Report for Waste Area Grouping 6 at Paducah Gaseous Diffusion Plant Paducah, Kentucky

Volume 1. Sections 1 through 8

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under General Order 18B-99345C

for the
U.S. Department of Energy
Office of Environmental Management

Environmental Management Activities at the
PADUCAH GASEOUS DIFFUSION PLANT
Paducah, Kentucky 42002
managed by
BECHTEL JACOBS COMPANY LLC
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-98OR22700

PREFACE

This Integrated Remedial Investigation Report for Waste Area Grouping (WAG) 6 at the Paducah Gaseous Diffusion Plant (DOE/OR/07-1727&D1) was prepared in accordance with the requirements under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Resource Conservation and Recovery Act (RCRA). This work was performed under Work Breakdown Structure 1.4.12.7.10.01.06 (Activity Data Sheet 5349). This document provides information derived from implementing the WAG 6 Remedial Investigation.

In accordance with Section IV of the draft Federal Facilities Agreement for the Paducah Gaseous Diffusion Plant, this integrated technical document was developed to satisfy both CERCLA and RCRA corrective action requirements. It is noted that the phases of the investigation process are referenced by CERCLA terminology within this document to reduce the potential for confusion.

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VOLUME 2

VOLUME 3

VOLUME 4

FIGURES

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TABLES

ACRONYMS

ACO	Administrative Order by Consent
^{241}Am	americium-241
amsl	above mean sea level
ANSI	American National Standards Institute
AOC	Area of Concern
ARARs	applicable or relevant and appropriate requirements
ASTM	American Society for Testing and Materials
AWQC	Ambient Water Quality Criteria
BCF	bioconcentration factor
BERA	baseline ecological risk assessment
bgs	below ground surface
BHHRA	baseline human health risk assessment
BMP	Biological Monitoring Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CLP	Contract Laboratory Program
COCs	contaminants of concern
COE	U.S. Army Corps of Engineers
COPCs	chemicals of potential concern
COPECs	chemicals of potential ecological concern
cpm	counts per minute
CRP	Community Relations Plan
^{134}Cs	cesium-134
^{137}Cs	cesium-137
CSL	Close Support Laboratory
CSM	conceptual site model
DCE	dichloroethene
D.I.	deionized
DNAPL	dense, nonaqueous-phase liquid
DNT	dinitrotoluene
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
dpm	disintegrations per minute
DPT	direct push technology
DQOs	data quality objectives
DRMP	Data and Records Management
DWRC	Dual Wall Reverse Air Circulation
EDDs	electronic data deliverables
EDGe	Engineering, Design & Geosciences Group, Inc.
EIMS	Environmental Information Management System
ELCR	excess lifetime cancer risk
EMEF	Environmental Management and Enrichment Facilities

Energy Systems	Lockheed Martin Energy Systems, Inc. (also referred to as LMES)
EPA	U.S. Environmental Protection Agency
ESPs	Environmental Surveillance Procedures
ETS	Environmental Technical Services
FCRF	Field Change Request Form
FFA	Federal Facilities Agreement
FOP	Field Operating Procedure
FR	*Federal Regulations*
FS	feasibility study
FSP	Field Sampling Plan
GS	gas chromatograph
GSA	general storage area
GWPP	Groundwater Protection Program
HASP	Health and Safety Plan
HEAST	Health Effects Assessment Summary Table
HI	hazard index
HQ	hazard quotient
HSWA	Hazardous and Solid Waste Amendments
I.D.	inside diameter
IDW	investigation-derived waste
IRIS	Integrated Risk Information System
KDEP	Kentucky Department for Environmental Protection
KPA	kinetic phosphorescence analyzer
KPDES	Kentucky Pollutant Discharge Elimination System
LCD	lower continental deposits
LMES	Lockheed Martin Energy Systems, Inc. (also referred to as Energy Systems)
LMUS	Lockheed Martin Utility Services, Inc.
MCL	maximum contaminant level
MDL	method detection limit
MSDSs	Material Safety Data Sheets
MS/MSD	matrix spike/matrix spike duplicate
NAPL	nonaqueous-phase liquid
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Policy Act
^{237}Np	neptunium-237
NPL	National Priorities List
NRC	Nuclear Regulatory Commission
NTU	nephelometric turbidity unit
O.D.	outside diameter
OREIS	Oak Ridge Environmental Information Systems
OSHA	Occupational Safety and Health Administration
OSWR	Off-Site Waste Release
OU	operable unit
OVA	organic vapor analyzer
OVM	organic vapor meter

PAH	polycyclic aromatic hydrocarbon
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCB	polychlorinated biphenyl
PCSR	Preliminary Characterization Summary Report
PEL	permissible exposure limit
PEMS	Project Environmental Measurements System
PGDP	Paducah Gaseous Diffusion Plant
PPE	personal protective equipment
ppm	parts per million
PQL	Practical Quantitation Limit
PRG	preliminary remediation goal
^{239}Pu	plutonium-239
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
RCRA	Resource Conservation and Recovery Act
RF	retardation factor
RfD	reference dose
RFD	Request for Disposal
RGA	Regional Gravel Aquifer
RI/FS	remedial investigation/feasibility study
RPP	Radiation Protection Program
SAA	satellite accumulation area
SARA	Superfund Amendments and Reauthorization Act of 1986
SHSO	Site Health and Safety Officer
SI	site investigation
SMP	Site Management Plan
SQL	Standard Quantitation Limit
SVOA	semivolatile organic analyte
SWMU	solid waste management unit
TAL	Target Analyte List
^{99}Tc	technetium-99
TCE	trichloroethene
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
230Th	thorium-230
TLD	thermoluminescent detector
TRU	transuranic
TSCA	Toxic Substances Control Act
TVA	Tennessee Valley Authority
^{234}U	uranium-234
^{235}U	uranium-235
^{238}U	uranium-238
UF$_6$	uranium hexafluoride
UCRS	Upper Continental Recharge System

USEC	United States Enrichment Corporation
VOA	volatile organic analyte
WAG	Waste Area Grouping
WKWMA	West Kentucky Wildlife Management Area
WMP	Waste Management Plan

EXECUTIVE SUMMARY

In 1997, the U.S. Department of Energy conducted a Remedial Investigation (RI) at five solid waste management units (SWMUs) and the C-400 area in Waste Area Grouping (WAG) 6 at the Paducah Gaseous Diffusion Plant (PGDP) in Paducah, Kentucky. The purpose of this activity was to assess the presence, nature, and extent of contaminants at each of the units. The investigation focused on source characterization of the surrounding soils and the potential impacts of contaminants on groundwater. Investigative activities included sampling and analysis of surface and subsurface soils and groundwater.

This report contains information about the regulatory framework under which the fieldwork was conducted (Sect. 1); describes the investigative methods used to sample the various media and analytical sampling parameters (Sect. 2); presents a physical description of each unit investigated, including topography, surface-water hydrology, geology, and hydrogeology (Sect. 3); defines the nature and extent of contamination at each unit as concluded from analyses of the collected data (Sect. 4); discusses the fate and transport of the contamination identified at each unit (Sect. 5); and provides estimates of the baseline risks to human health and the environment associated with the detected contaminants (Sect. 6). Conclusions are presented in Sect. 7.

The conclusions of the WAG 6 RI are presented using geographically related sectors. The sectors and their definitions are as follows:

- Sector 1–the area under the C-400 Building
- Sector 2–the area to the northeast of the C-400 Building. This sector contains the Neutralization Tank (SWMU 40).
- Sector 3–the area to the east of the C-400 Building. This sector does not contain a SWMU.
- Sector 4–the area to the southeast of the C-400 Building. This sector contains the Trichloroethene Leak Site (SWMU 11) and a trichloroethene (TCE) off-loading pump station.
- Sector 5–the area to the southwest of the C-400 Building. This sector does not contain a SWMU.
- Sector 6–the area to the west of the C-400 Building. This sector contains the Technetium Storage Tank (SWMU 47).
- Sector 7–the area to the northwest of the C-400 Building. This sector contains the Waste Discard Sump (SWMU 203).
- Sector 8–the area to the far north and far northwest of the C-400 Building. This sector contains the C-401 Transfer Line (SWMU 26).
- Sector 9–the area to the far east and far northeast of the C-400 Building. This sector does not contain a SWMU.

Contamination of the soil and groundwater at WAG 6 was found to be extensive. High concentrations of TCE that occur over large areas in the vadose zone, especially in Sectors 4 and 5, indicate that multiple releases of TCE have occurred around the C-400 Building. Concentrations above 225,000 micrograms per kilogram (μg/kg) in the shallow soils indicate that a dense, nonaqueous-phase liquid (DNAPL) of TCE exists at the southeast corner of the C-400 Building. The primary sources of contaminants have been identified as the Trichloroethene Leak Site (SWMU 11) and a TCE off-loading pump station located in Sector 4. Smaller areas of soil contaminated by volatile organic analytes (VOAs), semivolatile organic analytes (SVOAs), metals, polychlorinated biphenyls (PCBs), and radionuclides have also been impacted by releases from other identified SWMUs and associated utility lines.

Groundwater contaminant transport near the C-400 facility occurs by dissolution of sources present in the Upper Continental Recharge System (UCRS) soils and transport to the Regional Gravel Aquifer (RGA). This occurs as rainwater infiltrates from the surface and percolates through the source of contamination and its surrounding soil into the saturated zone. Lateral transport pathways follow groundwater flow paths established by the regional groundwater gradient. Due to the chemical's greater density and low solubility in water, DNAPL movement is gravity-driven, largely independent of groundwater flow, and often directed by subtle textural changes in the soils. Where spill volumes are sufficiently large, DNAPL has penetrated to significant depths. The C-400 Building is the source of a large DNAPL zone in the RGA. A large dissolved-phase plume of TCE, known as the Northwest Plume, results from this DNAPL zone. A smaller TCE plume, known as the Northeast Plume, may also be related to the presence of DNAPL at WAG 6.

The current and most plausible future use for the WAG 6 area is the industrial use scenario. For this scenario, the dermal contact with soil exposure route poses considerable risk from contact with metals (chiefly beryllium) and polycyclic aromatic hydrocarbons (PAHs). Vinyl chloride is the driver for inhalation of VOAs and particulates emitted from the soil exposure route for excavation workers at WAG 6.

The addition of groundwater drawn from the RGA and McNairy Formation as a medium of exposure adds significantly to the risk for the future industrial land use scenario. Contaminants driving risk under this scenario are TCE, vinyl chloride, beryllium, iron, arsenic, and lead-210 (excluding lead as a metal).

Contaminants of Concern (COCs) for future off-site residential groundwater users are: 1,1-dichloroethene; 1,2-dichloroethene; 2,4-dinitrotoluene; carbon tetrachloride; n-nitroso-di-n-propylamine; tetrachloroethene; *trans*-1,2-dichloroethene; TCE; vinyl chloride; antimony; copper; iron; and manganese. There are no radionuclide COCs migrating from the WAG 6 area based upon risk estimates derived from the fate and transport modeling. However, technetium-99 was not modeled and was assumed (without quantitation) to be a COC.

1. INTRODUCTION

1.1 OVERVIEW

Paducah Gaseous Diffusion Plant (PGDP) is located approximately 10 miles west of Paducah, Kentucky (population approximately 31,000), and 3.5 miles south of the Ohio River in the western part of McCracken County (Fig. 1.1). The plant is on an approximately 3556-acre U.S. Department of Energy (DOE) site; the total acreage is divided as follows:

- 748 acres–within a fenced security area;
- approximately 822 acres–uninhabited buffer zone surrounding the plant area; and
- 1986 acres–either deeded or leased to Commonwealth of Kentucky as part of West Kentucky Wildlife Management Area (WKWMA).

Bordering the PGDP reservation to the northeast, between the plant and the Ohio River, is a Tennessee Valley Authority (TVA) reservation on which is located the Shawnee Steam Plant (Fig. 1.2).

1.2 HISTORICAL BACKGROUND

1.2.1 Description of Paducah Gaseous Diffusion Plant

PGDP is a DOE-owned uranium enrichment plant, consisting of a diffusion cascade system and associated support facilities. Construction of the plant began in 1951, and operation was initiated in 1952. Effective July 1, 1993, DOE leased the plant production operations facilities to the United States Enrichment Corporation (USEC), which in turn contracted with Lockheed Martin Utility Services, Inc. (LMUS), to provide operations and maintenance services. The plant enriches uranium-235 (^{235}U), the second most abundant isotope in naturally occurring uranium, from much less than 1% (its natural abundance) to between 2% and 3%. Enrichment of ^{235}U is necessary because the most abundant isotope of uranium, uranium-238 [(^{238}U) >99%], is not a fissile material. The enrichment process requires extensive support facilities; some of the facilities currently active at PGDP include a steam plant, four major electrical switchyards, four sets of cooling towers, a building for chemical cleaning and decontamination, a water treatment plant, maintenance facilities, and laboratory facilities. Several inactive facilities also are located on the plant site.

The uranium enrichment process is a complicated process involving a number of steps. The first step is converting naturally occurring uranium, generally a solid oxide (e.g., U_3O_8), to uranium hexafluoride (UF_6), a gas. The UF_6 feedstock is received at PGDP and is then pumped through micropores in a series of barriers. Separation of the two principal uranium isotopes, ^{235}U and ^{238}U, occurs because the rate of flow, or diffusion, through the micropores is mass dependent, and the UF_6 molecules containing the lighter ^{235}U isotope flow at a slightly faster rate than molecules composed of the heavier ^{238}U isotope. However, because the mass difference between ^{235}U and ^{238}U is small, the separation is not very efficient; therefore, a large number of separation barriers must be arranged in a cascade to obtain ^{235}U enrichment of several percent.

From 1953 until 1977, most of the UF_6 used by PGDP was produced from feedstock in the PGDP feed plant (C-410 Building), which was designed to process both natural uranium and uranium from reactor tails. Since 1977, PGDP has been supplied with UF_6 feedstock from commercial converters such as Allied Signal in Metropolis, Illinois, from partially depleted tails from government reactors, and from foreign sources. The reactor tails included uranium that had been returned for re-enrichment from the plutonium production reactors at the DOE Hanford and Savannah River plants. Those tails received after 1975, however, were placed in storage rather than being processed. As a result of nuclear reactions in the plutonium production reactors, the reactor tails contained technetium-99 (^{99}Tc) before they entered PGDP and are believed to be the sole source of ^{99}Tc released to the environment at PGDP.

Although various hazardous, non-hazardous, and radioactive wastes resulting from ongoing operations have been generated and disposed of at PGDP, ^{99}Tc, polychlorinated biphenyls (PCBs), and trichloroethene (TCE) have been determined to be the most commonly occurring environmental contaminants of concern at the facility. Since the plant's construction, TCE has been used as a cleaning solvent to decontaminate equipment and waste material before disposal. The use of TCE as a degreaser ceased on July 1, 1993. PCBs have been used extensively as an insulating, non-flammable, thermally conductive fluid in electrical capacitors and transformers at PGDP. The large electrical switchyards that service the process buildings contain PCB-filled transformers. PCBs have also been used as flame retardants, on the gaskets of diffusion cascades and other sections of the plant, and as a hydraulic fluid.

1.3 REGULATORY FRAMEWORK

1.3.1 Federal Facilities Agreement

As a result of the listing of PGDP on the National Priorities List (NPL), the U.S. Environmental Protection Agency (EPA), the DOE, and the Kentucky Department for Environmental Protection (KDEP) have negotiated a Federal Facilities Agreement (FFA). The FFA was signed and became effective on February 13, 1998. The purpose of the FFA is to provide a comprehensive set of guidelines agreed upon by each of the agencies for cleanup of the PGDP site. PGDP is governed by both the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund) and the Resource Conservation and Recovery Act (RCRA), which is administered by the commonwealth. As a result, the FFA integrates both CERCLA and RCRA (hazardous waste) requirements to streamline the process by reducing duplication of efforts that would be required under the two acts if complied with separately.

The FFA for PGDP incorporates the site investigation (SI) process as begun at PGDP in accordance with (1) the CERCLA Administrative Order by Consent (ACO) issued in November 1988 and (2) the requirements in the EPA Hazardous and Solid Waste Amendments (HSWA) Permit and the Kentucky Hazardous Waste Permit (issued in July 1991). The FFA addresses releases at or from solid waste management units (SWMUs) or Areas of Concern (AOCs) not identified in the RCRA permits. The FFA sets forth the CERCLA requirements to address releases of hazardous or radioactive substances not specifically regulated by RCRA. The following list details the primary objectives of the FFA.

- Ensure that the environmental impacts associated with past and present activities at PGDP are thoroughly investigated and that appropriate response action is taken as necessary to protect human health and welfare and the environment.

- Ensure that all releases of hazardous substances, pollutants, or contaminants as defined by CERCLA, RCRA, and Commonwealth of Kentucky environmental laws are addressed so as to achieve a comprehensive remediation of any given site.

- Establish a procedural framework and schedule for developing, implementing, and monitoring appropriate response actions in accordance with CERCLA; the National Oil and Hazardous Substances Pollution Contingency Plan (NCP); RCRA Sects. 3004(u), 3004(v), and 3008(h); the corrective action provisions of *Kentucky Revised Statutes* (KRS) 224 Chapter 46; and the law of the Commonwealth of Kentucky.

- Facilitate cooperation, exchange of information, and participation between EPA, DOE, and KDEP and provide for effective public participation.

- Coordinate response actions under CERCLA, including actions taken under the ACO, with the corrective action activities required by the RCRA permits and Commonwealth of Kentucky hazardous waste laws.

The net result of the approval of the FFA for PGDP is that all SWMUs and AOCs will be required to undergo an integrated Remedial Investigation/Feasibility Study (RI/FS) process. This includes the sites that were originally scheduled for investigation under the RCRA permits and any sites discovered during subsequent investigations. Work completed and data generated before the effective date of the FFA will be retained and used as appropriate. All documents submitted, but not approved, as of the effective date of the draft FFA will be reviewed and approved in accordance with CERCLA; the NCP; RCRA Sects. 3004(u), 3004(v), and 3008(h); and the corrective action provisions of KRS 224, Chapter 46.

1.3.2 Administrative Order by Consent

With the participation of the Commonwealth of Kentucky, EPA and DOE entered into an ACO effective November 23, 1988, after the discovery of contamination in residential wells north of PGDP. The contaminants originated as process-derived wastes or commonly used materials employed during the operational history of PGDP.

The ACO is a legally binding agreement between DOE and EPA that initiated the investigation into the nature and extent of the contamination in the vicinity of PGDP. The ACO defines the following mutual objectives for DOE and EPA.

- Determine the nature and extent of threats to human health and welfare and the environment caused by off-site groundwater contamination originating from PGDP.

- Ensure that the environmental impact associated with the releases and potential releases is thoroughly investigated and that appropriate action is taken to protect human health and welfare and the environment.

- Establish a Work Plan and schedule(s) for developing, implementing, and monitoring response actions.

- Facilitate cooperation among, exchange of information between, and participation of the parties in the action.

The ACO was drafted under Sects. 104 and 106 of CERCLA. As amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), CERCLA was designed to provide for "liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive waste-disposal sites." For the purposes of the ACO, EPA determined that hazardous substances had been released into the environment and that the potential pathways of migration constitute both an actual release and a threatened release within the CERCLA definition.

To meet the requirements specified by the ACO, DOE undertook the following interim measures to protect human health.

- Supply drinking water to residents with contaminated drinking water wells.

- Conduct sampling (on at least a monthly basis) of drinking water wells potentially affected by contaminant migration.

- Identify the constituents of any elevated gross alpha and gross beta levels and evaluate these concentrations against the *National Interim Primary Drinking Water Regulations* [40 *Code of Federal Regulations* (CFR) 141, 142, and 143].

The ACO initiated the investigative activities designed to determine the extent and sources of off-site contamination surrounding PGDP. The SI (CH2M HILL 1991, 1992) was completed in 1992 under the guidelines of the ACO.

1.3.3 Resource Conservation and Recovery Act

The primary purpose of RCRA is to protect human health and the environment through the proper management of both hazardous and non-hazardous wastes at operating sites. Subtitle C of RCRA initially outlined the regulatory requirements for generation; transportation; and treatment, storage, and disposal of hazardous wastes. However, in 1984 the requirements of RCRA were significantly expanded when Congress signed HSWA into law. HSWA adds provisions requiring corrective action for SWMUs, outlines land disposal restrictions, mandates waste minimization, and establishes requirements for organic air emissions monitoring.

RCRA requirements for PGDP are contained in two separate but related permits: (1) the Hazardous Waste Management Permit, issued and administered by the Commonwealth of Kentucky and (2) the HSWA Permit, issued and administered by EPA. Both were issued on July 15, 1991, and constitute the RCRA Permits for PGDP. EPA's HSWA Permit is limited to the HSWA provisions of RCRA, which include corrective action requirements for SWMUs. The Kentucky Hazardous Waste Management Permit contains (pre-HSWA) regulatory provisions for treatment, storage, and disposal units under the RCRA base program, as well as the HSWA provisions that require corrective action for SWMUs. Although Kentucky has been authorized by EPA to exclusively administer the RCRA base program for treatment, storage, and disposal units, Kentucky has not received authorization to administer the HSWA provisions in lieu of EPA, resulting in dual requirements for corrective action under both state and federal law.

1.3.4 National Environmental Policy Act

The intent of the National Environmental Policy Act (NEPA) is to promote a decision-making process that results in minimization of adverse impacts to the human environment. On June 13, 1994, the Secretary of Energy issued a Secretarial Policy on NEPA that addresses NEPA requirements for actions taken under CERCLA. Sect. II.E. of the Policy indicates: "To facilitate meeting the environmental objectives of CERCLA and respond to concerns of regulators, consistent with the procedures of most other Federal agencies, the Department of Energy hereafter will rely on the CERCLA process for review of actions to be taken under CERCLA and will address NEPA values. Department of Energy CERCLA documents will incorporate NEPA values, such as analysis of cumulative, off-site, ecological, and socioeconomic impacts, to the extent practicable." To meet the Secretarial Policy objectives, appropriate NEPA values have been identified and incorporated in this document.

1.3.5 Environmental Programs

Environmental Management and Enrichment Facilities Program

The Environmental Management and Enrichment Facilities (EMEF) Program, under which the Environmental Restoration (ER) Program operates, is a proactive program established at PGDP by DOE/Lockheed Martin Energy Systems, Inc. (LMES) to investigate sites that may contaminate the environment with hazardous substances. The goals of the ER Program are to identify potential sources of contamination, evaluate the extent of off-site contamination, and determine the proper corrective actions for these source areas. The EMEF Program implements the following six-step process.

1. **Identification of Units**. DOE/Energy Systems completed Step 1 with the identification of approximately 205 SWMUs and AOCs at PGDP (as of May 23, 1996) that may have released contamination into the environment.

2. **SWMU Assessment Reports**. Available data on existing SWMUs have been gathered and evaluated, and SWMU assessment reports have been completed for each of these SWMUs. The RCRA permit issued to DOE in 1992 required that all SWMUs not previously addressed by the ACO undergo further investigation.

3. **Site Characterization.** DOE/Energy Systems has prioritized the SWMUs for site characterization. Investigation of the off-site groundwater and surface-water contamination north of the plant, source areas contributing to groundwater contamination, and the PCB sources contributing to off-site surface-water contamination have been given the highest priority. The *Results of the Site Investigation, Phase I* (CH2M HILL 1991) and *Results of*

the Site Investigation, Phase II (CH2M HILL 1992) were completed as part of the site characterization step of the ER Program under the direction of the ACO.

4. **Alternatives Assessment.** An alternatives assessment requires an evaluation of the data gathered during site characterization for preparation of a list of potential remedial action alternatives for each SWMU. Each of these remedial action alternatives (including a no-action alternative) is evaluated, and the end result of the alternatives assessment is a recommendation of a remedial action alternative for each SWMU.

5. **Corrective Action.** The corrective action step consists of the design and implementation of the remediation method chosen in the alternatives assessment.

6. **Monitoring of Units.** Site monitoring is performed to evaluate the effectiveness of the remedial action program and to ensure that no further releases occur. Site monitoring may not be applicable to some actions.

Groundwater Protection Program

DOE maintains an ongoing Groundwater Protection Program (GWPP) (Miller and Douthitt 1993) designed to monitor, document, and protect the groundwater resources at PGDP and the areas immediately surrounding the plant. Groundwater monitoring is mandated by state and federal regulations and by DOE Orders. DOE Order 5400.1 requires that a groundwater monitoring program be established at all DOE facilities and, at a minimum, encompass the following elements.

- Obtain data for determining baseline conditions of groundwater quality and quantity.

- Demonstrate compliance with and implementation of all applicable regulations and DOE Orders.

- Provide data to permit the early detection of groundwater contamination.

- Provide a reporting mechanism for detected groundwater contamination.

- Identify existing and potential groundwater contamination sources and maintain surveillance of these sources.

- Provide data upon which decisions can be made concerning land disposal practices and the management and protection of groundwater resources.

Before the first formalized groundwater monitoring plan was developed and proposed by Engineering, Design & Geosciences Group, Inc. (EDGe) in March 1987, PGDP personnel monitored 45 plant wells and 55 residential wells. The Groundwater Monitoring Phase II project was initiated in 1988 and included the following three elements.

- **Hydrological Characterization Study.** The drilling of 10 deep borings [through the Regional Gravel Aquifer (RGA) and into the McNairy Flow System] along two transects across PGDP.

- **C-404 Post-Closure Compliance Program**. The installation of 12 RCRA-quality monitoring wells around C-404 and the design and installation of a 6-in. well with ancillary piezometers to perform a pump test.

- **C-404 Well Abandonment**. The abandonment of five old wells in the vicinity of C-404.

The plan, *Groundwater Monitoring/Phase 2* (EDGe 1989), also formally addressed the characterization of PGDP geology and hydrogeology to develop a more effective monitoring and detection strategy.

In the early part of 1988, PGDP recognized that a groundwater monitoring program would be needed to meet the requirements of DOE Order 5400.1. The results and findings from *Groundwater Monitoring/Phase 2* were used in the development of a GWPP management plan. The GWPP management plan was formally outlined in the Energy Systems document, *Paducah Gaseous Diffusion Plant, Groundwater Protection Program Plan* (Clausen et al. 1992a), which was subsequently updated in 1993 (Miller and Douthitt 1993). The GWPP management plan provided a summary of the site geology and hydrogeology and current monitoring programs. It also assessed the current level of understanding of groundwater movement beneath PGDP, identified deficiencies, and outlined a plan to alleviate shortcomings in the current monitoring system. The identified deficiencies and additional requirements have been addressed in a subsequent investigation, *Report of the Paducah Gaseous Diffusion Plant, Groundwater Investigation Phase III* (Clausen et al. 1992b). In this study, the hydrogeology of areas of impending RIs for Waste Area Grouping (WAGs) was outlined, and a conceptual model was developed for groundwater flow at PGDP. Additional studies of the groundwater in the vicinity of PGDP include the Northwest Plume investigation, which delimited the Northwest Plume, and the Groundwater Monitoring Phase IV study, which established the C-400 Area as the primary source zone for the Northwest Plume.

Biological Monitoring Program

The Biological Monitoring Program (BMP) is designed to determine the impact of effluent discharge on the aquatic biota in the vicinity of the plant. PGDP discharges are regulated under a Kentucky Pollutant Discharge Elimination System (KPDES) permit. Interim discharge limits have been negotiated with the Commonwealth of Kentucky during the BMP investigation. The BMP includes chemical and toxicological characterizations of plant effluent at various KPDES monitoring points and bioaccumulation studies of fish and macroinvertebrates in surrounding surface water. The data gathered from the BMP were used to evaluate and determine the impact of plant activities on the surrounding ecology.

1.4 INVESTIGATIVE OVERVIEW

To facilitate the ER process at PGDP and focus investigations toward the most effective and efficient remedial actions, operable units (OUs) have been defined. These OUs consist of two types: source control units (i.e., units that may contribute contamination to other units) and integrator units (i.e., units that "collect" contamination from source control units—in the specific instance of the PGDP, the groundwater and surface-water units). The focus of the RI process is to collect data to define the extent of contamination and to estimate the human health and environmental risks associated with contamination at the source control OUs. Collected data are also necessary to design the appropriate corrective measures where necessary. Data on the contaminant contribution from the source control OUs to the integrator OU were also collected during implementation of the WAG 6 Work Plan. These data will be incorporated into subsequent studies focusing on remedial actions for the integrator OUs.

1.4.1 Site Investigation—Phases I and II

DOE/Energy Systems initiated an SI in 1989; the primary objectives were to investigate the nature and extent of contamination in the vicinity of PGDP and evaluate potential remedial alternatives. The objectives of the SI were consistent with the objective defined in the ACO. The execution and administration of the SI were handled through PGDP's ER Program, which was created to investigate potential hazardous waste sites associated with the operation of PGDP.

The SI was completed using a two-phased approach. The focus of the Phase I investigation, which began in June 1989, was to evaluate off-site contamination and selected on-site sources of ^{99}Tc, TCE, and PCBs. Phase II of the SI began in October 1990 and was completed in October 1991. The purpose of the Phase II investigation was to further characterize on-site sources, better define the extent of off-site contamination, and evaluate alternatives for remediation.

Additional environmental studies include the *Report of the Paducah Gaseous Diffusion Plant Groundwater Investigation Phase III* (Clausen et al. 1992b), the *Final Report on Drive-Point Profiling of the Northwest Plume and Analysis of Related Data* (Clausen et al. 1995), and the *Northeast Plume Preliminary Characterization Summary Report, Vols. 1 and 2* (DOE 1995b). Significant results of these studies include development of a model for groundwater flow in the Continental Deposits that underlie the plant.

1.4.2 WAG 6 Sectors

A major portion of the data gathered during the WAG 6 RI was collected as part of the C-400 Site Evaluation Area investigation. This information was gathered to determine whether undocumented releases had occurred at the facility and to establish whether the numerous buried utilities associated with the C-400 Building were conduits for the migration of contaminants. As such, data have been gathered on a C-400 Site Evaluation Area basis and on a SWMU-specific basis.

To facilitate a logical discussion of the data for the WAG 6 RI report, the entire WAG 6 area was divided into nine sectors (see Fig. 3.6). The sampling station locations within each sector are listed in Appendix A. Five of the nine sectors contain a SWMU that was to be investigated during implementation of the WAG 6 RI. The C-400 Building occupies an entire sector (1) and contains several SWMUs that were not investigated during the WAG 6 RI. Section 9 contains a portion of SWMU 202, which is the Northeast Plume. Two sectors (3 and 5) do not contain a SWMU, although each does contain buried utilities, piping, or ditches that may have served as or migration pathways for contamination. Each of the five SWMUs that were investigated and the C-400 Site Evaluation Area are discussed in Table 1.1.

1.4.2.1 C-400 Area

The C-400 Area is located near the center of the industrial section of PGDP bounded by 10th and 11th Streets extended to the west and east, respectively; and Virginia and Tennessee Avenues to the north and south, respectively. In general, the C-400 Building rests on the 16-in. concrete floor designed with four main pits/sumps and an east-side basement area that are 15 to 20 ft below grade. The east-side basement includes a plenum and fan room system to ventilate the building.

Cleaning (clothes laundry and machinery parts) and disassembly and testing of cascade components are the primary activities the building was designed to support. The building has also housed many other activities, including recovery of precious metals and treatment of radiological waste streams.

1.4.2.2 Trichloroethene Leak Site (SWMU 11)—Sector 4

The Trichloroethene Leak Site (SWMU 11) is located near the southeast corner of the C-400 Building, along the 11th Street storm sewer line. This SWMU consists of media contaminated by releases from a leaking storm sewer and a leaking TCE transfer pump near the C-400 Building.

The leak was discovered during construction of a discharge line from the truck unloading dock containment sump to the 11th Street storm sewer line. During excavation, TCE was discovered leaking from the joints of the storm sewer line.

1.4.2.3 C-401 Transfer Line (SWMU 26)—Sector 8

Between 1952 and 1957, the C-401 Transfer Line conveyed liquid effluent from the C-403 Neutralization Tank (SWMU 40) and the Waste Discard System Sump (SWMU 203) to the C-404 Holding Pond. With the development of treatment facilities within the C-400 Building, the Transfer Line was abandoned in 1957. At that time, effluent from the C-403 Neutralization Tank and the Waste Discard Sump was allowed to discharge to the North-South Diversion Ditch. No spills or releases associated with the transfer line have been documented or are known.

1.4.2.4 C-403 Neutralization Tank (SWMU 40)—Sector 2

The C-403 Neutralization Tank is located at the northeast corner of the C-400 Cleaning Facility. It consists of a 25-ft-square by 26-ft-deep, in-ground, open-top tank constructed of concrete and lined with two layers of acid-proof brick. Influent from the C-400 Building was received from an 8-in.-diameter Duriron acid waste line. The C-403 Neutralization Tank was connected to the C-402 Lime House by a 4-in.-diameter Duriron line.

The C-403 Neutralization Tank was used for the storage and treatment (i.e., neutralization) of acidic uranium-bearing waste solutions generated during cleaning operations in the C-400 Building. The operation of the C-403 Neutralization Tank may have been limited to the period between 1952 and 1957, although effluents from the C-400 Cleaning Facility were discharged to the C-403 Neutralization Tank until 1990. These discharges included primarily

UF_6 cylinder hydrostatic-test water, overflow and runoff from cleaning tanks, and discharge from floor drains.

1.4.2.5 Technetium Storage Tank Area (SWMU 47)—Sector 6

The Technetium Storage Tank was located within a bermed area on a concrete pad outside the C-400 Building, on the west side of the building. The tank was removed in 1986, but the concrete pad and berms are still present.

The 4000-gal storage tank was used in the early 1960s to store a waste solution containing ^{99}Tc and chromium. No spills are known to have occurred from the Technetium Storage Tank.

1.4.2.6 Waste Discard Sump (SWMU 203)—Sector 7

The Waste Discard Sump is a convergence point for effluent from the C-400 Cleaning Facility (primarily from the west side), located at the northwest corner of the building. The unit is a 6-ft-wide x 11-ft-deep concrete pit. The pit includes a 4-ft-diameter x 4.5-ft-deep sump in the floor. The concrete walls of the sump are lined with acid-proof brick. Influent to the system is discharged directly into the sump that empties into the North-South Diversion Ditch.

A pump discharged wastewater through the C-401 Transfer Line (SWMU 26) prior to 1957. Beginning in 1957, a drain in the sump was opened to allow gravity fed discharge through a storm sewer line to the North-South Diversion Ditch. In the 1950s, the Waste Discard Sump handled discharges from a variety of processes performed in the C-400 Building. Many of these discharges were discontinued after 1957. The sump continues to collect effluent from a high-pressure waterjet system on the C-400 Spray Booth and a vacuum pump on the C-400 Lime Precipitation Unit.

1.5 PROJECT SCOPE

The scope of the WAG 6 field effort included conducting a RI at the C-400 Site Evaluation Area and five SWMUs located within the fenced security area at PGDP. The primary focus was to collect sufficient information about surface and subsurface soil and the shallow groundwater of the Upper Continental Recharge System (UCRS) contamination to support an assessment of risks to human health and the environment and the selection of actions to reduce these risks, if required. In addition, contamination in the RGA was characterized during the RI to determine whether contamination in the RGA acts as a secondary source area. The uppermost 50 ft of the McNairy Formation was characterized. All data collected during the WAG 6 RI will be evaluated and incorporated as appropriate in future PGDP remedial action planning documents.

Within this scope, the goals of the WAG 6 RI were to:

- characterize the nature of contaminant source materials;
- define the nature, extent (vertical and lateral), and magnitude of source area contamination in soils and sediments and where groundwater contaminants migrate outside of currently recognized plumes in groundwater;

- identify and define the extent of hot spots of groundwater contamination and migration trends;
- identify areal trends of soil contamination;
- determine the presence, general location, if possible, and magnitude of any dense, non-aqueous phase liquid (DNAPL) zones;
- provide sufficient information associated with the C-400 Area to support a baseline risk assessment for WAG 6, the groundwater OU, and the surface-water OU; and
- gather adequate data to analyze contaminant transport mechanisms and support an FS.

The objectives and goals of the WAG 6 RI are consistent with those established in the FFA and Site Management Plan (SMP) negotiated between DOE, EPA, and the Commonwealth of Kentucky. The FFA requires that PGDP identify, investigate, and remediate all AOCs and SWMUs that could potentially pose a threat to human health and the environment.

1.6 REPORT ORGANIZATION

Section 1 of this report has presented an overview of the regulatory framework under which the WAG 6 RI was conducted and has discussed the ER process at PGDP. This section also discussed current and past activities conducted at PGDP.

Section 2 describes the investigative methods used to sample the various media, the analytical sampling parameters, and the historical waste management practices at each of the nine sectors covered under this investigation.

Section 3 details the physical characteristics of each sector including the topography, surface-water hydrology, geology, and hydrogeology. In addition, a description of the meteorology, ecology, demography, and land use at PGDP is presented.

Section 4 presents the nature and extent of the contamination at each sector as concluded from analyses of the data collected throughout the investigation. The history of contamination as found in previous investigations is also presented.

Section 5 presents the fate and transport of the contamination at each sector. A conceptual site model has been developed in which exposure pathways of potential concern are discussed and contaminant persistence is evaluated. Models of contaminant transport are also presented.

Section 6 presents the results of a baseline human health risk assessment, including results of previous studies, identification of chemicals of concern (COCs), the exposure assessment, the toxicity assessment, the risk characterization, a summary and conclusions, and site-specific remedial action goals. Also included in Section 6 are the results of a baseline ecological risk assessment, including identification of contaminants, receptors, and exposure pathways of concern; any site that poses no risk; any site that may require immediate action; and any site that requires further investigation, as well as the data gaps that must be filled to complete such an investigation.

The final sections (Sections 7 and 8) present the conclusions and references, respectively, of this report.

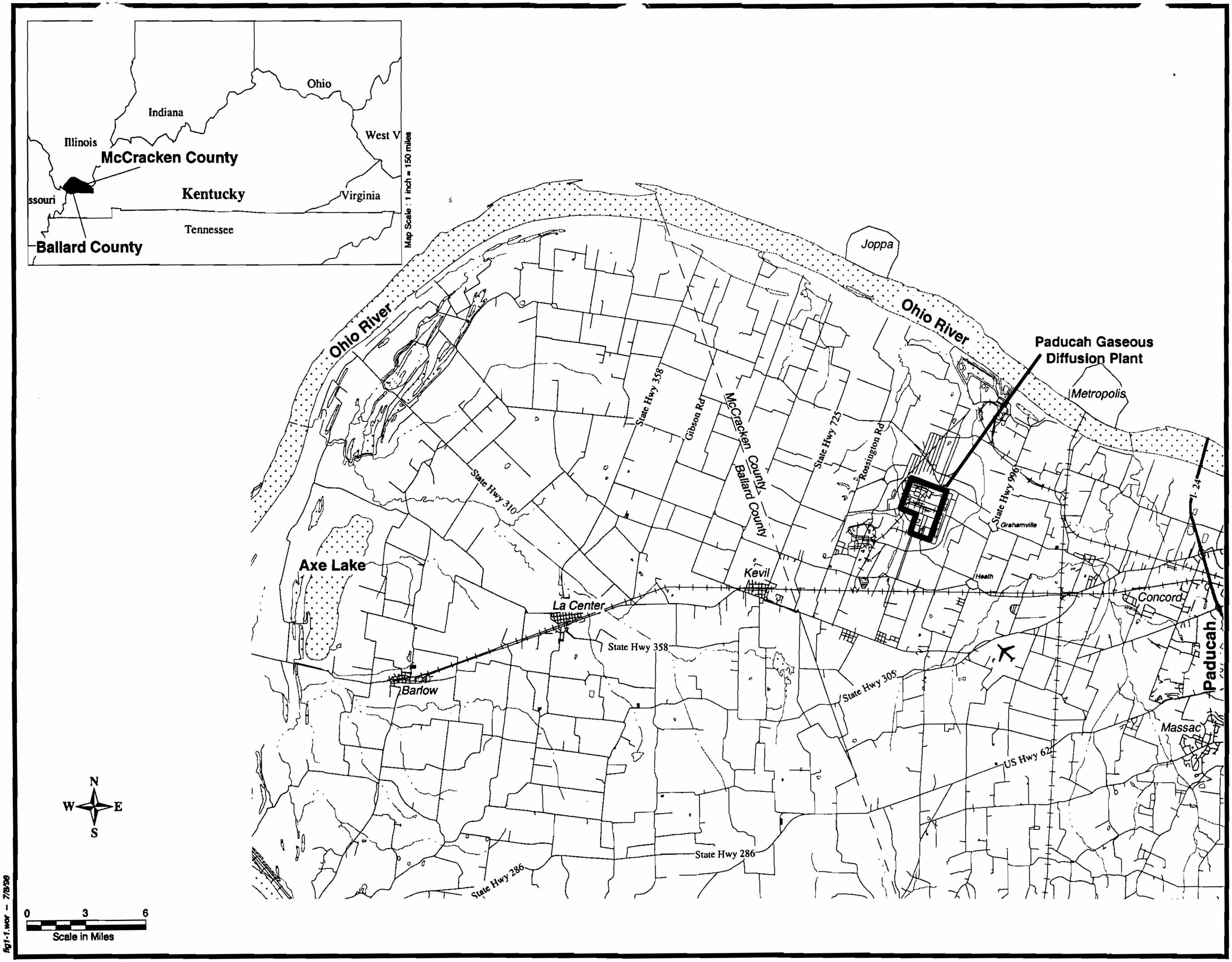

Fig. 1.1. PGDP location map.

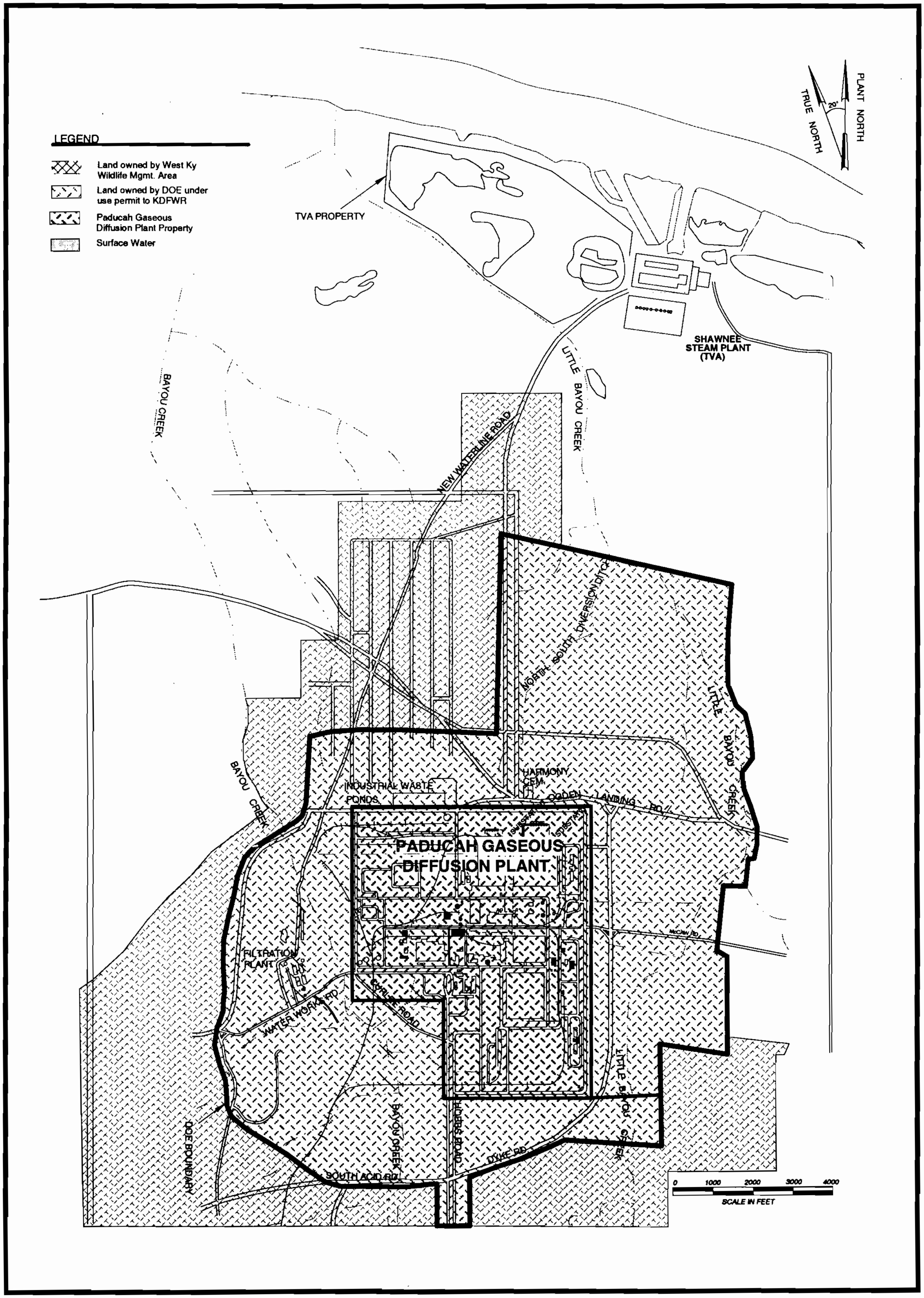

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Fig. 1.2 Current land ownership map.

Table 1.1. SWMUs investigated in WAG 6 RI

Sectors	SWMU	PGDP Facility Number	Description
1	None	C-400	Processing Building
2	40	C-403	Neutralization Tank
3	None	N/A	Area Between SWMU 11 and SWMU 40
4	11	C-400	Trichloroethene Leak Site
5	None	N/A	Area Between SWMU 11 and SWMU 47
6	47	C-400	Technetium Storage Tank Area
7	203	C-400	C-400 Waste Discard System Sump
8	26	C-401	C-400 to C-404 Transfer Line
9	None	N/A	Open Area Northeast of C-400 Building

Notes:
N/A = not applicable

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Section 2
Field Investigation

1. INTRODUCTION

1.1 OVERVIEW

Paducah Gaseous Diffusion Plant (PGDP) is located approximately 10 miles west of Paducah, Kentucky (population approximately 31,000), and 3.5 miles south of the Ohio River in the western part of McCracken County (Fig. 1.1). The plant is on an approximately 3556-acre U.S. Department of Energy (DOE) site; the total acreage is divided as follows:

- 748 acres–within a fenced security area;
- approximately 822 acres–uninhabited buffer zone surrounding the plant area; and
- 1986 acres–either deeded or leased to Commonwealth of Kentucky as part of West Kentucky Wildlife Management Area (WKWMA).

Bordering the PGDP reservation to the northeast, between the plant and the Ohio River, is a Tennessee Valley Authority (TVA) reservation on which is located the Shawnee Steam Plant (Fig. 1.2).

1.2 HISTORICAL BACKGROUND

1.2.1 Description of Paducah Gaseous Diffusion Plant

PGDP is a DOE-owned uranium enrichment plant, consisting of a diffusion cascade system and associated support facilities. Construction of the plant began in 1951, and operation was initiated in 1952. Effective July 1, 1993, DOE leased the plant production operations facilities to the United States Enrichment Corporation (USEC), which in turn contracted with Lockheed Martin Utility Services, Inc. (LMUS), to provide operations and maintenance services. The plant enriches uranium-235 (^{235}U), the second most abundant isotope in naturally occurring uranium, from much less than 1% (its natural abundance) to between 2% and 3%. Enrichment of ^{235}U is necessary because the most abundant isotope of uranium, uranium-238 [(^{238}U) >99%], is not a fissile material. The enrichment process requires extensive support facilities; some of the facilities currently active at PGDP include a steam plant, four major electrical switchyards, four sets of cooling towers, a building for chemical cleaning and decontamination, a water treatment plant, maintenance facilities, and laboratory facilities. Several inactive facilities also are located on the plant site.

The uranium enrichment process is a complicated process involving a number of steps. The first step is converting naturally occurring uranium, generally a solid oxide (e.g., U_3O_8), to uranium hexafluoride (UF_6), a gas. The UF_6 feedstock is received at PGDP and is then pumped through micropores in a series of barriers. Separation of the two principal uranium isotopes, ^{235}U and ^{238}U, occurs because the rate of flow, or diffusion, through the micropores is mass dependent, and the UF_6 molecules containing the lighter ^{235}U isotope flow at a slightly faster rate than molecules composed of the heavier ^{238}U isotope. However, because the mass difference between ^{235}U and ^{238}U is small, the separation is not very efficient; therefore, a large number of separation barriers must be arranged in a cascade to obtain ^{235}U enrichment of several percent.

From 1953 until 1977, most of the UF_6 used by PGDP was produced from feedstock in the PGDP feed plant (C-410 Building), which was designed to process both natural uranium and uranium from reactor tails. Since 1977, PGDP has been supplied with UF_6 feedstock from commercial converters such as Allied Signal in Metropolis, Illinois, from partially depleted tails from government reactors, and from foreign sources. The reactor tails included uranium that had been returned for re-enrichment from the plutonium production reactors at the DOE Hanford and Savannah River plants. Those tails received after 1975, however, were placed in storage rather than being processed. As a result of nuclear reactions in the plutonium production reactors, the reactor tails contained technetium-99 (^{99}Tc) before they entered PGDP and are believed to be the sole source of ^{99}Tc released to the environment at PGDP.

Although various hazardous, non-hazardous, and radioactive wastes resulting from ongoing operations have been generated and disposed of at PGDP, ^{99}Tc, polychlorinated biphenyls (PCBs), and trichloroethene (TCE) have been determined to be the most commonly occurring environmental contaminants of concern at the facility. Since the plant's construction, TCE has been used as a cleaning solvent to decontaminate equipment and waste material before disposal. The use of TCE as a degreaser ceased on July 1, 1993. PCBs have been used extensively as an insulating, non-flammable, thermally conductive fluid in electrical capacitors and transformers at PGDP. The large electrical switchyards that service the process buildings contain PCB-filled transformers. PCBs have also been used as flame retardants, on the gaskets of diffusion cascades and other sections of the plant, and as a hydraulic fluid.

1.3 REGULATORY FRAMEWORK

1.3.1 Federal Facilities Agreement

As a result of the listing of PGDP on the National Priorities List (NPL), the U.S. Environmental Protection Agency (EPA), the DOE, and the Kentucky Department for Environmental Protection (KDEP) have negotiated a Federal Facilities Agreement (FFA). The FFA was signed and became effective on February 13, 1998. The purpose of the FFA is to provide a comprehensive set of guidelines agreed upon by each of the agencies for cleanup of the PGDP site. PGDP is governed by both the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund) and the Resource Conservation and Recovery Act (RCRA), which is administered by the commonwealth. As a result, the FFA integrates both CERCLA and RCRA (hazardous waste) requirements to streamline the process by reducing duplication of efforts that would be required under the two acts if complied with separately.

The FFA for PGDP incorporates the site investigation (SI) process as begun at PGDP in accordance with (1) the CERCLA Administrative Order by Consent (ACO) issued in November 1988 and (2) the requirements in the EPA Hazardous and Solid Waste Amendments (HSWA) Permit and the Kentucky Hazardous Waste Permit (issued in July 1991). The FFA addresses releases at or from solid waste management units (SWMUs) or Areas of Concern (AOCs) not identified in the RCRA permits. The FFA sets forth the CERCLA requirements to address releases of hazardous or radioactive substances not specifically regulated by RCRA. The following list details the primary objectives of the FFA.

- Ensure that the environmental impacts associated with past and present activities at PGDP are thoroughly investigated and that appropriate response action is taken as necessary to protect human health and welfare and the environment.

- Ensure that all releases of hazardous substances, pollutants, or contaminants as defined by CERCLA, RCRA, and Commonwealth of Kentucky environmental laws are addressed so as to achieve a comprehensive remediation of any given site.

- Establish a procedural framework and schedule for developing, implementing, and monitoring appropriate response actions in accordance with CERCLA; the National Oil and Hazardous Substances Pollution Contingency Plan (NCP); RCRA Sects. 3004(u), 3004(v), and 3008(h); the corrective action provisions of *Kentucky Revised Statutes* (KRS) 224 Chapter 46; and the law of the Commonwealth of Kentucky.

- Facilitate cooperation, exchange of information, and participation between EPA, DOE, and KDEP and provide for effective public participation.

- Coordinate response actions under CERCLA, including actions taken under the ACO, with the corrective action activities required by the RCRA permits and Commonwealth of Kentucky hazardous waste laws.

The net result of the approval of the FFA for PGDP is that all SWMUs and AOCs will be required to undergo an integrated Remedial Investigation/Feasibility Study (RI/FS) process. This includes the sites that were originally scheduled for investigation under the RCRA permits and any sites discovered during subsequent investigations. Work completed and data generated before the effective date of the FFA will be retained and used as appropriate. All documents submitted, but not approved, as of the effective date of the draft FFA will be reviewed and approved in accordance with CERCLA; the NCP; RCRA Sects. 3004(u), 3004(v), and 3008(h); and the corrective action provisions of KRS 224, Chapter 46.

1.3.2 Administrative Order by Consent

With the participation of the Commonwealth of Kentucky, EPA and DOE entered into an ACO effective November 23, 1988, after the discovery of contamination in residential wells north of PGDP. The contaminants originated as process-derived wastes or commonly used materials employed during the operational history of PGDP.

The ACO is a legally binding agreement between DOE and EPA that initiated the investigation into the nature and extent of the contamination in the vicinity of PGDP. The ACO defines the following mutual objectives for DOE and EPA.

- Determine the nature and extent of threats to human health and welfare and the environment caused by off-site groundwater contamination originating from PGDP.

- Ensure that the environmental impact associated with the releases and potential releases is thoroughly investigated and that appropriate action is taken to protect human health and welfare and the environment.

- Establish a Work Plan and schedule(s) for developing, implementing, and monitoring response actions.

- Facilitate cooperation among, exchange of information between, and participation of the parties in the action.

The ACO was drafted under Sects. 104 and 106 of CERCLA. As amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), CERCLA was designed to provide for "liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive waste-disposal sites." For the purposes of the ACO, EPA determined that hazardous substances had been released into the environment and that the potential pathways of migration constitute both an actual release and a threatened release within the CERCLA definition.

To meet the requirements specified by the ACO, DOE undertook the following interim measures to protect human health.

- Supply drinking water to residents with contaminated drinking water wells.

- Conduct sampling (on at least a monthly basis) of drinking water wells potentially affected by contaminant migration.

- Identify the constituents of any elevated gross alpha and gross beta levels and evaluate these concentrations against the *National Interim Primary Drinking Water Regulations* [40 *Code of Federal Regulations* (CFR) 141, 142, and 143].

The ACO initiated the investigative activities designed to determine the extent and sources of off-site contamination surrounding PGDP. The SI (CH2M HILL 1991, 1992) was completed in 1992 under the guidelines of the ACO.

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1.3.4 National Environmental Policy Act

The intent of the National Environmental Policy Act (NEPA) is to promote a decision-making process that results in minimization of adverse impacts to the human environment. On June 13, 1994, the Secretary of Energy issued a Secretarial Policy on NEPA that addresses NEPA requirements for actions taken under CERCLA. Sect. II.E. of the Policy indicates: "To facilitate meeting the environmental objectives of CERCLA and respond to concerns of regulators, consistent with the procedures of most other Federal agencies, the Department of Energy hereafter will rely on the CERCLA process for review of actions to be taken under CERCLA and will address NEPA values. Department of Energy CERCLA documents will incorporate NEPA values, such as analysis of cumulative, off-site, ecological, and socioeconomic impacts, to the extent practicable." To meet the Secretarial Policy objectives, appropriate NEPA values have been identified and incorporated in this document.

1.3.5 Environmental Programs

Environmental Management and Enrichment Facilities Program

The Environmental Management and Enrichment Facilities (EMEF) Program, under which the Environmental Restoration (ER) Program operates, is a proactive program established at PGDP by DOE/Lockheed Martin Energy Systems, Inc. (LMES) to investigate sites that may contaminate the environment with hazardous substances. The goals of the ER Program are to identify potential sources of contamination, evaluate the extent of off-site contamination, and determine the proper corrective actions for these source areas. The EMEF Program implements the following six-step process.

1. **Identification of Units**. DOE/Energy Systems completed Step 1 with the identification of approximately 205 SWMUs and AOCs at PGDP (as of May 23, 1996) that may have released contamination into the environment.

2. **SWMU Assessment Reports**. Available data on existing SWMUs have been gathered and evaluated, and SWMU assessment reports have been completed for each of these SWMUs. The RCRA permit issued to DOE in 1992 required that all SWMUs not previously addressed by the ACO undergo further investigation.

3. **Site Characterization**. DOE/Energy Systems has prioritized the SWMUs for site characterization. Investigation of the off-site groundwater and surface-water contamination north of the plant, source areas contributing to groundwater contamination, and the PCB sources contributing to off-site surface-water contamination have been given the highest priority. The *Results of the Site Investigation, Phase I* (CH2M HILL 1991) and *Results of*

the Site Investigation, Phase II (CH2M HILL 1992) were completed as part of the site characterization step of the ER Program under the direction of the ACO.

4. **Alternatives Assessment**. An alternatives assessment requires an evaluation of the data gathered during site characterization for preparation of a list of potential remedial action alternatives for each SWMU. Each of these remedial action alternatives (including a no-action alternative) is evaluated, and the end result of the alternatives assessment is a recommendation of a remedial action alternative for each SWMU.

5. **Corrective Action**. The corrective action step consists of the design and implementation of the remediation method chosen in the alternatives assessment.

6. **Monitoring of Units**. Site monitoring is performed to evaluate the effectiveness of the remedial action program and to ensure that no further releases occur. Site monitoring may not be applicable to some actions.

Groundwater Protection Program

DOE maintains an ongoing Groundwater Protection Program (GWPP) (Miller and Douthitt 1993) designed to monitor, document, and protect the groundwater resources at PGDP and the areas immediately surrounding the plant. Groundwater monitoring is mandated by state and federal regulations and by DOE Orders. DOE Order 5400.1 requires that a groundwater monitoring program be established at all DOE facilities and, at a minimum, encompass the following elements.

- Obtain data for determining baseline conditions of groundwater quality and quantity.

- Demonstrate compliance with and implementation of all applicable regulations and DOE Orders.

- Provide data to permit the early detection of groundwater contamination.

- Provide a reporting mechanism for detected groundwater contamination.

- Identify existing and potential groundwater contamination sources and maintain surveillance of these sources.

- Provide data upon which decisions can be made concerning land disposal practices and the management and protection of groundwater resources.

Before the first formalized groundwater monitoring plan was developed and proposed by Engineering, Design & Geosciences Group, Inc. (EDGe) in March 1987, PGDP personnel monitored 45 plant wells and 55 residential wells. The Groundwater Monitoring Phase II project was initiated in 1988 and included the following three elements.

- **Hydrological Characterization Study**. The drilling of 10 deep borings [through the Regional Gravel Aquifer (RGA) and into the McNairy Flow System] along two transects across PGDP.

- **C-404 Post-Closure Compliance Program**. The installation of 12 RCRA-quality monitoring wells around C-404 and the design and installation of a 6-in. well with ancillary piezometers to perform a pump test.

- **C-404 Well Abandonment**. The abandonment of five old wells in the vicinity of C-404.

The plan, *Groundwater Monitoring/Phase 2* (EDGe 1989), also formally addressed the characterization of PGDP geology and hydrogeology to develop a more effective monitoring and detection strategy.

In the early part of 1988, PGDP recognized that a groundwater monitoring program would be needed to meet the requirements of DOE Order 5400.1. The results and findings from *Groundwater Monitoring/Phase 2* were used in the development of a GWPP management plan. The GWPP management plan was formally outlined in the Energy Systems document, *Paducah Gaseous Diffusion Plant, Groundwater Protection Program Plan* (Clausen et al. 1992a), which was subsequently updated in 1993 (Miller and Douthitt 1993). The GWPP management plan provided a summary of the site geology and hydrogeology and current monitoring programs. It also assessed the current level of understanding of groundwater movement beneath PGDP, identified deficiencies, and outlined a plan to alleviate shortcomings in the current monitoring system. The identified deficiencies and additional requirements have been addressed in a subsequent investigation, *Report of the Paducah Gaseous Diffusion Plant, Groundwater Investigation Phase III* (Clausen et al. 1992b). In this study, the hydrogeology of areas of impending RIs for Waste Area Grouping (WAGs) was outlined, and a conceptual model was developed for groundwater flow at PGDP. Additional studies of the groundwater in the vicinity of PGDP include the Northwest Plume investigation, which delimited the Northwest Plume, and the Groundwater Monitoring Phase IV study, which established the C-400 Area as the primary source zone for the Northwest Plume.

Biological Monitoring Program

The Biological Monitoring Program (BMP) is designed to determine the impact of effluent discharge on the aquatic biota in the vicinity of the plant. PGDP discharges are regulated under a Kentucky Pollutant Discharge Elimination System (KPDES) permit. Interim discharge limits have been negotiated with the Commonwealth of Kentucky during the BMP investigation. The BMP includes chemical and toxicological characterizations of plant effluent at various KPDES monitoring points and bioaccumulation studies of fish and macroinvertebrates in surrounding surface water. The data gathered from the BMP were used to evaluate and determine the impact of plant activities on the surrounding ecology.

1.4 INVESTIGATIVE OVERVIEW

To facilitate the ER process at PGDP and focus investigations toward the most effective and efficient remedial actions, operable units (OUs) have been defined. These OUs consist of two types: source control units (i.e., units that may contribute contamination to other units) and integrator units (i.e., units that "collect" contamination from source control units—in the specific instance of the PGDP, the groundwater and surface-water units). The focus of the RI process is to collect data to define the extent of contamination and to estimate the human health and environmental risks associated with contamination at the source control OUs. Collected data are also necessary to design the appropriate corrective measures where necessary. Data on the contaminant contribution from the source control OUs to the integrator OU were also collected during implementation of the WAG 6 Work Plan. These data will be incorporated into subsequent studies focusing on remedial actions for the integrator OUs.

1.4.1 Site Investigation—Phases I and II

DOE/Energy Systems initiated an SI in 1989; the primary objectives were to investigate the nature and extent of contamination in the vicinity of PGDP and evaluate potential remedial alternatives. The objectives of the SI were consistent with the objective defined in the ACO. The execution and administration of the SI were handled through PGDP's ER Program, which was created to investigate potential hazardous waste sites associated with the operation of PGDP.

The SI was completed using a two-phased approach. The focus of the Phase I investigation, which began in June 1989, was to evaluate off-site contamination and selected on-site sources of ^{99}Tc, TCE, and PCBs. Phase II of the SI began in October 1990 and was completed in October 1991. The purpose of the Phase II investigation was to further characterize on-site sources, better define the extent of off-site contamination, and evaluate alternatives for remediation.

Additional environmental studies include the *Report of the Paducah Gaseous Diffusion Plant Groundwater Investigation Phase III* (Clausen et al. 1992b), the *Final Report on Drive-Point Profiling of the Northwest Plume and Analysis of Related Data* (Clausen et al. 1995), and the *Northeast Plume Preliminary Characterization Summary Report, Vols. 1 and 2* (DOE 1995b). Significant results of these studies include development of a model for groundwater flow in the Continental Deposits that underlie the plant.

1.4.2 WAG 6 Sectors

A major portion of the data gathered during the WAG 6 RI was collected as part of the C-400 Site Evaluation Area investigation. This information was gathered to determine whether undocumented releases had occurred at the facility and to establish whether the numerous buried utilities associated with the C-400 Building were conduits for the migration of contaminants. As such, data have been gathered on a C-400 Site Evaluation Area basis and on a SWMU-specific basis.

To facilitate a logical discussion of the data for the WAG 6 RI report, the entire WAG 6 area was divided into nine sectors (see Fig. 3.6). The sampling station locations within each sector are listed in Appendix A. Five of the nine sectors contain a SWMU that was to be investigated during implementation of the WAG 6 RI. The C-400 Building occupies an entire sector (1) and contains several SWMUs that were not investigated during the WAG 6 RI. Section 9 contains a portion of SWMU 202, which is the Northeast Plume. Two sectors (3 and 5) do not contain a SWMU, although each does contain buried utilities, piping, or ditches that may have served as or migration pathways for contamination. Each of the five SWMUs that were investigated and the C-400 Site Evaluation Area are discussed in Table 1.1.

1.4.2.1 C-400 Area

The C-400 Area is located near the center of the industrial section of PGDP bounded by 10th and 11th Streets extended to the west and east, respectively; and Virginia and Tennessee Avenues to the north and south, respectively. In general, the C-400 Building rests on the 16-in. concrete floor designed with four main pits/sumps and an east-side basement area that are 15 to 20 ft below grade. The east-side basement includes a plenum and fan room system to ventilate the building.

Cleaning (clothes laundry and machinery parts) and disassembly and testing of cascade components are the primary activities the building was designed to support. The building has also housed many other activities, including recovery of precious metals and treatment of radiological waste streams.

1.4.2.2 Trichloroethene Leak Site (SWMU 11)—Sector 4

The Trichloroethene Leak Site (SWMU 11) is located near the southeast corner of the C-400 Building, along the 11th Street storm sewer line. This SWMU consists of media contaminated by releases from a leaking storm sewer and a leaking TCE transfer pump near the C-400 Building.

The leak was discovered during construction of a discharge line from the truck unloading dock containment sump to the 11th Street storm sewer line. During excavation, TCE was discovered leaking from the joints of the storm sewer line.

1.4.2.3 C-401 Transfer Line (SWMU 26)—Sector 8

Between 1952 and 1957, the C-401 Transfer Line conveyed liquid effluent from the C-403 Neutralization Tank (SWMU 40) and the Waste Discard System Sump (SWMU 203) to the C-404 Holding Pond. With the development of treatment facilities within the C-400 Building, the Transfer Line was abandoned in 1957. At that time, effluent from the C-403 Neutralization Tank and the Waste Discard Sump was allowed to discharge to the North-South Diversion Ditch. No spills or releases associated with the transfer line have been documented or are known.

1.4.2.4 C-403 Neutralization Tank (SWMU 40)—Sector 2

The C-403 Neutralization Tank is located at the northeast corner of the C-400 Cleaning Facility. It consists of a 25-ft-square by 26-ft-deep, in-ground, open-top tank constructed of concrete and lined with two layers of acid-proof brick. Influent from the C-400 Building was received from an 8-in.-diameter Duriron acid waste line. The C-403 Neutralization Tank was connected to the C-402 Lime House by a 4-in.-diameter Duriron line.

The C-403 Neutralization Tank was used for the storage and treatment (i.e., neutralization) of acidic uranium-bearing waste solutions generated during cleaning operations in the C-400 Building. The operation of the C-403 Neutralization Tank may have been limited to the period between 1952 and 1957, although effluents from the C-400 Cleaning Facility were discharged to the C-403 Neutralization Tank until 1990. These discharges included primarily

UF_6 cylinder hydrostatic-test water, overflow and runoff from cleaning tanks, and discharge from floor drains.

1.4.2.5 Technetium Storage Tank Area (SWMU 47)—Sector 6

The Technetium Storage Tank was located within a bermed area on a concrete pad outside the C-400 Building, on the west side of the building. The tank was removed in 1986, but the concrete pad and berms are still present.

The 4000-gal storage tank was used in the early 1960s to store a waste solution containing ^{99}Tc and chromium. No spills are known to have occurred from the Technetium Storage Tank.

1.4.2.6 Waste Discard Sump (SWMU 203)—Sector 7

The Waste Discard Sump is a convergence point for effluent from the C-400 Cleaning Facility (primarily from the west side), located at the northwest corner of the building. The unit is a 6-ft-wide x 11-ft-deep concrete pit. The pit includes a 4-ft-diameter x 4.5-ft-deep sump in the floor. The concrete walls of the sump are lined with acid-proof brick. Influent to the system is discharged directly into the sump that empties into the North-South Diversion Ditch.

A pump discharged wastewater through the C-401 Transfer Line (SWMU 26) prior to 1957. Beginning in 1957, a drain in the sump was opened to allow gravity fed discharge through a storm sewer line to the North-South Diversion Ditch. In the 1950s, the Waste Discard Sump handled discharges from a variety of processes performed in the C-400 Building. Many of these discharges were discontinued after 1957. The sump continues to collect effluent from a high-pressure waterjet system on the C-400 Spray Booth and a vacuum pump on the C-400 Lime Precipitation Unit.

1.5 PROJECT SCOPE

The scope of the WAG 6 field effort included conducting a RI at the C-400 Site Evaluation Area and five SWMUs located within the fenced security area at PGDP. The primary focus was to collect sufficient information about surface and subsurface soil and the shallow groundwater of the Upper Continental Recharge System (UCRS) contamination to support an assessment of risks to human health and the environment and the selection of actions to reduce these risks, if required. In addition, contamination in the RGA was characterized during the RI to determine whether contamination in the RGA acts as a secondary source area. The uppermost 50 ft of the McNairy Formation was characterized. All data collected during the WAG 6 RI will be evaluated and incorporated as appropriate in future PGDP remedial action planning documents.

Within this scope, the goals of the WAG 6 RI were to:

- characterize the nature of contaminant source materials;
- define the nature, extent (vertical and lateral), and magnitude of source area contamination in soils and sediments and where groundwater contaminants migrate outside of currently recognized plumes in groundwater;

- identify and define the extent of hot spots of groundwater contamination and migration trends;
- identify areal trends of soil contamination;
- determine the presence, general location, if possible, and magnitude of any dense, non-aqueous phase liquid (DNAPL) zones;
- provide sufficient information associated with the C-400 Area to support a baseline risk assessment for WAG 6, the groundwater OU, and the surface-water OU; and
- gather adequate data to analyze contaminant transport mechanisms and support an FS.

The objectives and goals of the WAG 6 RI are consistent with those established in the FFA and Site Management Plan (SMP) negotiated between DOE, EPA, and the Commonwealth of Kentucky. The FFA requires that PGDP identify, investigate, and remediate all AOCs and SWMUs that could potentially pose a threat to human health and the environment.

1.6 REPORT ORGANIZATION

Section 1 of this report has presented an overview of the regulatory framework under which the WAG 6 RI was conducted and has discussed the ER process at PGDP. This section also discussed current and past activities conducted at PGDP.

Section 2 describes the investigative methods used to sample the various media, the analytical sampling parameters, and the historical waste management practices at each of the nine sectors covered under this investigation.

Section 3 details the physical characteristics of each sector including the topography, surface-water hydrology, geology, and hydrogeology. In addition, a description of the meteorology, ecology, demography, and land use at PGDP is presented.

Section 4 presents the nature and extent of the contamination at each sector as concluded from analyses of the data collected throughout the investigation. The history of contamination as found in previous investigations is also presented.

Section 5 presents the fate and transport of the contamination at each sector. A conceptual site model has been developed in which exposure pathways of potential concern are discussed and contaminant persistence is evaluated. Models of contaminant transport are also presented.

Section 6 presents the results of a baseline human health risk assessment, including results of previous studies, identification of chemicals of concern (COCs), the exposure assessment, the toxicity assessment, the risk characterization, a summary and conclusions, and site-specific remedial action goals. Also included in Section 6 are the results of a baseline ecological risk assessment, including identification of contaminants, receptors, and exposure pathways of concern; any site that poses no risk; any site that may require immediate action; and any site that requires further investigation, as well as the data gaps that must be filled to complete such an investigation.

The final sections (Sections 7 and 8) present the conclusions and references, respectively, of this report.

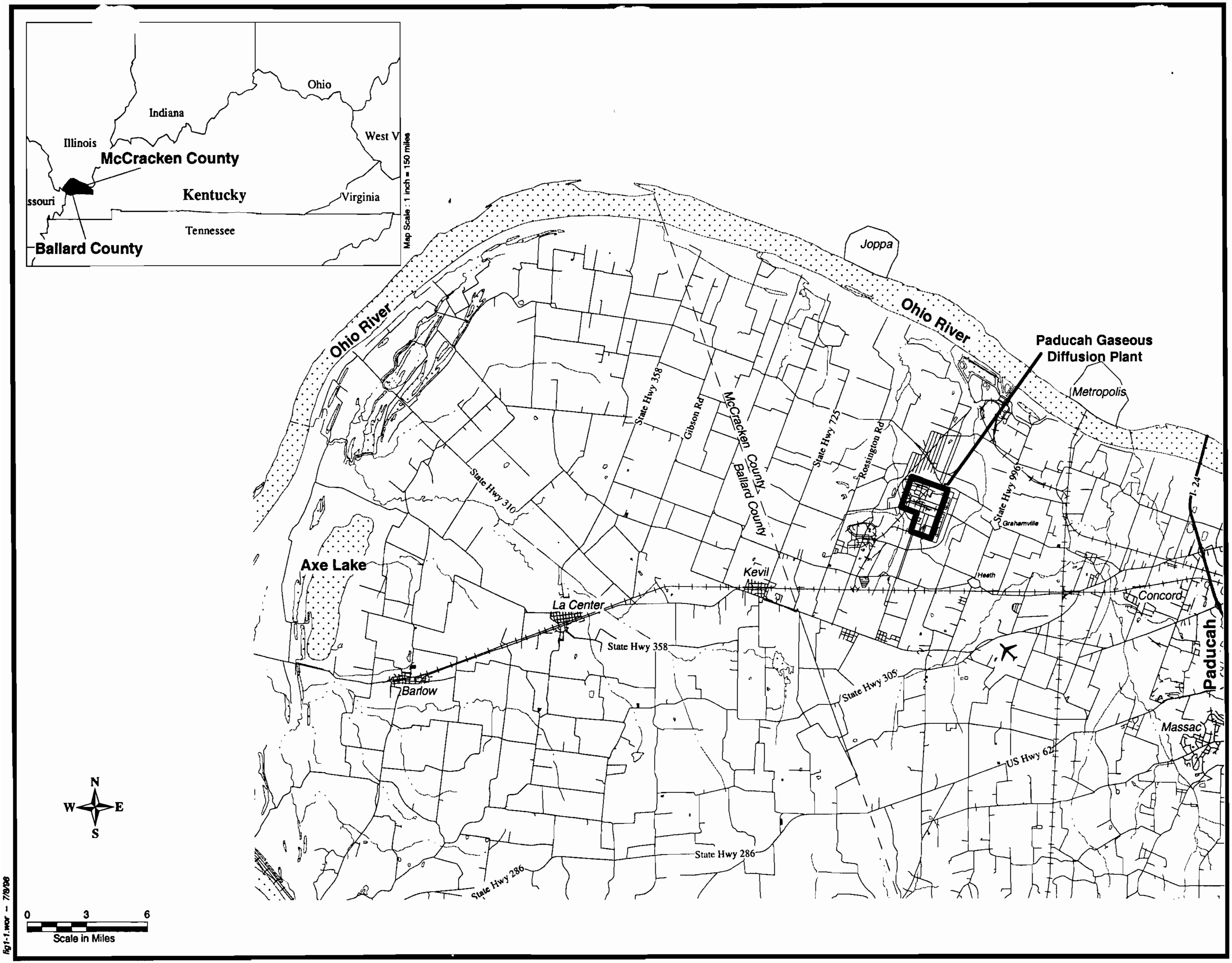

Fig. 1.1. PGDP location map.

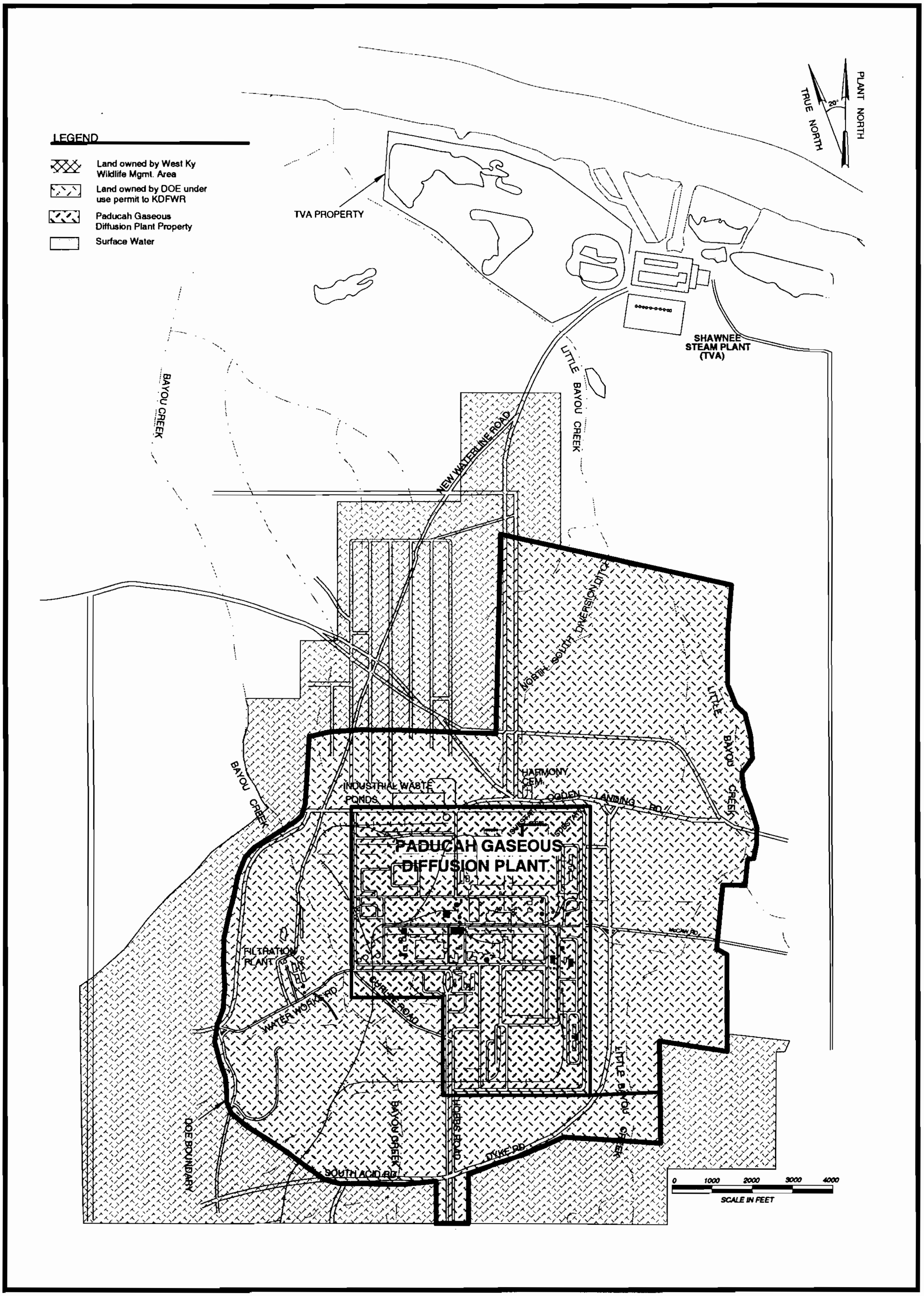

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Fig. 1.2 Current land ownership map.

Table 1.1. SWMUs investigated in WAG 6 RI

Sectors	SWMU	PGDP Facility Number	Description
1	None	C-400	Processing Building
2	40	C-403	Neutralization Tank
3	None	N/A	Area Between SWMU 11 and SWMU 40
4	11	C-400	Trichloroethene Leak Site
5	None	N/A	Area Between SWMU 11 and SWMU 47
6	47	C-400	Technetium Storage Tank Area
7	203	C-400	C-400 Waste Discard System Sump
8	26	C-401	C-400 to C-404 Transfer Line
9	None	N/A	Open Area Northeast of C-400 Building

Notes:
N/A = not applicable

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2.0 FIELD INVESTIGATION

This section presents a description of the field investigation activities and methods used during the WAG 6 RI. Major topics include sampling activities, procedures, and equipment, as well as analyses conducted on the samples.

All sampling at PGDP was conducted in accordance with the medium-specific procedures set forth in the Paducah EMEF Program Procedures Manual. These procedures are consistent with EPA Region IV Standard Operating Procedures (EPA 1991). Table 2.1 is a list of the PGDP procedures that provided guidance for the WAG 6 RI.

2.1 SURFACE SOIL SAMPLING METHODS

The materials and supplies that were used to collect the WAG 6 environmental media samples were screened against DOE-established limits to determine if the items were acceptable for unrestricted or "free release" from the site, or if decontamination was required to remove radioactive contamination before being allowed off-site. All tools and equipment that were used to collect samples of environmental media were considered to be contaminated until a Health and Safety staff member scanned the items for the presence of radioactivity. The results of the radiological screening survey were compared to the Free Release Criteria Values listed in the Paducah Operations Work Instruction P202, found in Appendix A of the *Radiation Protection Program Manual* for WAG 6.

Surface soil samples were collected from the uppermost 1-ft of soil. Surface soil samples were collected in accordance with PGDP Environmental Restoration and Waste Management (ERWM) Field Operating Procedure (FOP) CP4-ER-SAM4201, Surface Soil Sampling. This procedure was revised and replaced with PTSA-4201, Surface Soil Sampling, on December 22, 1997. Surface soil samples were collected by two different methods:(1) a 4-in.-outside diameter (O.D.) stainless-steel bucket hand auger for samples collected by hand and (2) a 2-in.-O.D. stainless-steel spoon for samples collected using a drill rig. Spoon samplers were lined with an acetate sleeve liner.

Before a surface soil sample was collected, plastic sheeting was placed over the sampling location. A hole was then cut through the plastic and the upper 1 to 2 in. of soil was removed to expose fresh material. Samples collected by hand auger for volatile organic analyte (VOA) analyses were immediately placed into the a sample container, which was then sealed, labeled, and placed on ice. Samples collected by split-spoon sampler for VOA analyses were left in the liner, which was then sealed, labeled, and placed on ice. Samples collected for analyses other than VOA were placed into a stainless-steel bowl and mixed thoroughly; a representative composite sample was then prepared in accordance with PTSA-4204, Composite Sample Preparation. After the surface soil samples were containerized, a site safety professional field-scanned the container using a direct-measure radioactivity meter, wiped the container to determine radiation activity, and compared the readings against the free release criteria. A label was then affixed to the container and secured with tape, and the container was placed in a zippered plastic bag. The bags were then packed in ice within coolers and kept at a temperature of 4°C ± 2°C.

A total of 48 surface soil samples were collected during the WAG 6 RI. Table 2.2 indicates the number of surface soil samples collected in each sector during the WAG 6 RI.

2.2 SOIL GAS SAMPLING METHODS

Soil gas samples were collected within the utility bedding corridors. Sampling of the utility bedding soil is discussed in Section 2.4. The soil gas samples were collected according to CP4-ER-SAM9001, Soil Gas Sampling. This procedure was revised and replaced with PTSA-4206-IAD, Soil Gas Sampling, on December 30, 1997. In an effort to avoid penetrating the subject utility, soil gas was collected at a minimum standoff distance from the utility. These minimum standoff distances were assigned by the utility owner, and the actual locations of the utilities were determined by a geophysical survey and as-built utility drawings at each site as a part of the excavation permit process. Soil gas samples were collected at a depth ranging from approximately 3 feet above the utility to the depth of the subject utility. Underground utility lines that were selected for soil gas sampling in the WAG 6 RI ranged in depth from 2 to 17 feet. Soil gas samples were collected using a 2-in.-O.D. screened sampler that was pushed to depth via direct push technology (DPT) rig. At depth, a low-volume vacuum pump was attached to the sampler and, after the sampler volume was evacuated, a soil gas sample was collected in a Tedlar™ bag.

One-hundred-thirty-seven soil gas samples were collected during the WAG 6 RI. Midway through the RI, the integrity of the soil gas sampling system was tested and the system was determined to be leaking. This leak adversely affected the soil gas results. A discussion of this problem is presented in Appendix D. Table 2.3 indicates the number of soil gas samples obtained in each sector during the WAG 6 RI.

2.3 SUBSURFACE SOIL SAMPLING METHODS

Shallow and deep subsurface soil samples were collected during the WAG 6 RI. Subsurface soil samples were collected in accordance with PGDP ERWM FOP CP4-ER-SAM4202, Subsurface Soil Sampling, and EPA Region IV protocol (EPA 1991a). The PGDP procedure was revised and replaced with PTSA-4202, Subsurface Soil Sampling, on June 6, 1997. Two drilling methods were used to collect soil samples in the subsurface: DPT and Rotasonic.

Before sampling was conducted at each site, plastic sheeting was placed on the sampling location and a hole cut through the plastic. Surface debris (e. g., gravel) and the upper 1 to 2 in. of soil were removed to expose fresh material.

DPT Subsurface Soil Sampling Methods. The majority of the shallow subsurface soil samples were collected using a DPT rig. DPT methods significantly minimized the volume of waste soil cuttings generated. Soil samples were collected using a 3-in.-O.D. 5-ft-long Central Mine Equipment (CME)™ continuous sampler fitted with clear acetate liner. The sampler was advanced in 5-ft intervals. Once a 5-ft section of soil was collected in the sampler, the sampler was removed from the subsurface and detached. Before the sampler was opened, the entire sample (with additional focus on the ends) was screened by a site safety professional for volatile organic vapors using a flame ionization detector or a photoionization detector. Problems with organic vapor monitoring of the soil core are discussed in Appendix D. The sampler was also measured for alpha radioactivity emissions and beta/gamma radioactivity emissions.

Soil core intervals with readings greater than 100 units on the organic vapor monitor or greater than 2 times background on the radioactivity meters were collected as samples. If readings exceeding these action levels were not detected, the soil core intervals with the highest readings on the field instrumentation were collected. VOA samples were collected first. VOA samples collected for the fixed-base laboratory consisted of a 6-in. cut section of the acetate liner, which was sealed, labeled, and immediately placed on ice. VOA samples for the Close Support Laboratory (CSL) were collected using a veterinary syringe (with the end cut off) to transfer the soil from the fresh cut end of the liner to a 40-mL vial containing deionized (D.I.) water and hexane. The vial was sealed, labeled, and immediately placed on ice. Subsurface soil samples collected for analyses other than VOA were placed into stainless-steel bowls and mixed thoroughly. This representative composite sample was placed into appropriate sample container(s). These composite samples were prepared in accordance with PGDP Procedure PTSA-4204, Composite Sample Preparation. In most cases, the entire soil core was needed to fill the sample containers, significantly reducing the waste soil cuttings generated during the RI.

After the subsurface soil samples were containerized, a site safety professional field-scanned the container using a direct-measure radioactivity meter, wiped the container to determine radiation activity, and compared the readings against the free release criteria. A label was then affixed to the container and secured with tape, and the container was placed in a zippered plastic bag. The bags were then packed in ice within coolers and kept at a temperature of 4°C ± 2°C.

Rotasonic Subsurface Soil Sampling Methods. Deep subsurface soil samples, as well as some shallow subsurface soil samples, were collected using Rotasonic drill methods. These were collected by pulling the inner drill casing, which contained the soil core, and extruding the core into a plastic bag (sample sock). Before the sample sock was opened, it was punctured at 1-foot intervals and the sample was screened by a site safety professional for volatile organic vapors. The sample was then screened at 2-foot intervals for alpha radioactivity emissions and beta/gamma radioactivity emissions. Soil core intervals with readings greater than action levels or intervals with the highest readings were collected for samples. VOA samples were collected first. For VOA samples collected for the fixed-base laboratory, the sample container was filled, sealed, labeled, and immediately placed on ice. VOA samples collected for the CSL were collected using a veterinary syringe (with the end cut off) to transfer the soil from the soil core to a 40-mL vial containing D.I. water and hexane. The vial was sealed, labeled, and immediately placed on ice. Soil samples collected for analyses other than VOA were mixed thoroughly in stainless steel bowls and the required sample container(s) filled with the composite sample. After the subsurface soil samples were containerized, a site safety professional field-scanned the container using a direct-measure radioactivity meter, wiped the container to determine radiation activity, and compared the readings against the free release criteria. A label was then affixed to the container and secured with tape, and the container was placed in a zippered plastic bag. The bags were then packed in ice within coolers and kept at a temperature of 4°C ± 2°C. Samples for geotechnical analyses were collected in Shelby tubes, which were sealed, labeled, taped, and stored upright.

A total of 496 subsurface soil samples ranging in depth from 1 to 144 feet were collected during the WAG 6 RI. Table 2.4 indicates the number of subsurface soil samples obtained from each hydrogeologic unit within each sector. The various analytical groups tested for in each sector number are listed in Appendix B. Completed lithologic logs are included in Appendix C.

2.4 BOREHOLE GROUNDWATER GRAB SAMPLES

2.4.1 Filtered and Unfiltered Groundwater Sampling Rationale

Groundwater samples collected during the WAG 6 RI were submitted for laboratory analyses in both a filtered and unfiltered condition. This was accomplished by collecting a sufficient volume of groundwater at each sampling point to divide the sample into separate aliquots for analyses. As discussed in Section 4, Nature and Extent of Contamination, for metals the filtered results were primarily used to preclude biased-high results that are inherent to groundwater that percolates through clay-rich soils. Results from both filtered and unfiltered samples for metals were assessed in the baseline risk assessment as discussed in the Section 6 summary and in Volume 3a.

2.4.2 Borehole Groundwater Sampling, Screening and Handling

Collection of borehole groundwater grab samples was attempted when shallow groundwater was encountered (shallower than 50 feet deep) and at 5-ft intervals throughout the entire thickness of the Regional Gravel Aquifer (RGA) and into the upper McNairy Formation. The purpose of these samples was to obtain a vertical profile of groundwater contamination. Three drilling methods were used to collect groundwater grab samples: DPT, Rotasonic, and Dual Wall Reverse Circulation (DWRC).

Fifteen groundwater grab samples were collected from the shallow groundwater (i.e., less than 50 ft deep). Three samples were collected using the DPT drill method. The remaining 12 were collected from piezometers at the conclusion of the field activities. Sampling of the shallow groundwater was performed using a mini-bailer. Because the recharge rate of the shallow groundwater was very slow, purging was not feasible and sufficient water was available only to collect a sample for VOA analysis.

Borehole groundwater grab samples of the deep groundwater (i.e., greater than 50 ft deep) were collected during drilling with Rotasonic and DWRC methods. Rotasonic methods required injection of water to circulate drill cuttings. The water that was injected for circulation was evacuated before the groundwater was purged and sampled. Boreholes drilled by the DWRC method were blown dry prior to purging and sampling.

Purging and sampling were completed using a QED Well Wizard™ bladder pump or a Grundfos™ electric submersible pump with an inflatable packer assembly. The use of a packer assembly ensures that a representative sample is collected from within the subject interval of the boring, eliminates atmospheric exchange, and reduces the purge volume requirements for borings with water columns extending significantly above the top of the sampling interval. The use of these pumps allowed low-flow-rate purging and sampling, which significantly reduces the turbidity of the sample and results in more representative metals concentrations.

Selected water quality parameters including pH, temperature, dissolved oxygen (DO), and specific conductivity were monitored during purging and sampling using a QED™ water quality logger equipped with an in-line flow cell. Purging was discontinued when (1) pH stabilized to within 0.10 units, (2) specific conductivity stabilized to within 10 micromhos per centimeter (mhos/cm), or (3) a minimum of three well volumes had been purged. Occasionally, a well was purged to dryness before the parameters had stabilized. In these cases, the well was then allowed to recharge without additional purging. Early groundwater samples collected using the Rotasonic drilling method showed abnormally high pH values. This problem is discussed in Section 2.8.5.3.

All samples were collected directly into appropriate sample containers from the discharge line of the pump. VOA samples were collected first at a flow rate of approximately 100 mL/min. After the borehole groundwater grab samples were containerized, a site safety professional field-scanned the container using a direct-measure radioactivity meter, wiped the container, and compared the readings against the free release criteria. A label was then affixed to the container and secured with tape, and the container was placed in a zippered plastic bag. The bags were then packed in ice within coolers and kept at a temperature of 4°C ± 2°C.

Two-hundred-twenty-three borehole groundwater grab samples were collected during the WAG 6 RI. Table 2.5 indicates the number of borehole groundwater grab samples collected within each sector during the WAG 6 RI. Completed lithologic logs are included in Appendix C.

2.5 PIEZOMETER AND MONITORING WELL INSTALLATION, DEVELOPMENT, AND SAMPLING

Piezometer Installation. Eighteen piezometers were installed at depths ranging from 32 to 42 feet during the WAG 6 RI. The piezometers were constructed with 1.5-in.-diameter polyvinyl chloride (PVC) well screens and casing. Construction materials were selected in accordance with the requirements and specifications of PGDP Procedure PTSA-4305-IAD, Filter Pack and Screen Selection for Wells and Piezometers. Shallow piezometers were installed using a DPT rig. The purpose of the shallow piezometers was to measure the potentiometric surface of the Upper Continental Recharge System (UCRS) in the WAG 6 area. Water levels were measured weekly for the duration of the field effort. The measurements are presented in Appendix E.

Most piezometers were finished above the ground surface with a 4-in.-square protective steel casing with lockable cover and 1-ft x 1-ft x 6-in.-thick concrete pad. The remaining piezometers, generally located in high traffic areas or on the concrete, were finished below the surface with a flush-mount vault sealed with concrete. Piezometers were surveyed in accordance with the PGDP Procedure PTSA-3013-IAD, Site Surveying.

Monitoring Well Installation. Three monitoring wells were installed at depths from approximately 75 to 85 feet during the WAG 6 RI. Installations were completed in accordance with the requirements and specifications of PGDP Procedure PTSA-4306-IAD, Monitoring Well Installation. The monitoring wells were installed by a driller certified by the Commonwealth of Kentucky. The installations were supervised and monitored by KDEP representatives. Construction materials were selected in accordance with the requirements and specifications of PGDP Procedure PTSA-4305-IAD, Filter Pack and Screen Selection for Wells and Piezometers.

The monitoring wells were constructed with 2-in.-diameter type 316 schedule 5S stainless-steel well screens and casing. Screens had a 6-in.-long sump and were 10 ft in length wire-wound with 0.010-in. slot size. Casings were flush-thread equipped with Viton™ o-rings. Sandpack of commercially available No. 5 quartz sand (compatible with the well screen and formation characteristics) was placed through drill string at least 1 ft below the sump to a minimum of 2 ft above the screen. A 3-ft bentonite seal of 3/8-in.-diameter CETCO Pure Gold™ pellets was placed on top of the sandpack through drill string and hydrated. The remaining annular space was grouted through drill string using CETCO Pure Gold™ bentonite grout (30% solids mixture). Isolation casings were removed during the installation process. Surface settlement of the grout was topped off in 24-hr intervals.

The well was finished above the ground surface with 6-in.-diameter protective steel casing with lockable cover and 4-ft x 4-ft x 8-in.-thick concrete pad. Four seamless Schedule 40, ASTM A53-90 6-in.-diameter steel guard posts were installed surrounding the well and subsequently painted with Occupational Safety and Health Administration (OSHA)-yellow paint. All wells were surveyed and labeled in accordance with the PGDP Procedure PTSA-3013-IAD, Site Surveying.

Monitoring well construction logs are included in Appendix E.

Monitoring Well Development. Newly installed monitoring wells or existing monitoring wells to be sampled were developed by mechanical surge techniques using a surge block and a QED Well Wizard™ bladder pump or a Grundfos™ electric submersible pump. During development, the groundwater quality parameters of pH, specific conductivity, and turbidity were monitored using a QED™ water quality logger equipped with an in-line flow cell. Development continued until (1) pH stabilized to within 0.10 units, (2) specific conductivity stabilized to within 10 mhos/cm, or (3) turbidity stabilized below 10 nephelometric turbidity units. Well development guidance and acceptance criteria were provided in Paducah EMEF Procedure CP4-ER-SRV4004, Monitoring Well Development, which was revised and replaced with PTSA-4308-IAD on December 30, 1997.

After installation and development were completed, a dedicated QED Environmental Systems Well Wizard™ bladder pump, Model T-1200, and Purge Mizer packer assembly were installed in each of the three newly installed monitoring wells. Installation of the pump and packer assembly was performed in preparation for sampling and future groundwater monitoring activities by LMES.

Monitoring well development forms are included in Appendix E.

Groundwater Sampling. Three monitoring wells were installed and sampled, and seven existing monitoring wells were sampled during implementation of the WAG 6 RI. The depths of the samples are presented in Table 2.6. Groundwater sampling was conducted in accordance with the following Paducah EMEF procedures:

- Water Level Measurements—CP4-ER-SAM4301, which was revised and replaced with PTSA-4301-IAD on December 30, 1997
- Monitoring Well Purging—CP4-ER-SAM4302, which was revised and replaced with PTSA-4302-IAD on December 30, 1997
- Field Measurement of Water Temperature—PTSA-4305
- Field Measurement: pH—CP4-ER-SAM4502, which was revised and replaced with PTSA-4502-IAD on December 20, 1997
- Field Measurement: Dissolved Oxygen—CP4-ER-SAM4503, which was revised and replaced with PTSA-4503-IAD on December 30, 1997.
- Field Measurement: Specific Conductance—CP4-ER-SAM4506, which was revised and replaced with PTSA-4506-IAD on December 30, 1997.

- Groundwater Sampling—PTER-2033, which was revised and replaced with PTSA-4303-IAD on December 20, 1997

All monitoring wells were purged before sampling in accordance with Paducah EMEF FOP, CP4-ER-SAM4302, Monitoring Well Purging, which was revised and replaced by PTSA-4302-IAD on December 30, 1997. Selected water quality parameters, including pH, temperature, DO, specific conductivity, and turbidity, were monitored during purging and sampling using a QED™ water quality logger equipped with an in-line flow cell. Purging was discontinued when certain water quality parameters (pH, conductivity, temperature, and turbidity) stabilized in accordance with the requirements of the PGDP procedure or when a minimum of three well volumes had been purged. Occasionally, a well was purged to dryness before the parameters had stabilized. In these cases, the well was then allowed to recharge without additional purging.

All samples were collected directly into the appropriate sample containers from the discharge line of the pump at a flow rate of approximately 100 mL/min. Upon arrival at the CSL, samples collected for dissolved metals were filtered with a 0.45-micron filter. After the groundwater samples were containerized, a site safety professional field-scanned the container using a direct-measure radioactivity meter, wiped the container to determine radiation activity, and compared the readings against the free release criteria. A label was then affixed to the container and secured with tape, and the container was placed in a zippered plastic bag. The bags were then packed in ice within coolers and kept at a temperature of 4°C ± 2°C.

Eight monitoring well (MW) samples were collected during the WAG 6 RI. Table 2.6 summarizes the monitoring well sampling.

2.6 PIPELINE SAMPLING METHODS

Three samples were collected during the excavation of the abandoned C-401 Transfer Line. The abandoned line, located north and northwest of the C-400 Building, conveyed wastewater containing uranium and other radionuclides to the C-404 Holding Pond for settling prior to discharge. A small excavation was dug adjacent to the pipeline at a point where the pipeline from the C-403 Neutralization Tank (SWMU 40) was disconnected from the C-401 Transfer Pipeline (SWMU 26) and a grab sample of the soil was collected. Grab samples (one each) of the sludge from the interior of the pipe and the liquid leaking from the disconnected pipe were also collected.

To sample the pipeline, an excavation that measured approximately 5 ft by 12 ft by 3.5 ft deep was dug using a backhoe. The pipeline was located at a depth of 2 ft. For the sample collection event, a site safety professional continuously monitored for radioactivity and volatile organic vapor emissions. The sampler donned the appropriate personal protective equipment (PPE) and entered the excavation.

The sludge grab sample collected from inside the pipeline was obtained by scraping the material out of the pipe using a stainless-steel spoon and transferring the material to the appropriate container. The soil sample was collected in a similar manner. The liquid leaking from the pipeline was sampled by holding the sample container underneath the drip. The volume of liquid was low and VOA samples were the only ones collected. After the samples were containerized, a site safety professional field-scanned the container using a direct-measure radioactivity meter, wiped the container to determine radiation activity, and compared the readings against the free release criteria. A label was then affixed to the container and secured with tape, and the container was placed in a zippered plastic bag. The bags were then packed in ice within coolers and kept at a temperature of 4°C ± 2°C.

2.7 SUMP SAMPLING METHODS

A water sample was collected from the C-403 Neutralization Tank (SWMU 40), which is a sump located northeast of (and adjacent to) the C-400 Building. The sample was collected at an access man-way located at the north end of the sump. For the sample collection event, a site safety professional continuously monitored for radioactivity and organic vapor emissions. The sampler donned the appropriate PPE, but did not enter the tank.

The samples were obtained by tying a rope to a disposable Teflon™ bailer and lowering the bailer down the man-way. When the bailer was retrieved, the water sample was transferred to the appropriate container. A site safety professional then field-scanned the container using a direct-measure radioactivity meter, wiped the container to determine radiation activity, and compared the readings against the free release criteria. A label was then affixed to the container and secured with tape, and the container was placed in a zippered plastic bag. The bags were then packed in ice within coolers and kept at a temperature of 4°C ± 2°C.

2.8 ANALYTICAL METHODS

During the analytical program for the WAG 6 RI, the following laboratories were used:

- CSL located on-site equipped with a gas chromatograph (GC) for screening soil, soil gas, and groundwater samples;
- CSL located on-site equipped with a gas proportional radioactivity counter for gross alpha and gross beta screening of soil, water, and wipe screens;
- Fixed-Base Laboratory for soil samples (Core Laboratory in Aurora, CO);
- Fixed-Base Laboratory for water samples (used both Lockheed Analytical in Las Vegas, NV, and McDermott Laboratory, a subsidiary of Babcock and Wilcox, in Lynchburg, VA); and
- Fixed-Base Laboratory for geotechnical samples (General Engineering in Charleston, SC).

Previous sampling has allowed the development of a list of contaminants of potential concern associated with WAG 6. CSL screening techniques permitted adequate measurement of contaminant levels while reducing the overall cost of field and analytical services for the WAG 6 RI. In particular, field screening was relied upon to assess the presence of VOA, semivolatile organic analytes (SVOAs), radionuclides, surfactants, and polychlorinated biphenyls (PCB). An on-site GC using SW846 methods (EPA 1986) was used to perform field screening for VOA and SVOA. Immunoassay analytical kits were used for on-site field screening for PCB. An ultra-violet visible spectrophotometer was used for field screening of surfactant. A nuclear spectroscopy analyzer was used to perform field screening for gross alpha, beta, and gamma activities.

In addition, a minimum of 10% of the sample total (by medium), excluding soil gas samples, were split and submitted to an off-site fixed-base laboratory for analysis. These samples provided definitive data to confirm the results from the CSL screens. A separate sample aliquot was collected from each sample interval scheduled for off-site fixed-base laboratory analysis. This sample aliquot was analyzed at the CSL radiochemistry laboratory, where it underwent a radiation screening. A wipe sample also was collected from the exterior of each sample container. The WAG 6 RI sample shipping team determined whether the samples could be shipped off-site for analysis based on wipe samples and radiological screening sample results compared to the U.S. Department of Transportation (DOT) and DOE specified limits.

2.8.1 Close Support Laboratory Methods

A CSL was mobilized to analyze soil gas, soil, and groundwater samples. The samples were analyzed for:

- VOA,
- SVOA,
- Surfactant,
- PCB screening, and
- Gross alpha and gross beta activity.

Equipment. GC analysis was performed using two Hewlett-Packard HP5890 series II GC. Owens-Illinois electrolytic conductivity detectors (Models 4420 and 5200) were used for the assessment of TCE and its degradation products. A Hewlett-Packard Model 5971 mass spectrometry detector was used for assessment of SVOAs. The GC used for SVOA analysis was converted to analyze VOA midway through the RI due to the lack of detected SVOA concentrations in the soil beneath the surface and an increased demand for VOA screening. One GC was used to analyze VOA in soil and the other was used to analyze VOA in water.

Immunoassay analytical kits manufactured by HACH Chemical Company or by Strategic Diagnostics Incorporated were used to assess levels of PCB contamination in soil samples. Surfactant analysis was performed using a Perkin-Elmer ultra-violet visible spectrophotometer.

Gross alpha and gross beta assessments were performed using a Tennelec Series 5 Low Background Gas Proportional Counter.

Methods. Table 2.7 indicates the types of analyses performed in the CSL.

CSL VOA Analysis for Soil Samples (Hexane Extraction). Veterinary syringes (with the ends cut off) were used to transfer soil from the sampling sleeve (soil core) to a 40-mL vial containing D.I. water and hexane. The hexane extracts the VOAs from the soil/water solution. In the laboratory, a syringe was used to sample the hexane layer in the vial. The hexane, along with the VOAs dissolved in it, was injected into the GC for analysis.

CSL Radiological Analysis Procedures. When appropriate for the sample matrix, SW-846 methods were used. When SW-846 methods were not available or not appropriate, other nationally recognized methods such as EPA, DOE, and American Society for Testing and Materials (ASTM) methods were used. The following standardized procedure manuals were used as references for radiological analysis:

- *Prescribed Procedures for Measurement of Radioactivity in Drinking Water*, EPA-600/4-80-032 (EPA 1980);
- *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, SW-846 (EPA 1986);
- Eastern Environmental Radiation Facility, *Radiochemistry Procedures Manual*, EPA 520/ 5-84-006, (EPA 1984); and
- *Environmental Measurements Laboratory Procedures Manual*, HASL-300 (DOE 1982).

Sample Requirements. Table 2.8 indicates the analytical methods and sample requirements for CSL analysis.

2.8.2 Fixed-Base Laboratory Methods

Fixed base laboratory analyses of soil samples were performed by Core Laboratory and fixed-base analyses of water samples were performed by Lockheed Analytical Laboratory and McDermott Laboratory. These laboratories were contracted through the DOE Oak Ridge Sample Management Office (ORO-SMO) and are DOE-approved, Nuclear Regulatory Commission licensed laboratories. SW-846 methods were used for all samples, except those parameters for which other methods are necessary. The analysis followed SW-846 protocols, and "Forms Only" data packages were provided along with electronic data deliverables. Table 2.9 summarizes the analytical methods and sample requirements of the fixed-base laboratories.

2.8.3 Analytical Data Quality

Precision, Accuracy, Representativeness, Completeness, and Comparability. An assessment of the precision, accuracy, representativeness, completeness, and comparability of field measurements and analytical data was performed. The results of this assessment are discussed below.

- **Precision**. "Precision" is defined as the degree of agreement between repeated measurements of one property using the same method or technique. Duplicate samples are collected as a measure of precision of the sample collection and analytical process. For this field program, duplicate samples were collected for all media, at a frequency of 5%.
- **Accuracy**. "Accuracy" is defined as the degree of agreement of a measurement with an accepted reference or true value. Accuracy of laboratory analyses is estimated through the analysis of blank spikes, matrix spikes, or surrogate spikes. These laboratory quality control samples are analyzed as required by the appropriate analytical method.
- **Representativeness**. "Representativeness" is defined as the degree to which data accurately and precisely represent the nature and extent of contamination. The data collected during the RI were both accurate and precise. As indicated in Section 2.8.5, the samples required in the WAG 6 RI Work Plan to define the nature and extent of contamination were in fact collected. Based on these points, it was determined that the data collected during the RI are representative.
- **Completeness**. "Completeness" is defined as a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained. In this

RI, "completeness" refers to the percentage of valid measurements versus the total measurements planned. The Quality Assurance Project Plan (QAPP) specified a completeness objective of 90% for the analyses performed. The WAG 6 RI achieved a completeness of 97%, which means the RI met the completeness objective of greater than 90%.

- **Comparability**. "Comparability" is defined as the degree of confidence with which one data set can be compared to another. Data collected for this investigation were generally collected according to the RI Work Plan and QAPP, and all field changes were approved by LMES. Comparability of VOA analyses is discussed in Sect. 2.8.2.4.

Surveillances. LMES and CH2M HILL conducted surveillances of the field activities and the CSL. Surveillance covered the following areas: CSL activities, sample management activities, log keeping and chain of custody documentation, equipment decontamination, waste management activities, sampling activities, implementation of quality-assured data policies, and well installation and development. Findings identified were corrected by CH2M HILL as requested. The ORO-SMO conducted laboratory surveillance of the fixed-base laboratories.

Data Quality Objectives. Data Quality Objectives (DQOs) are qualitative and quantitative criteria used to establish requirements for sample collection and analysis and are based on the intended uses of the data. The overall intent of DQOs is to generate data of appropriate quality to support the assessment of risks to human health and the environment and the selection of remedial actions. DQOs were documented in the approved WAG 6 RI Work Plan and were implemented as documented in the Field Sampling Plan and QAPP.

CSL Performance. All data generated at the CSL were of sufficient quality to support the project decision-making process. Detection limits are method- and matrix-specific. CSL VOA reporting packages included chromatograms for all samples and standards, chain-of-custody information, raw instrument output, sample and data management logs, complete reports of quality control (QC) samples, copies of laboratory logbooks, and all other supporting documentation and QC. SVOA reporting conformed with standard SW-846 documentation for each analytical batch by date.

Included in the documentation were initial and continuing instrument calibration, performance results, determination of method detection limits, identification and quantification of compounds and analytes detected, and laboratory QC samples. Selected data were conveyed to the Data Coordinator for direct download into the project database. The Project Chemist reviewed results before the data were input to the project database. The following criteria were reviewed to determine acceptability.

- Holding times—Most holding times were met. Samples for which holding times were not met were analyzed by the fixed-base laboratory.
- Initial calibration—Most initial calibrations met acceptance criteria. If the daily initial calibration criteria were not met, the instrument was recalibrated prior to use.
- Continuing calibration checks—Most calibration checks met acceptance criteria. If continuing calibration criteria were not met, the sample was reanalyzed or qualified.
- Method blanks—If target compounds were found in the blank and the associated sample, the sample records were flagged as "estimated." Only a few records were assigned flags for this reason.

- Laboratory duplicates—Most laboratory duplicates were within the acceptance criteria.

In general, all GC data were assessed as usable for their intended purpose (field screening). For SVOA analyses, the majority of matrix spike/matrix spike duplicate (MS/MSD) and associated relative percent difference (RPD) results were within acceptance limits established in SW-846 for the method. Two spiked SVOA samples (047010SA001 and 400076SA015) exhibited poor recovery and precision, indicating possible matrix interference for these samples. For VOA analyses, average soil spike recoveries ranged from 92.9% for vinyl chloride to 110.9% for TCE, and average water spike recoveries ranged from 105.4% for vinyl chloride to 117.4% for TCE. The majority of duplicate VOA results above the quantitation limit were for TCE, and the average RPD for TCE was 7.7% for soil, 12.6% for water, and 7.0% for soil gas. For gross alpha/gross beta determinations, spiked water samples averaged 89.8% recovery for alpha and 100.7% recovery for beta. For duplicate results above the minimum detectable activity, water RPDs averaged 25.7% for alpha and 12.3% for beta, and soil RPDs averaged 30.7% for alpha and 19.51% for beta. For PCB (immunoassay analytical kit) analysis, all duplicate results were non-detects and spiked samples were not required.

Fixed-Base Laboratory Performance. Fixed-base laboratory performance was based on the results of laboratory QC samples, MS/MSD analysis, and adherence to laboratory procedures through data validation. The laboratories are audited annually by the ORO-SMO and are contracted to follow the Analytical Master Specification documents for various analytical chemistry protocols mandated by the ORO-SMO.

No significant data problems were reported for any of the laboratories used during this investigation.

Data Validation. Data validation is a process performed for a data set by a qualified individual independent from sampling, laboratory, project management, or other decision-making personnel for the project. In the data validation process, the laboratory adherence to analytical method requirements is evaluated. Level C data collected for this RI were validated by CDM Federal Programs according to the following procedures:

- EMEF Intersite Procedure ERWM/ER-P2209, Radiochemical Data Verification and Validation, Revision 0
- EMEF Intersite Procedure ERWM/ER-P2210, Volatile and Semivolatile Data Verification and Validation, Revision 0
- EMEF Intersite Procedure ERWM/ER-P2211, Pesticide and PCB Data Verification and Validation, Revision 0
- EMEF Intersite Procedure ERWM/ER-P2212, Inorganic Data Verification and Validation, Revision 0

As part of the data review process, findings were qualified as necessary to reflect data validation results. The following qualifiers were assigned by the data validators:

U	The material was analyzed for, but was not detected. The associated numerical value is the quantitation limit.
J	Estimated value, either because QC criteria were not met or because the amount detected is below the documented quantitation limit

UJ	Undetected, but the number reported as the quantitation limit is an estimated value.
EJ	Estimated value, either because QC criteria were not met or because the amount detected is below the documented quantitation limit.
DJ	Duplicate control limits were exceeded, the number reported as the quantitation limit is an estimated value.
JR	Estimated value and rejected, so data are of "information only" quality and should be supplemented with additional data for decision-making.
R	Rejected, so data are of "information only" quality and should be supplemented with additional data for decision-making.
=	Data were validated; however, no qualifier was added.
?	Data were not validated

Data generated by Core Laboratory, Lockheed Analytical Laboratory, and McDermott Laboratory were independently validated on a 10% frequency. Actual data records indicated that 13% (13,065 data points) of the overall analytical data were validated.

The data validation summary reports indicate that the majority of data quality parameters, including MS/MSD recovery and RPD criteria, for the validated data packages were within established method-specific limits. Although some quality problems with individual samples or analytes were identified in each of validated data packages, the only widespread data quality trend identified was for arsenic, which exhibited some data quality parameter values outside of established acceptance criteria in nearly all of the validated data packages.

Of the overall analytical data, 815 data points (0.8%) were assigned one of the above qualifiers. Only seven individual data points were rejected, and only one rejection was attributable to a problem with chain of custody rather than laboratory analysis. The total number of data points collected and included in these percentages was 103,892.

2.8.4 Data Management

The WAG 6 Project Environmental Measurements System (PEMS) was used to manage field-generated data; import laboratory-generated data; add data qualifiers based on data verification, validation, and assessment; and transfer data to Paducah's Oak Ridge Environmental Information System (Paducah OREIS). PEMS included a tracking system to identify, track, and monitor each sample and associated data from point of collection through final data reporting. The system included field measurements, chain-of-custody information, and a tracking system for tracking hard copy data packages and electronic data deliverables (EDDs). PEMS also included information for field planning and data evaluation.

All data packages and EDDs received from the laboratory were tracked, reviewed, and maintained in a secure environment. When first received, data packages were assigned a document control number and then logged into a tracking system. The following information was tracked: sample delivery group number, date received, document control number, number of samples, sample analyses, receipt of EDDs, and comments.

The data verification processes for laboratory data were implemented for both hard-copy data and EDDs. The data packages were reviewed to confirm that all samples had been analyzed for the requested parameters. Discrepancies were reported to the laboratory and the data validators. As part of a series of internal integrity checks within PEMS, a check was run to identify which of the requested samples and analyses were not received in an EDD. The hard copy was checked to confirm that missing fractions were in fact analyzed for and that the missing fractions from the EDD had been requested from the laboratory. Integrity checks in PEMS were also used to check the list of compounds generated by the laboratory to confirm that data were provided for all requested analytes. Discrepancies were reported to the laboratory and the data validators.

Data verification within PEMS included standardization of analytical methods, chemical names, and units, as well as checks for holding time violations and detections above background values.

Data validated results were imported electronically from the data validators into PEMS. These results included data validation qualifiers.

PEMS system requirements included backups, security, change control, and interfacing with other data management systems. PEMS was housed on the Paducah EMEF network. System backups were performed nightly following standard Paducah EMEF network protocol. Updates made to the files were copied to a computer backup tape each night, and a entire backup was performed each week.

Security of PEMS and data used for the data management effort was considered essential to success of the project. The security protocol followed by the data management team followed that of the Paducah EMEF network. Access to the network is password-protected. Access to PEMS was limited, on an as-needed basis, to the data management and project team. Read-write, graded access to PEMS was limited to the data management team, which consisted of the Project Data Coordinator, the Data Entry Coordinator, the Sample Manager, and the Data Manager. Read-only access to PEMS was granted to other members of the project team, including the Technical Manager.

Sample Location and Identification Number. Each sampling location and sample collected during the WAG 6 RI was assigned a discrete identification number, which consisted of a four-part alpha/numeric sequence. For example:

400-018-WA-095

Each segment of the sequence is used to designate information concerning the location from which a sample was collected, the medium from which it was collected, the nature of the sample, and the depth from which the sample was collected. The first three-digit code is a location definition corresponding to the SWMU from which the sample was collected (or "area" as in the case of the C-400 Site Evaluation Area). For example, "400" would indicate the C-400 Building site-wide study, and "047" would indicate SWMU 47. This code is followed by another three-digit code used to define the boring or location within the SWMU (or area) from which the sample was collected. For example, "018" would indicate the 18th boring drilled in that area. The two-letter sequence is used to indicate the nature of the sample. "N" stands for a quality control sample. An "N" followed by an "E," "A," "T," or "P" means equipment rinsate, ambient, trip blank, or preservative, respectively. Other codes in the third field are: "WA" for water sample and "WD" for a duplicate water sample collected for a single location; "SA" for a soil sample, and "SD" for a duplicate soil sample collected for a single location; and "GA" for a soil gas sample and "GD" for a subsequent soil gas sample collected for a single location. The predetermined three-digit field is used to designate the depth from which the sample was to have been collected. For example, "095" would mean the sample was to have been collected at 95 ft. In conclusion, for the example above, the sample identification code "reads": *within the C-400 Site Evaluation Area, from boring location 18, a water sample was collected at approximately 95 ft bgs.*

2.8.5 Data Assessment

A large volume of data was generated during the WAG 6 RI. With four field teams using three different drilling methods to collect samples and six laboratories involved in sample analysis, the opportunities for problems, inconsistencies, and errors were significant. To confirm that the data set could be used in the decision-making process, the RI team performed various checks and reviews during and after the fieldwork to maintain data consistency and identify problem areas. These checks and reviews included electronic verification and manual assessments by the RI team, as well as third-party validation of fixed-base laboratory data. More than 103,000 records were reviewed during the data assessment.

2.8.5.1 Field Data

Field data consist of data generated by the on-site CSL and measurements taken in the field during a sampling event. For example, measurements taken in the field during a groundwater sampling event included water temperature, specific conductivity, DO, and pH. The CSL measured concentrations of TCE and its degradation products in soil gas, soil, and groundwater; measured surfactant concentrations in groundwater; measured gross alpha and beta radiation in soil and groundwater; and screened samples for PCBs using immunoassay analytical kits.

The field data underwent two reviews: one near the mid-point and a second when field activities were completed. These reviews were conducted primarily as a planning tool (for contingency sampling) and as a means of identifying data entry errors, missing data, and inconsistencies. A hard copy of all the field data entered in the database at the time of the review was printed and reviewed manually by the Bechtel Jacobs Company, LLC project team. Questions and problems were noted and submitted to the RI contractor (CH2M HILL) for resolution and correction. The types of problems found included missing or incorrect sample depths, missing or incorrect data qualifiers, and mis-keyed data. A "sanity check" was also performed, comparing data against expected conditions to assess whether the results "made sense" within the context of the investigation.

2.8.5.2 Fixed-Base Data

The fixed-base data consist of data generated by the off-site laboratories contracted for the project. These laboratories provided analyses of VOAs, SVOA, PCBs, metals, radioisotopes, and soil properties. Ten percent of the fixed-base data was submitted to a third-party subcontractor (CDM Federal Systems) for independent validation of the data quality. The validation included (but was not limited to) review of sample holding times, minimum detection limits, analytical blanks, matrix spikes, laboratory duplicates, surrogates, and instrument calibrations. When appropriate, a qualifier was added to the data. The validation subcontractor submitted a report on each data package when the package was returned to the RI team. The results of the validation were then included in the data set.

2.8.5.3 Final Review

After the last data package was received from the fixed-base laboratory and loaded into the database, a final review and assessment of all the data was completed. This effort included electronic verification, database queries targeting known problem areas, and manual assessment. For manageability, the data set was divided to correspond to the sectors described in Section. 1.

The electronic verification was used to compare the data set against various reference values, specifically holding time exceedances for all analyses and background exceedances for metals and radioisotopes in soils. Data records for all samples that exceeded holding times were flagged with a "T" in the verification field. Data records for all metals and radioisotopes in soils that exceeded established background levels for the site were flagged with an "I" in the verification field.

In conjunction with electronic verification, a set of data assessment queries was developed. These queries were designed to check the internal consistency of the database and to identify all analytes detected, the concentration and distribution of the analytes detected within the volume of soil and groundwater investigated, and the samples that might have been impacted by various problems that are inevitable during the course of a major investigation. The underlying data assessment question consistently asked was "Does this number make sense and what does it mean?"

The first group of data reviewed was from the quality control samples. These included equipment rinsate samples, trip blanks, refrigerator blanks, a comparison of field duplicates, and analysis of the potable water and D.I. water used in drilling and decontamination. Assessment of these samples identified three problem areas:

- Possible incomplete decontamination of sampling and/or analytical equipment
- Possible cross-contamination from VOAs during sample storage
- Possible impacts attributable to the potable water used during drilling

Additional queries were run to identify which environmental samples might have been affected by these problems.

Some of the equipment rinsate samples had detects of analytes that indicated either incomplete decontamination of the sampling equipment and/or possible cross-contamination in the laboratory at the time of analysis. The environmental samples collected the day after the rinsate sample was collected were identified with a collection date query. The samples that were analyzed on the same day as the rinsate sample were identified with an analysis date query. Data records for these samples were then assigned the assessment flag "BH-ER," meaning that the chemical was detected in the associated equipment rinsate and that the result may be biased high due to incomplete decontamination or cross-contamination in the laboratory. Only 15 records in the database were assigned the "BH-ER" flag.

Analysis of refrigerator blanks, which served as trip blanks while samples were stored in on-site refrigerators prior to shipping or on-site analysis, resulted in two blanks with detects of VOAs. These detects indicate either cross-contamination in storage or in the laboratory during analysis. The VOA samples in storage or analyzed on the same day as the two refrigerator blanks were identified. Records for these samples were then assigned the assessment flag "BH-RB," indicating that the chemical was detected in the refrigerator blank and that the result may be biased high due to cross-contamination during storage or in the laboratory during analysis. Sixty-seven records in the database were assigned the "BH-RB" flag.

Holding time exceedances were a problem, particularly during the United Parcel Service strike. All holding time exceedances were identified during the verification process. During the assessment process, the impact of those exceedances was evaluated. Analyses of VOAs and certain metals are sensitive to holding times, whereas most SVOAs, metals, and radioisotopes are less sensitive. Both the analyses to be performed and the length of the holding time exceedance were evaluated to assess the potential impact. Records for those samples judged to be significantly impacted (i.e., the sample holding time was exceeded by 14 days or more) were assigned an assessment flag of "BL-T," meaning that the result may be biased low due to holding time exceedance. A total of 102 records in the database were assigned the "BL-T" flag.

Early groundwater samples collected using the Rotasonic drilling method showed abnormally high pH values. The groundwater from the RGA normally has a pH of around 6.5, but these samples had values above 8.0. Researching the problem revealed that the drilling method requires the addition of potable water while drilling to flush cuttings from the drill pipe and prevent clogging. The potable water used in drilling had a pH of about 8.5. This indicated that, although the pH, temperature, DO, and specific conductivity had stabilized as measured in the flow cell, the material being sampled was not groundwater but a groundwater-potable water mixture. Direction was provided to the field crews with the Rotasonic rig to use a stabilized pH of 6.5 or less as an indicator of sufficient purging prior to sampling. During assessment, data records for all groundwater samples with a pH greater than 6.5 and collected with the Rotasonic rig were assigned one of two assessment flags:

- VOA records were assigned a "BL-Purge" flag, indicating that these values were biased low due to dilution with potable water.
- Metals records were assigned a "BH-Purge" flag, indicating that these values were biased high due to possible added metals from the potable water.

The "BL-Purge" flag was assigned to 992 records, and the "BH-Purge" flag was assigned to 115 records.

In assessing outliers and questionable results, two types of cross-contamination were identified: field-introduced and laboratory-introduced. The field contamination consisted of particles of the acetate sampling sleeve used by the direct push rigs being incorporated into the sample when the sleeve was cut before the sample was placed into the appropriate bottle. An assessment flag of "BH-SS" was assigned to all vinyl acetate records in soil samples collected using the direct push rigs to indicate that values for this chemical may be biased high due to contamination from the sample sleeve. This flag is appropriate since vinyl acetate was not used in the WAG 6 area. Six records were assigned the "BH-SS" flag.

The second group of contaminants, those introduced in the laboratory, consist of chemicals that are used in sample preparation or equipment cleaning and appear frequently in sample results. Laboratory contaminants were identified using protocol set forth in the U.S. EPA National Functional Guidelines for Organic Compounds. This protocol is based on a comparison of field or method blanks to environmental results. In the WAG 6 data set, these chemicals included methylene chloride, carbon disulfide, acetone, bis (2-ethylhexyl) phthalate, di-n-butyl phthalate, and butyl benzyl phthalate. Records for these chemicals were assigned the assessment flag "IN-Lab," indicating that they are due to laboratory contamination and to be used for information only. A total of 616 records in the database were assigned this flag.

The "R-C" assessment flag was used to reject data that did not pass the "sanity check" such as chemicals that have not been used on-site or results that made no sense, e. g., if the dissolved concentration of a metal in groundwater exceeded the total concentration of the metal in the same sample. If this exceedance was greater than 10%, the dissolved metal result was considered questionable. Forty-eight records in the database were assigned the "R-C" flag.

Two additional assessment flags, dealing with radioisotopes, were used on the WAG 6 RI. The first is "U-Rad," indicating that the reported result is considered a non-detect. This flag was applied at the time the laboratory data were entered and is based on the following premise: if the result is so low that the instrument measurement error bar is greater than or equal to the reported result, the result should be considered a non-detect. A total of 2,769 records in the database were assigned this flag. The second assessment flag, "IN-Norad," is specific to the calculation of the percent of ^{235}U contained in the sample. Although there was usually a small amount of total uranium present in every sample, measurable ^{235}U was not common. The radiological laboratory reported a value for ^{235}U equal to the method detection limit. This number was used in the calculation of the percent ^{235}U, yielding an abnormally high result. These records were assigned the "IN-Norad" flag, meaning they were defined as unusable. A total of 369 records were assigned this flag.

2.8.5.4 Comparison of TCE Results in Soils Analyzed Using Hexane Extraction vs Conventional Methods

The WAG 6 RI is the first major investigation at PGDP to use hexane extraction for analysis of chlorinated solvents in soils. The methodology had been refined on smaller projects, most notably in support of the LASAGNA technology demonstration, and incorporated in the PGDP subsurface soil sampling Procedure PTSA-4202. The method is relatively new, and most fixed-base laboratories are not equipped to use it. In the WAG 6 RI, samples were analyzed at the CSL using hexane extraction, while a section of sample sleeve was sent to the fixed-base laboratory for more conventional analysis. As results were received from the fixed-base laboratory and compared with the CSL results, it became obvious that the results of the two methods were not directly comparable. Fig. 2.1 shows a comparison of the field and fixed laboratory results. A line representing a one-to-one match extends from lower left to upper right on the graph. Points that fall above and to the left of the line represent samples for which the fixed-base laboratory reported higher TCE results than the CSL. Those points that fall below and to the right of the line represent samples for which the CSL reported results higher than the fixed-base laboratory. As the graph indicates, the CSL always returned higher values than the fixed-base laboratory. On average, the CSL reported TCE values nearly 500 times greater than those reported by the fixed-base laboratory. In general, as TCE concentrations increased, the difference in the two results decreased.

To provide a validity check on the CSL data, eight samples were sent to the Lockheed Martin (K-25) Laboratory in Oak Ridge. This fixed-base laboratory had the capability to run the hexane extraction samples. Fig. 2.2 shows a comparison of the results from the CSL and the Oak Ridge K-25 Laboratory. As shown by this comparison, there was generally good agreement between the two sets of results, although slight differences can be attributed to the differences in analytical equipment. The K-25 data yielded results an average of three times greater than those from the CSL.

This comparison demonstrates the effectiveness of using hexane extraction for chlorinated solvents in soil. This method, however, does have three disadvantages:

- The method detection limit is 1 mg/kg or 1 ppm; at WAG 6, the hexane extraction method detected TCE three times when the fixed-base laboratory had a non-detect.
- At TCE levels below the hexane method detection limit, the fixed-base laboratory detected TCE in 76 samples.
- The hexane method masks other VOAs.

2.8.6 Field Quality Control Procedures

Field QC Samples. EPA, DOE, the Commonwealth of Kentucky, and PGDP procedures require that field QC samples be collected to assess data quality. The QC samples collected and analyzed included:

- Equipment rinsates;
- source blanks (water supply samples);
- trip blanks; and
- duplicate samples.

Equipment Rinsates. Equipment rinsates were collected at a frequency of 1 in 10 samples. Appendix J provides the data from the equipment rinsate samples. A total of 53 equipment rinsates were collected during the project.

Water Supply Samples. Source blanks of potable water and D.I. water used for equipment decontamination were collected at a frequency of one sample per water supply. Two water supply samples were collected during the project.

Trip Blanks. Trip blanks were collected at a frequency of one sample per cooler containing samples for VOA analysis. A total of 149 trip blanks were analyzed during the project. Appendix J provides the results of the trip blank samples.

Duplicate Samples. Split samples were collected as field duplicates and sent to the fixed-base laboratory for analysis. Eight soil gas, 22 soil, and 11 water duplicate samples were collected during the project. Appendix J provides the results of the duplicate samples.

2.9 CIVIL SURVEY

An extensive civil surveying effort was required to assure the safety of personnel working on the WAG 6 RI. For example, the exact location of the sampling point was necessary to prevent penetrating the vast network of underground utilities in the immediate WAG 6 area. Each sampling location was surveyed and an exhaustive excavation permit process was conducted. On numerous occasions, the sampling point was relocated and then surveyed again. No underground utilities were penetrated during the WAG 6 RI field activities. Upon completion of the activities associated with the sampling points, soil borings, piezometers, and groundwater monitoring wells, a final survey of the location and elevation was conducted.

The surveying was conducted in accordance with the Paducah EMEF Procedure PTSA 3013 IAD, Site Surveying. However, this procedure was deleted on December 30, 1997 and replaced with engineering specifications. The civil survey was performed by a registered and licensed surveyor of the Commonwealth of Kentucky.

Site locations were surveyed on the Kentucky State Plane Coordinate System and the PGDP Plane Coordinate System. Benchmarks and reference points were supplied by the Bechtel Jacobs Company, LLC Civil Engineering Department.

Grid coordinates were measured to an accuracy of plus or minus 0.01 ft and tied to the U.S. Geological Survey National Geodetic Vertical Datum of 1929 or the North American Datum of 1983. Elevations were measured to a hundredth (0.01) of a foot. Surveying field activities were documented in field logbooks for archiving. The civil survey data are included in Appendix F.

2.10 SURFACE AND BOREHOLE GEOPHYSICAL SURVEYS

Surface Geophysical Surveys. As noted previously, the WAG 6 area includes a vast network of underground utilities. Penetration of these utilities during the intrusive sampling activities was a primary concern at the beginning of the effort. Therefore, an extensive excavation permit process, which included a geophysical survey, was conducted at each sampling point prior to intrusive sampling. The geophysical surveys were conducted in a 20- by 20-foot area surrounding the proposed sampling points. The other elements of the permit process consisted of measuring to the proposed drill location by PGDP coordinates, reviewing the existing PGDP utility drawings, measuring to underground utilities which are known to exist, performing a geophysical survey, and interviewing employees with extensive site knowledge.

The geophysical investigation was designed to measure the conductive, magnetic, and dielectric properties of subsurface materials in the vicinity of the intrusive sampling and the nearby utility corridors. The geophysical investigation was conducted using a Geonics G-858G Cesium Vapor Magnetometer/Gradiometer, EM-31 electromagnetic conductivity meter, and GeoRadar 1000B Stepped-FM Ground Penetrating Radar System (GR-1000B).

Typically, one or more of the geophysical instruments detected the location of an underground utility expected to be present. Each site was unique and no single instrument was adequate to confirm the presence or absence of underground utilities. Underground utilities, which are shown on the as-built drawings and were detected by the instruments, were marked on the ground with spray paint. At some locations, however, the geophysical data were inconclusive and the utilities could not be located with a high level of confidence. Examples of these sites include reinforced steel bar in concrete, overhead power lines, and underground utility lines constructed with materials such as transite, concrete, or polyvinyl chloride (PVC). In these instances, the problems were noted in the logbook and the underground utilities were located using the as-built drawings.

Whenever necessary, sampling points were relocated based on a review of the pertinent information, such as the as-built drawings, the utility markings on the ground from the geophysical study, and site appurtenances (overhead power lines, buildings, roads, etc.). Some sampling points were relocated because sampling activities could not be conducted due to plant operation activities. In most cases whenever a sampling point was relocated, the permit process–including a geophysical survey–started again at the relocated point. At some locations, however, an excavation permit existed and a geophysical survey was not required.

More than 215 intrusive samples were collected during the WAG 6 RI, and no penetrations of underground utility lines occurred. Geophysical investigation activities at each sampling point were documented in field logbooks.

Borehole Geophysical Surveys. Borehole geophysical logging of natural gamma count and neutron porosity was conducted inside the drill string at each RGA and McNairy location. The logging was conducted in accordance with PGDP Procedure PTSA-3010-IAD, Geophysical Logging.

Geophysical logging was conducted in 27 boreholes. Problems with the logging instrumentation are discussed in Appendix D. A vertical deviation log was performed in 2 of the borings, 400-040 and 400-041, which were drilled on an angle beneath the C-400 Building. The vertical deviation logs provided true vertical depth and adjusted coordinates for sampling locations beneath the building. Copies of the geophysical logs are included in Appendix G.

2.11 HEALTH AND SAFETY MONITORING

To protect the health and safety of personnel during field activities, full-time site safety professionals were assigned to observe, monitor, direct, and document each activity. In addition, a Radiation Protection Program (RPP) was developed, approved, and implemented prior to the start of field activities. All of the site safety professionals were trained and accredited as radiation control technicians, as required by the RPP, prior to start of site monitoring activities.

Numerous types of monitoring were performed. Monitoring included continuous observation of the work site for safety hazards, biological hazards, and the parameters listed in Table 2.10 using real-time instruments.

Work Area Monitoring. Many of the drilling and sampling locations for the WAG 6 RI were within the boundaries of known areas of surface radiation contamination. Before field activities began, an initial site radiation survey was performed covering a 60- x 60-ft area around the point of sampling or drilling. This area was scanned with the ESP-2 and Vic450P. The surveys were conducted in accordance with the CH2M HILL Radiation Protection Plan screening procedures. Data were recorded on Form RP-301.1, "Special Purpose/Routine Radiological Survey Results." The purpose of the survey was to ensure that the members of the sampling crew and the equipment were properly protected and to ensure that surface contamination, if present, was properly managed. All radiation abnormalities were reported immediately to the EMEF Health Physics Department and the project construction engineer.

Once the site had been thoroughly scanned for radiation and proper actions had been taken to protect workers from site hazards, equipment was moved in and work zones (with barriers) were established. These zones included an outer construction zone and an inner exclusion zone. The exclusion zone was a strictly controlled area. Every person or item that passed into this zone was considered contaminated and could not be removed until fully scanned for radiation. This was accomplished by discrete measurements with the Ludlum 2224 and smear counting using the Ludlum 2929. Site safety professionals were trained on proper operation of the equipment and guidelines used for releasing equipment and personnel from the zones in accordance with the CH2M HILL Radiation Protection Program.

Once the ground surface was broken at a work site, air was continuously monitored with direct read instruments until field activities were completed. Tools and equipment in direct contact with soil were presumed to be contaminated until they were measured and were therefore smeared before they were cleared. If levels were above the release limits, the material was bagged and properly tagged. The bagged material was then surveyed again to confirm that levels were below the release limits. The material was then moved to a designated area until it could be properly decontaminated. Instrument readings were recorded in the health and safety logbook by a site safety professional. Typically, readings were recorded from soil cuttings created during the drilling operations, air space monitoring at the drilling location, smears and direct measurements, and readings that met or exceeded the project action levels specified in the Health and Safety Plan.

Work area monitoring was also performed to prevent overexposure to temperature extremes. On-site ambient temperature was measured and discussed on a daily basis. Cold stress monitoring of personnel was conducted in the work area by a site safety professional. This monitoring included close scrutiny of personnel behavior, obvious signs of overexertion, and heart rates of exposed personnel. Heart rate checks were performed periodically during each exposure period. These data were recorded in the site safety professionals' logbook.

Excessive noise was surveyed at each source of elevated noise. These included drill rigs, pressure washing equipment, generators, and other items equipped with combustion engines. Sound level monitoring data were recorded on a Sound Level Survey Form. Sound level surveys were performed with a Quest Model 2700 sound level meter at each source of elevated noise. Working conditions in the vicinity of this equipment were checked at regular intervals to confirm that the site was properly delineated with hearing conservation signs and to reassess the use of proper PPE. Hearing protection was required at any levels equal to or above 85 decibels.

Employee Biological Monitoring. All personnel who were required to enter a zone of potential contamination were required to participate in the LMES Biological Monitoring Program. As part of this program, personnel wore TLD badges to track possible radiation exposure; in addition, monthly urinalysis was conducted to document radiological ion uptake. The 29 CFR 1910.120 requirements were used for training and biological monitoring of WAG 6 field employees, including a physical examination consisting of blood analysis, audiometric testing, respiratory testing, and cardiopulmonary testing.

Upon arrival at the project site and before any participation in site work, employees were issued a TLD by LMES Health Physics Department personnel and provided a urine sample to establish a baseline. The TLDs were exchanged and analyzed on a quarterly basis. The internal dose evaluation was performed each month and at the end of project participation.

2.12 DECONTAMINATION PRACTICES

All heavy equipment, drill rigs, and other large drilling-related equipment such as drill rods, casing, liners, and bits were steam-cleaned on the C-752-C Decontamination Pad. Decontamination of drilling-related equipment was conducted in accordance with PGDP EMEF Procedure CP4-ER-DCN4002, Decontamination of Drilling-Related Equipment. This procedure was deleted on December 30, 1997 and replaced with PTSA-5001-IAD.

The drilling equipment was thoroughly steam cleaned and rinsed, then allowed to air dry. After decontamination, the drill rod and flights were wrapped in plastic and placed on the drill rig prior to transport back to the site. The wastewater generated during the decontamination process was allowed to collect in a sump before being pumped into a 3,000-gal holding tank located at the decontamination (decon) pad. The decon pad was operated in accordance with Paducah EMEF Procedure PTSA-5003, Operation of the C-752-C Decontamination Pad.

The sampling equipment, including all stainless-steel field sampling equipment such as spatulas, spoons, knives, and bowls, was decontaminated in accordance with Paducah EMEF Procedure PTER-2034, Decontamination of Field Equipment. This procedure was deleted on December 30, 1997, and replaced by PTSA-5002-IAD. The decontamination process occurred in the following order:

- Steam cleaned,
- rinsed with potable water,
- washed and scrubbed with phosphate-free detergent and water,
- rinsed with clean tap water,
- rinsed with D.I. water,
- double-rinsed with isopropanol,
- air-dried, and
- wrapped in aluminum foil.

2.13 WASTE HANDLING PRACTICES

The following Paducah EMEF waste management procedures were used during the RI:

- CP4-ER-SAM4601, Drum and Special Container Staging and Sampling

- CP4-ER-SAM4602, Manual Drum Opening, which was deleted and replaced with PTWM-5501-IAD, Opening Containerized Waste

- CP4-ER-WM2001, Handling of Investigation-Derived Waste, which was replaced with PMWM-1002-IAD, On-Site Handling and Disposal of Waste Materials

A variety of potentially contaminated and non-contaminated wastes were generated during the RI activities. All wastes generated as a result of field-related investigative activities had the potential to contain contaminants related to past practices. These investigative techniques resulted in the generation of investigation-derived waste (IDW) that required proper containers, storage, and disposal.

Soil Cuttings and Drilling Mud. Shallow soil borings drilled via DPT generated subsurface soil cuttings, all of which were placed in appropriately labeled drums and managed according to applicable regulations and PGDP procedures.

RGA/McNairy borings drilled via dual wall reverse circulation or Rotasonic methods generated a mixture of soil cuttings and drilling water. This mixture was collected in 1,000-gal mobile tanks and transported to the C-752-C Building for separation. The mixture was separated into solids and liquids using one or more of the following methods: natural gravity settling of solids, separation by the addition of various polymers to aid flocculation, and physical separation via centrifuge. The solids (soils) were placed in appropriately labeled drums and sufficient quantities of absorbent media were added to prevent future separation of liquids from the solids. The drums were managed according to applicable regulations and PGDP procedures. The liquids (water)were transferred to decontamination rinsate storage for proper disposal.

Many of the borings were drilled on concrete pads where the surface of the concrete was contaminated with radioactivity. For these borings, the concrete was cored and the plug of concrete was placed into appropriately labeled drums and managed according to applicable regulations and PGDP procedures.

A total of 322 drums of soil were generated during the WAG 6 RI.

Well Development, Drilling Water, Decontamination Rinsate, and Purge Water. Water generated from monitoring well development, purging, and sampling was placed into 1,000-gal mobile tanks and evaluated against field screening data. If the water was found to be acceptable, it was transferred to the decontamination rinsate storage area for proper disposal.

Decontamination rinsate was generated from the cleaning of drilling and sampling equipment. Water from decontamination activities was collected in sumps located at the C-752-C decontamination pad. Some solids (soils) separated and were left in the sump for subsequent transfer to appropriately labeled drums. Water collected during other activities, such as well drilling, development, or purging, was mixed with the decontamination rinsate. The collected water was treated for total suspended solids, if necessary, using one or more of the following methods: natural gravity settling of solids, separation by the addition of various polymers to aid flocculation, and physical separation via centrifuge.

Wastewater, mixed with solvents, generated from the decontamination of laboratory equipment was collected in 55-gal drums and temporarily stored at the CSL.

In general, water generated from this project, except water generated at the laboratory, was transferred to a dedicated stationary tank (approximately 3,000-gal capacity). When the tank was near capacity, a set of water samples was collected and analyzed for PCBs. PCBs were not detected in any of the samples and the water was transferred to a large water tank (approximately 20,000-gal capacity). Once this tank was near capacity, a set of water samples was collected and analyzed for the list of analytes required by the KPDES Outfall Permit. When the results were approved by the PGDP Waste Management Coordinator, the water was transported to the KPDES 001 Outfall for discharge.

A total of 58,000 gallons of wastewater were generated and disposed of during the WAG 6 RI.

Personal Protective Equipment and Dirty Plastic. Modified Level D was the highest level of PPE worn, as required by the WAG 6 RI Health and Safety Plan (HASP). Before exiting an exclusion zone, personnel doffed and containerized all disposable PPE. This PPE was considered the same waste classification as the materials with which it had come into contact. Dirty plastic also was generated during the activities. During mobilization from the sampling sites and during the decontamination process, plastic was collected and placed in labeled containers. The dirty plastic was also considered the same waste classification as the materials with which it had come into contact.

In accordance with field screening information and laboratory results, PPE and dirty plastic determined to be contaminated was placed into appropriately labeled drums and managed according to applicable regulations and PGDP protocol. PPE and dirty plastic determined to be non-contaminated were placed into appropriately labeled bags and transferred into a roll-off container.

Fifty drums of PPE and 1 roll-off container of clean PPE were generated during the WAG 6 RI.

CSL Wastes. Used sample containers (glass and plastic), PPE, soil, and wastewater were generated at the CSL. The PPE and soil were combined with PPE and soil generated during the field activities. Used glass and used plastic containers were separated and managed as contaminated material. Wastewater generated at the CSL was collected and managed as RCRA waste. The wastewater was temporarily stored at a Satellite Accumulation Area (SAA) set up at the CSL.

Six drums of used glass containers, 8 drums of used plastic containers, and 6 drums of RCRA wastewater were generated at the CSL during the WAG 6 RI.

Non-contaminated IDW. PGDP has implemented waste management activities for the segregation of all clean trash (i.e., trash that is not chemically or radiologically contaminated), such as office paper, aluminum cans, glass bottles not used to store potentially hazardous chemicals, aluminum foil, and food items. During this RI, all clean trash was segregated according to PGDP guidelines and then collected and placed into a dumpster located at the C-755 area for subsequent delivery to the landfill as sanitary waste. Approval for off-site disposal of clean trash was granted by the Off-Site Waste Release (OSWR) Board prior to waste generation.

IDW Forms. Request for Disposal (RFD) forms and Waste Item Container log sheets were completed as the waste was generated at the work site. PGDP supplied RFD forms as needed. Completed forms were delivered to the PGDP EMEF Waste Disposal Coordinator for approval. Waste Item Container log sheets were completed for each applicable waste container that was removed from the work site. The PGDP Waste Item Container log sheets are used to document each addition of waste to a particular container.

IDW Labeling. IDW containers were carefully labeled or marked to ensure proper management of the wastes as outlined in PGDP EMEF Procedure CP4-ER-WM2001, Handling of Investigation-Derived Wastes.

IDW Storage. General Storage Areas (GSAs) and SAAs were established as necessary. The GSAs and SAAs were set up, inspected, and maintained in accordance with PGDP Procedure PMWM-1002.

Once the waste was accepted by the PGDP EMEF Waste Disposal Coordinator, the drums were transported to the C-752-A Building and the C-746-H3 Environmental Restoration Waste Storage Pads. These areas were available for the storage of non-hazardous waste, with no storage time limitation. The C-746-H3 storage pad was also available for the storage of hazardous waste for less than 90 days.

Types of containers. Solid waste was containerized in 55-gal drums with a minimum rating of DOT 1A2/X 400/S or approved equals that were lined with a minimum 12-mil-thick plastic liner and absorbent pad. Liquid IDW was transported in 1,000-gal mobile tanks and was transferred into 1,000-gal portable tanks, 2,500- or 3,000-gal stationary tanks, or the large 20,000-gal tank located at C-752-C.

IDW Characterization, Sampling, and Analysis. Unless wastes had been previously characterized using process knowledge, wastes generated from sites designated as potentially contaminated were sampled and analyzed to characterize and classify them for proper laboratory handling, record keeping, transfer, storage, and disposal. Waste analyses were performed using EPA-approved procedures as applicable. Analysis required for hazardous waste classification was performed in accordance with EPA SW-846 (1986). Wastewater analysis was performed in accordance with Clean Water Act and/or Safe Drinking Water Act procedures.

2.14 DOCUMENTATION

Field documentation was maintained throughout the RI in various types of documents and formats, including field logbooks, field change requests, and lithologic logs.

Field Logbooks. Field team personnel used bound field logbooks with sequentially numbered pages to maintain field records and to document information pertinent to field activities. Information in the field logbooks obtained from site exploration, observation, and sampling activities were recorded by a designated field team member. Field documentation was in accordance with LMES guidance as detailed in the Paducah EMEF Procedure CP4-ER-A1101, Site and Field Logbook Content and Control. This procedure was revised and replaced on December 30, 1997. The new procedure, PMSA-1201-IAD, Site and Field Logbooks, was implemented. Logbooks were maintained by the following to document each day's field activities:

- Field Team Leader
- Site Safety Coordinator
- Sample Coordinator
- Data Coordinator
- Waste Coordinator
- QA/QC Manager
- Field Geologist
- Site Health and Safety Officer
- Laboratory Manager
- Close Support Radiological Laboratory
- Close Support Gas Chromatography Laboratory

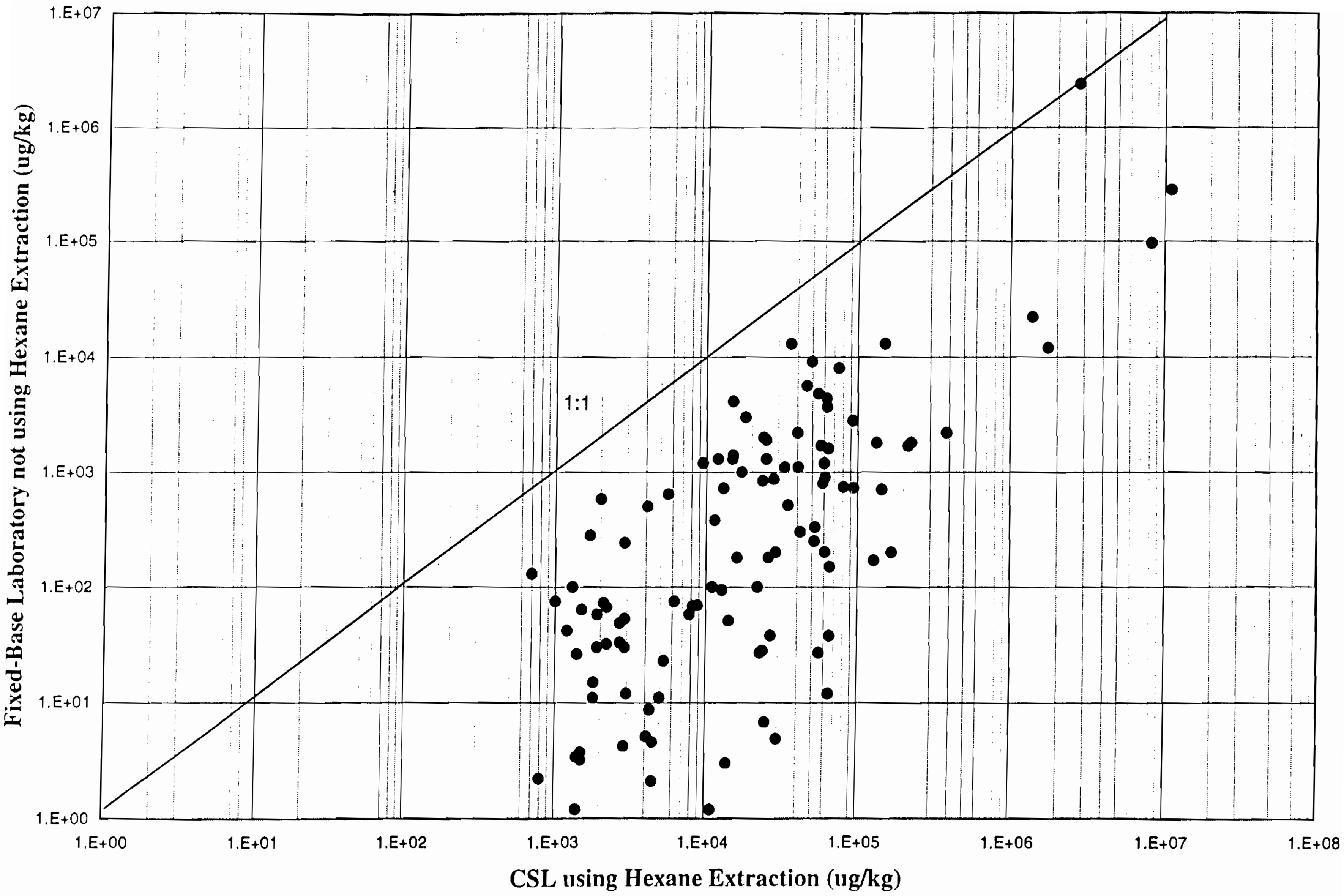


Fig. 2.1. TCE in soil - CSL vs. fixed-base.

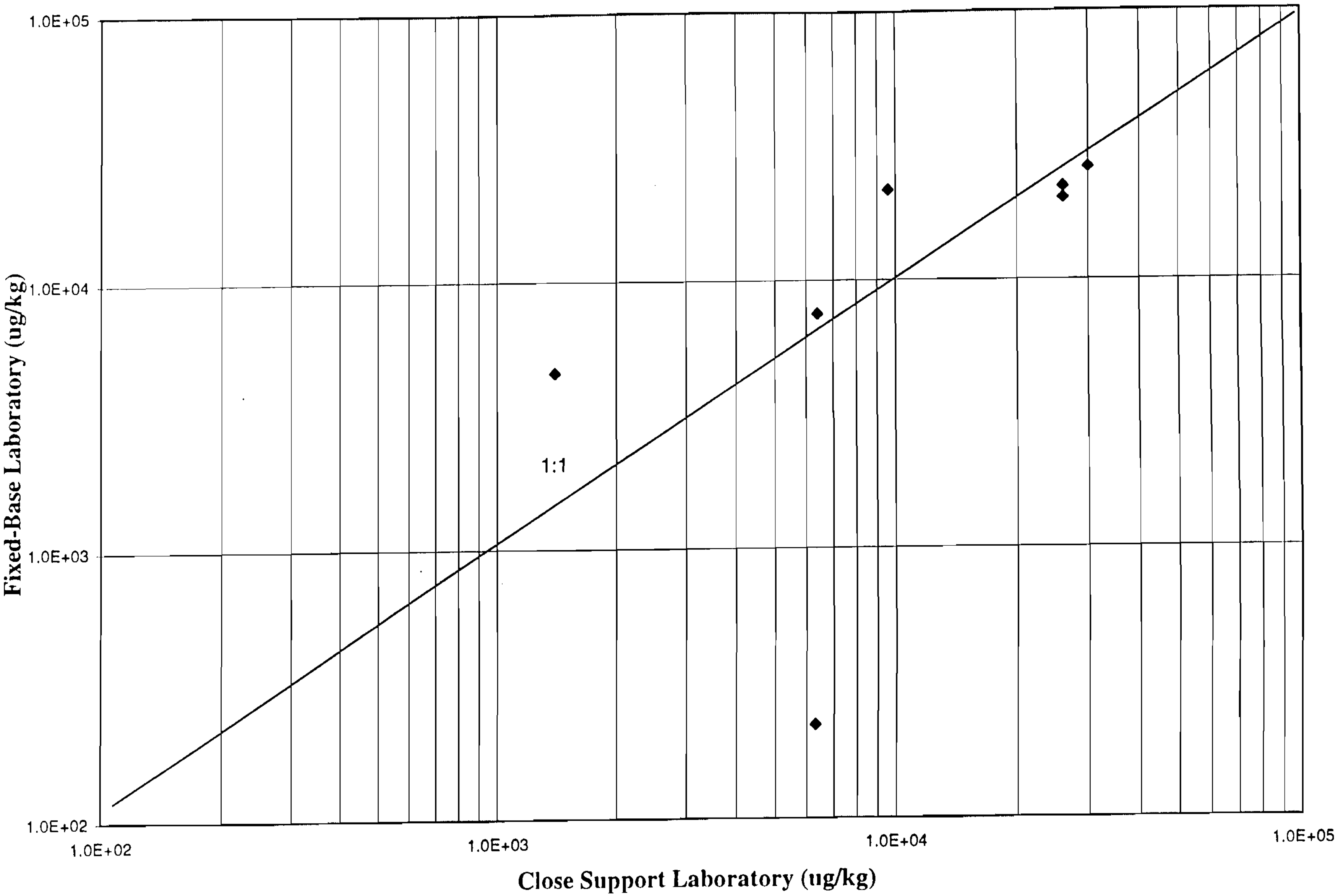


Fig. 2.2. TCE in soil - CSL hexane vs fixed-base hexane.

Table 2.1. Paducah EMEF program procedures

Procedure No.	Procedure Title
CP4-ER-A1101	Site and Field Logbook Content and Control
CP4-ER-A1103	Lithologic Logging
CP4-ER-SAM4201	Surface Soil Sampling
CP4-ER-SAM4202	Subsurface Soil Sampling
CP4-ER-SAM4204	Composite Sample Preparation
CP4-ER-SAM4301	Water Level Measurements
CP4-ER-SAM4302	Monitoring Well Purging
PTER-2033	Groundwater Sampling
CP4-ER-SRV4001	Monitoring Well Filter Pack and Screen Selection
CP4-ER-SRV4002	Monitoring Well Installation
CP4-ER-SRV4004	Monitoring Well Development
CP4-ER-SAM4501	Field Measurement: Temperature
CP4-ER-SAM4502	Field Measurement: pH
CP4-ER-SAM4503	Field Measurement: Dissolved Oxygen
CP4-ER-SAM4506	Field Measurement: Specific Conductance
PTER-2029	Field Gas Chromatography
CP4-ER-SAM4601	Drum and Special Container Staging and Sampling
CP4-ER-SAM4602	Manual Drum Opening
CP4-ER-SAM4603	Drum and Special Waste Handling
CP4-ER-WM2001	Handling of Investigation-Derived Waste
PTER-2031	Sample Identification
PTER-2036	Sample Chain-of-Custody
PTER-2035	Sample Packaging and Shipment
PTER-2032	Sample Preservation, Container Selection, and Determination of Holding Times
CP4-ER-SAM2005	Wipe Sample Collection
CP4-ER-Q4001	Preparation of Field Quality Control Samples
CP4-ER-Q1001	Sample Tracking and Laboratory Coordination
CP4-ER-Q1002	Data Management
CP4-ER-DCN4001	Decontamination of Drilling-Related Equipment
PTSA-5003	Operation of the C-752-C Decontamination Pad
PTER-2034	Decontamination of Field Equipment
CP4-ER-SAM2006	Radiation Screening
CP4-ER-SAM9001	Soil Gas Sampling

Table 2.2. Number of surface soil samples collected at each sector

Sector	Number of Samples	Sector	Number of Samples
1	0	6	9
2	6	7	11
3	3	8	2
4	3	9	7
5	7		

Table 2.3. Number of soil gas samples collected at each sector

Sector	Number of Samples	Sector	Number of Samples
1	2	6	9
2	16	7	20
3	11	8	16
4	29	9	0
5	34		

Table 2.4. Number of subsurface soil samples collected from each hydrogeologic unit at each sector

Sector	UCRS	RGA	McNairy
1	20	0	0
2	31	0	0
3	34	1	0
4	164	10	5
5	107	12	5
6	12	0	0
7	31	12	6
8	18	10	7
9	2	6	3

Table 2.5. Number of borehole groundwater grab samples collected from each hydrogeologic unit at each sector

Sector	UCRS	RGA	McNairy
1	0	0	0
2	3	5	0
3	3	12	0
4	3	20	8
5	2	29	12
6	1	8	0
7	4	11	10
8	2	24	17
9	0	39	10

Table 2.6. Summary of groundwater monitoring well sampling

Monitoring Well Number	Approximate Depth	Sample Identification	Description
MW-155	100	011009WA100	Existing MW in Sector 4
MW-156	70	011010WA070	Existing MW in Sector 4
MW-157	40	011011WA040	Existing MW in Sector 4
MW-175	60	047012WA060	Existing MW in Sector 6
MW-176[a]	40	047013WA040, not analyzed	Dry, Existing MW in Sector 6
MW-178	60	040011WA060	Existing MW in Sector 2
MW-179[a]	40	040012WA040, not analyzed	Dry, Existing MW in Sector 2
MW-341	85	400212WB085	Newly installed MW in Sector 9
MW-342	85	400210WB085	Newly Installed MW in Sector 7
MW-343	85	400208WB085	Newly Installed MW in Sector 8

[a] Did not have sufficient yields to collect a sample

Table 2.7. CSL analyses

Analysis	Parameters	Prep. Method (Matrix)	Analytical Method
VOA	TCE and TCE degradation products	SW-846 5030A (water)	Modified SW-846 8010
VOA	TCE and TCE degradation products	Direct Inject(hexane and soil gas)	Modified SW-846 8010
SVOA	SW-846 Method 8270 TCL	SW-846 3540C or 3550B (soil)	SW-846 8270C
Surfactant	Surfactant	None (water)	T-MAZ-80K[a]
PCB	PCB	Immunoassay (soil)	SW-846 Method 4020

Notes:

TCL = Target Compound List

T-MAZ-80K[a] = Method developed for "DNAPL Solubilization Test at PGDP" by INTERA, Inc. for MMES on July 21, 1994.

Table 2.8. Analytical methods and sample requirements for CSL screening samples

Parameter	Matrix	Holding time	Detection Limit	Container	Preservative
VOA	Water	14 days	4 µg/L	Two 40-mL amber glass vials with Teflon™-lined lids	Cool to 4°C
	Solid	14 days	1 mg/kg	One 40 mL glass vial with Teflon™-lined lids	Cool to 4°C, 5 mL D.I. water, 5 mL hexane
	Gas	14 days	1 mg/L	Tedlar™ bags	None
SVOA	Solid	14 days to extraction 40 days to analysis	660 mg/kg	One 8-oz widemouth glass jar	None
PCB screen	Solid	14 days	1 mg/kg	One 60-mL widemouth glass jar	None
Surfactant	Water	14 days	0.05%	One 250-mL plastic	None
Gross alpha and gross beta	Water	6 months	10 pCi/L alpha 20 pCi/L beta	One 1-L plastic	Nitric pH<2
	Solid	6 months	12 pCi/g alpha 22 pCi/g beta	4-oz. widemouth glass jar with Teflon™-lined lid	None
Wipe samples (gross alpha and beta)	Wipe Media	6 months	< 1 cpm	One wipe per sample	None

Notes:
µg/L = micrograms per liter
mg/kg = milligrams per kilogram
mg/L = milligrams per liter
pCi/L = picoCuries per liter
cpm = counts per minute

Table 2.9. Analytical methods, preservation, and container type for all samples analyzed by the fixed-base laboratories

Analysis	Analytical Method	Container Type	Preservative
Soil			
TCL metals	6010A 7060 7471 7740	8-oz wide glass	None
Cyanide	9010	8-oz wide glass	None
PCBs	8080	4-oz wide glass	4°C
Radiological	EPA 908.1 EPA 901.1 HASL-300 9310	16-oz wide glass	None
TCL SVOA	3550/8270	4-oz wide glass	4°C
TCL VOA	8240	Acetate sleeve or 2-oz wide glass	4°C
Groundwater			
Major ion analysis	EPA 310.2 EPA 300	1-L plastic	None
Cyanide	9010	1-L plastic	NaOH pH>12 at 4°C, if no residual chlorine is present
TCL metals/ uranium	KPA, uranium 6010 7060 7130 7420 7470 7740 7840	(2) 1-L Plastic One bottle filtered and one unfiltered	Nitric pH<2
PCBs	8080	2-L amber	4°C
Radiological	HASL-300 9310	1-gal cubic 1-L plastic	Nitric pH<2
TCL SVOA	3510/8270	2-L amber	4°C
TCL VOA	8260	(3) 40-ml vial	HCl pH< 2, 4°C

[a]DOE 1982

Note:

KPA = kinetic phosphorescence analyzer

Table 2.10. Parameters monitored using real-time instruments

Parameter	Instrument
Airborne Organics	Organic Vapor Monitor—Photoionization Detector 11.8 eV
	Organic Vapor Analyzer—Flame Ionization Detector
	Colorimetric Tubes—Draeger Accuro 2000 Bellows Pump with Tubes for Benzene and Vinyl Chloride
Particulate	Aerosol Monitor—Miniram Personal Monitor PDM-3
Combustible Gas Indicators (CGI) and Oxygen Content	O_2/LEL Meter—MSA Model 360
Radioactivity	Eberline Model ESP-2 with SPA-8 Scintillation Probe
	Ludlum Model 3 with 44-9 GM Pancake and 43-5 Scintillation Detector
	Ludlum Model 2224 Scaler Instrument with 43-89 Scintillation Detector
	Ludlum Model 2929 Counter Instrument with 43-10-1 Detector
	Thermo-Luminescent Dosimeter (TLD)
	Vic450P Dose Rate Meter
Noise	Sound Level Meter – Quest 2700 with Octave Band Analyzer

3.0 PHYSICAL CHARACTERISTICS OF WASTE AREA GROUPING 6

The on-site physical characteristics of PGDP have been detailed in previous investigations by Clausen et al. (1992b), CH2M HILL (1992), CDM Federal (1992), and EDGe (1989). Miller and Douthitt (1993), TCT-St. Louis (1991), EDGe (1989), and Wehran (1981) have addressed the off-site physical characteristics. For this report, previous investigations of the geology and hydrogeology were used to describe the regional physical characteristics of western Kentucky and summarize the physical characteristic data compiled for the PGDP area during the WAG 6 RI.

3.1 REGIONAL TOPOGRAPHY AND SURFACE WATER

PGDP lies in the Jackson Purchase Region of western Kentucky between the Tennessee and Mississippi Rivers, bounded on the north by the Ohio River. The confluence of the Ohio and Mississippi Rivers is approximately 20 miles downstream (southwest) from the site. The confluence of the Ohio and Tennessee Rivers is approximately 15 miles upstream (east) from the site. The western Kentucky region has gently rolling terrain between 330 and 500 ft above mean sea level (amsl). Tributaries of the Ohio, Tennessee, and Mississippi Rivers dissect the region.

The average pool elevation of the Ohio River is 290 ft amsl, and the high water elevation is 342 ft amsl (TCT-St. Louis 1991). Approximately 100 small lakes and ponds exist within the PGDP site (TCT-St. Louis 1991). Seven settling basins and 17 gravel pits are also located within the boundary. A wetland area covering 165 acres exists immediately south of the confluence of Bayou Creek and Little Bayou Creek (TCT-St. Louis 1991).

All creeks that drain the site flow northward toward the Ohio River. Specific details of regional hydrology are presented in Section 3.7.

Local elevations range from 290 ft amsl along the Ohio River to 450 ft amsl in the southwestern portion of PGDP near Bethel Church Road. Generally, the topography in the PGDP area slopes toward the Ohio River at an approximate gradient of 27 ft per mile (CH2M HILL 1992). Within the 960 acres of the plant boundaries, ground surface elevations vary from 360 to 390 ft amsl. Primary land uses at PGDP include industry and wildlife management; secondary uses include agriculture and fishing.

3.2 METEOROLOGY

Information presented herein regarding the climate at PGDP was derived from *Results of the Site Investigation, Phase II* (CH2M HILL 1992). The region in which PGDP is located has a humid-continental climate characterized by extremes of both temperature and precipitation. Table 3.1 presents a summary of the average monthly precipitation, temperature, potential evapotranspiration, estimated actual evapotranspiration, and infiltration and surface runoff for the region between 1969 and 1989, based on data generated at Barkley Field Airport, located southeast of PGDP. The 20-year average monthly precipitation is 4.19 in., varying from an average of 2.99 in. in January to an average of 5.16 in. in April. From March through July and during November and December, the weather is generally wetter than average. From August through October and during January and February, the weather is generally drier than average. The 20-year average monthly temperature is 57.1°F, varying from 29.9°F in January to 79.0°F in July.

Estimated actual and potential evapotranspiration rates are equal in all months except June, July, August, and September. For these 4 months, estimated actual evapotranspiration is a function of the available soil moisture and is less than potential evapotranspiration. Maximum potential and maximum estimated actual evapotranspiration rates occur in July. From June through October, precipitation either dissipates through evapotranspiration or replenishes the depleted soil moisture. During this time, water from precipitation is generally not available for infiltration, groundwater recharge either does not occur or is very limited, and little of the precipitation that falls within the stream drainage basins runs off and is available for stream flow.

From November through May, evapotranspiration is less, and water is available for infiltration and runoff. Most groundwater recharge and stream flooding occur during this part of the year, and contaminant migration in these two media would be increased during this time. The average annual amount of precipitation available for infiltration and runoff in the PGDP area is estimated to be 21.04 in. Both regional and PGDP groundwater investigations indicate that approximately 4.7 in. of rainfall per year infiltrates into the groundwater system.

Information on wind direction and speed was obtained from Barkley Field Airport. Fig. 3.1 illustrates the wind rose for the average annual wind speed and direction. The average prevailing wind has a speed of 9.8 mph and blows from directions varying from south to southwest. Generally, stronger winds are recorded when the winds are from the southwest.

3.3 SOIL

The general soil map for Ballard and McCracken Counties indicates that three soil associations are present within the vicinity of PGDP (USDA 1976): the Rosebloom-Wheeling-Dubbs association, the Grenada-Calloway association, and the Calloway-Henry association. The predominant soil association in the vicinity of PGDP is the Calloway-Henry association, which consists of nearly level, somewhat poorly ~~drained to~~ poorly drained, medium-textured soils on upland positions. Several other soil groups also occur in the region in limited areas, including the Grenada, Falaya-Collins, Waverly, Vicksburg, and Loring.

The Henry and Calloway soil series are classified as fragiaqualfs and fragiudalfs, respectively. The fragipan subsurface horizon within these soils is a dense silty or loamy layer, which may be cemented by amorphous material. This diagnostic subsurface horizon greatly reduces the vertical movement of water in the soil and is typically responsible for causing seasonal high water tables in these soils. The lateral continuity and integrity of this layer may have been reduced due to construction activities (CH2M HILL 1991). The soil over the majority of PGDP is the Henry silt loam with a transition to Calloway, Falaya-Collins, and Vicksburg away from the site.

The soils in the vicinity of PGDP tend to have a low buffering capacity with a pH ranging from 4.5 to 5.5. Low pH values are often associated with high cation exchange capacities, so these factors may alter the mobility of soil contaminants (particularly metals) (Birge et al. 1990). The range of cation exchange capacities measured during the WAG RI range from 8.92 to 69.8 milliequivalents per liter. The degree to which the soil attenuates metals transport is discussed in Section 5.3.3.

Although the soil over most of PGDP may be have been Henry silt loam with a transition to Calloway, Falaya-Collins, and Vicksburg away from the site, many of the characteristics of the original soil have been lost due to industrial activity which has occurred over the past 45 years. Activities that have disrupted the original soil classifications include filling, mixing, and grading.

3.4 POPULATION AND LAND USE

The WKWMA and sparsely populated agricultural lands surround PGDP. The closest communities to the plant are Heath, Grahamville, and Kevil, all of which are located within 3 miles of DOE reservation boundaries. The closest municipalities are Paducah, Kentucky; Cape Girardeau, Missouri, which is approximately 40 miles west of the plant; and the cities of Metropolis and Joppa, Illinois, which are located across the Ohio River from PGDP.

Historically, the economy of western Kentucky has been based on agriculture, although there has been increased industrial development in recent years. PGDP employs approximately 2500 people and the TVA Shawnee Steam Plant employs 500 people (Oakes et al. 1987). Total population within a 50-mile radius of PGDP is approximately 500,000; approximately 50,000 people live within 10 miles of the plant. The population of McCracken County is approximately 63,000 (Slater and Hall 1992).

In addition to the residential population surrounding the plant, WKWMA draws thousands of visitors each year for recreational purposes. Visitors use the area primarily for hunting and fishing; other activities include horseback riding, hiking, sanctioned field trials for hunting dogs, and bird watching. According to WKWMA management, an estimated 5000 anglers visit the area each year.

3.5 ECOLOGY

The following sections give a brief overview of the terrestrial and aquatic systems at PGDP. A more detailed description, including an identification and discussion of sensitive habitats and threatened/endangered species, is contained in the *Investigation of Sensitive Ecological Resources Inside the Paducah Gaseous Diffusion Plant* (CDM 1994) and *Environmental Investigations at the Paducah Gaseous Diffusion Plant and Surrounding Area, McCracken County, Kentucky* [U. S. Army Corps of Engineers (COE) 1994].

Terrestrial Systems. The terrestrial component of the PGDP ecosystem includes the plants and animals that use the upland habitats for food, reproduction, and protection. The communities range from an oak and hickory forest in areas that have been undisturbed to managed fencerows and agricultural lands in the more developed areas. The main crops present in the PGDP area include soybean, corn, tobacco, and various grain crops such as millet.

Old field grasslands constitute approximately 2000 acres of the WKWMA. Much of this herbaceous community is dominated by members of the *Compositae* family and various grasses. Woody species, such as red maple, are also occasionally present. Some of this area includes remnant prairie, as indicated by the presence of eastern gama and Indian grasses. The shrub community represents a more diverse habitat, including both herbaceous and woody species. Within WKWMA, approximately 800 acres consists of scrub-shrub habitat. Dominant trees include cherry, persimmon, sumac, young hickory, and three species of oak, as well as scattered growths of sweetgum and hackberry. Forest and shrub tracts alternate with fencerows and transitional edge habitats along roads and power transmission-line corridors. Elm, locust, oak, and maple, with an understory of sumac, honeysuckle, blackberry, poison ivy, and grape dominate fence-row communities. Herbaceous growth in these areas includes clover, plantain, and numerous grasses.

Rabbits, mice, and a variety of other small mammals frequent open herbaceous areas. Birds identified in the area include red-winged blackbirds, quail, sparrows, and predators such as hawks and owls. In transitional areas, including fencerows, low shrub, and young forests, a variety of wildlife is present, including opossum, vole, mole, raccoon, and deer. Birds typically found in the transitional areas include red-winged blackbirds, shrikes, mourning doves, quail, turkeys, cardinals, and meadowlarks. Several groups of coyotes also reside in areas around PGDP. In addition to the larger mammals, mature forests contain squirrels, songbirds, and great horned owls. Muskrat and beaver are found in the aquatic habitats of the PGDP area. Many species of waterfowl also use these areas, including wood ducks, geese, herons, and various other migratory birds. Various reptiles, amphibians, and terrestrial invertebrates (e.g., insects and spiders) are present in all areas. Finally, domestic livestock is abundant in surrounding farmlands.

Aquatic Systems. The aquatic communities in and around the PGDP area that could be impacted by plant discharges include two perennial streams, Bayou Creek and Little Bayou Creek; the North-South Diversion Ditch; a marsh located at the confluence of Bayou Creek and Little Bayou Creek; and other smaller drainage areas. The dominant taxa in the surface water includes several species of sunfish, especially bluegill and green sunfish, as well as bass and catfish. Bluegills, green and longear sunfish, and stonerollers dominate shallow streams, characteristic of the two area creeks.

Wetlands and Floodplains. Wetlands were identified during the 1994 COE environmental investigation of 11,719 acres surrounding PGDP. In this investigation 1083 separate wetland areas were identified and grouped into 16 vegetation cover types (COE 1994). Wetlands inside the plant security fence are confined to portions of drainage ditches traversing the site (CDM 1994). Functions and values of these areas as wetlands are low to moderate (Jacobs 1995); these areas provide some groundwater recharge, floodwater retention, and sediment/toxicant retention. While the opportunity for these functions and values is high, the effectiveness is low due to water exiting the area quickly via the drainage system. Other functions and values (e.g., wildlife benefits, recreation) are very low.

At PGDP, three bodies of water cause most area flooding: the Ohio River, Bayou Creek, and Little Bayou Creek. A floodplain analysis performed by COE (1994) indicated that much of the built-up portions of the plant lie outside the 100- and 500-year floodplains of these streams. In addition, this analysis indicated that ditches within the plant area can contain the expected 100- and 500-year discharges.

3.6 REGIONAL GEOLOGY

Regional Geologic Setting. PGDP is located in the Jackson Purchase Region of western Kentucky, which represents the northern tip of the Mississippi Embayment portion of the Coastal Plain Province (Fig. 3.2). The Jackson Purchase Region is an area of land that includes all of Kentucky west of the Tennessee River. The stratigraphic sequence in the region consists of

Cretaceous, Tertiary, and Quaternary sediments unconformably overlying Paleozoic bedrock. A lithostratigraphic column of the Jackson Purchase Region is shown in Fig. 3.3.

Within the Jackson Purchase Region, strata deposited above the Precambrian basement rock attain a maximum thickness of 12,000 to 15,000 ft. Exposed strata in the region range in age from Devonian to Holocene. The Devonian stratum crops out along the western shore of Kentucky Lake. Mississippian carbonates form the nearest outcrop of bedrock and are exposed approximately 9 miles northwest of PGDP in southern Illinois (Clausen et al. 1992a). The Coastal Plain deposits unconformably overlie Mississippian carbonate bedrock and consist of the following: the Tuscaloosa Formation, the sand and clays of the Clayton/McNairy Formations, the Porters Creek Clay, and the Eocene sand and clay deposits (undivided Jackson, Claiborne, and Wilcox Formations). Continental deposits uncomformably overlie the Coastal Plain deposits, which are, in turn, covered by surface loess and/or alluvium. The following is a discussion of the strata.

Bedrock. The entire PGDP area is underlain by Mississippian carbonates. The bedrock consists of dark gray limestone with some interbedded chert and shale. The bedrock was not encountered during the WAG 6 RI.

Rubble Zone. The rubble zone consists of angular to subangular chert and silicified limestone fragments (Olive 1980). In the Late Eocene, before deposition of the Upper Cretaceous sediments, a long period of weathering occurred. During this time, erosion removed strata of the Upper Mississippian System (bedrock) and the Pennsylvanian System. Remnants of this weathering form the rubble zone. The rubble zone was not encountered during the WAG 6 RI.

McNairy Formation. In the Late Cretaceous, a sea encroached northward, leading to deposition of the McNairy Formation (Clausen et. al. 1992b). In the southeastern part of the Jackson Purchase Region, the McNairy Formation consists of mostly sand. Farther north, including PGDP, the McNairy Formation consists of light gray to dark gray clay with lenses of fine to coarse sand that weathers to moderate yellow to reddish-brown. It is interbedded with varying amounts of gravel and dark gray silt.

The Clayton Formation is Paleocene in age but is difficult to differentiate from the underlying McNairy Formation. The two formations are discussed as one geologic unit (the McNairy Formation) in this report because of ~~the~~ lithologic similarity and uncertainty associated with placement of the contact.

Porters Creek Clay, Porters Creek Terrace, and Eocene Sands. The Porters Creek Clay consists of dark gray to black clay with varying amounts of silt and fine-grained, micaceous, glauconitic sand. This is indicative of marine and brackish-water sediments deposited in a sea that occupied most of the Mississippi Embayment (Olive 1980). Eocene sediments consisting of interbedded and interlensing sand, silt, and clay overlie the Porters Creek Clay in the southern portion of the DOE property. Abrupt change from fine-grained deposition of the Porters Creek Clay to coarser-grained sedimentation during the Eocene probably resulted from regional uplift.

Post-Eocene erosion into the Paleocene Porters Creek Clay resulted in an important feature known as the Porters Creek Terrace. The Porters Creek Terrace lies immediately south, southeast, and southwest of PGDP; the terrace slope extends northward toward the southern boundary of the PGDP fenced security area. Regionally, the Porters Creek Terrace is hydrogeologically important because it marks the southern extent of the Lower Continental Deposits (LCD) and therefore the southern extent of the RGA. It also serves as the aquitard below the RGA where the RGA laps onto the terrace slope. The Porters Creek Clay, Porters Creek Terrace, or Eocene Sands are not present in the WAG 6 area and were not encountered during the RI.

Continental Deposits. Pleistocene Continental Deposits unconformably overlie the Cretaceous through Eocene strata throughout the area. Ancestral rivers bordered the Jackson Purchase Region in approximately the same position as the present Tennessee, Ohio, and Mississippi Rivers (Olive 1980). Increased flow in the ancestral Tennessee River, combined with large sediment loads, resulted in the formation of an alluvial fan in the area of the confluence of the Ohio and Tennessee Rivers (Olive 1980). The Continental Deposits resemble a large low-gradient alluvial fan that covered much of the region and eventually buried the erosional topography.

Erosion and reworking of alluvial fan deposits have resulted in the present thickness and distribution of the Continental Deposits. The thicker sequences of Continental Deposits represent valley fill deposits and can be informally divided into a lower unit (gravel facies) and an upper unit (clay facies). The two distinct facies are as follows:

- Lower Continental Deposits (LCD). The valley fill sequence began with deposition of coarse sand and gravel in a braided fluvial environment. The LCD are gravel facies consisting of chert gravel in a matrix of poorly sorted sand and silt. The LCD consist of a Pleistocene gravel deposit resting on an erosional surface representing the beginning of the valley fill sequence. The LCD were deposited on an irregular east-west trending erosional surface exhibiting steps or terraces. Alluvial terraces are former floodplains corresponding to different glacial events. The LCD are found throughout the plant area and to the north, but pinches out to the south, southeast, and southwest along the slope of the Porters Creek Terrace. The gravel deposit averages approximately 30 ft thick but some thicker deposits (as much as 50 ft) exist in deeper scour channels that trend east-west across the site. During the onset of glacial episodes, stream systems became entrenched in alluvial fan and underlying deposits. Valley alluviation followed periods of erosion and entrenchment during interglacial stages.

- Upper Continental Deposits (UCD). As aggradation of the fluvial system continued, stream gradients in the ancestral Tennessee River and tributaries lessened. Lower gradients favored a transition from a braided environment to a meandering environment. A very gravelly lower sequence becoming sandier upwards identifies the transition in the subsurface. The UCD are primarily fine-grained, clastic facies varying in thickness from 15 to 55 ft. The UCD consist of clayey silt with lenses of sand and occasional gravel. The UCD represent a fluvial and lacustrine environment (Finch 1967; Frye et al. 1972). Widespread lacustrine sedimentation occurred along the present Ohio River and Tennessee River valleys when they became choked from draining glaciated areas. The sediment dammed valleys of tributaries, creating slackwater lakes that resulted in deposition of fine-grained sediments of the UCD. Depending on stages of glaciation, periods of lacustrine deposition were followed by periods of erosion.

Surface Soil/Loess/Fill. The surface deposits found in the vicinity of PGDP are Pleistocene to Recent in age and consist of loess and alluvium. Both units are composed of clayey silt or silty clay and range in color from yellowish-brown to brownish-gray or tan, making field differentiation difficult.

The loess (wind-blown) deposits overlie the UCD throughout the PGDP area. Only the most recent (Illinoisan- and Wisconsinian-aged) deposits are represented in the sedimentary sequence.

Orphan

The loess deposits are not always distinguishable from lacustrine sediments of the UCD.

As discussed in Sect. 3.3, the predominant soil association in the vicinity of PGDP is the Calloway-Henry association (USDA 1976). The fragipan subsurface horizon within this soil is a densified silty or loamy layer, which may be cemented by amorphous material. Excavation and construction activities at PGDP during the past 45 years have reduced the continuity of the fragipan layer and increased vertical drainage throughout the plant area (CH2M HILL 1992).

3.7 REGIONAL HYDROGEOLOGY

Regional Surface Water. Information presented herein regarding the surface water setting at PGDP was derived from *Results of the Site Investigation, Phase II* (CH2M HILL 1992). PGDP is located in the western portion of the Ohio River basin. Locally, it is within the drainage areas of Bayou Creek and Little Bayou Creek; the plant is situated on the divide between the two creeks (Fig. 3.4).

Bayou Creek is a perennial stream with drainage area of approximately 18.6 square miles that flows generally northward from approximately 2.5 miles south of the plant site to the Ohio River and extends along the western boundary of the plant. Little Bayou Creek, also a perennial stream, originates within the WKWMA, flows northward to the Ohio River, and extends along the eastern boundary of the plant. The approximate drainage area of Little Bayou Creek is 8.5 square miles (CH2M HILL 1992). The confluence of the two creeks is approximately 3 miles north of the plant site, just upstream of the location at which the creeks discharge into the Ohio River. The drainage areas for both creeks are generally rural; however, they receive surface drainage from numerous swales that drain residential and commercial properties, including the WKWMA, PGDP, and the TVA Shawnee Steam Plant. A major portion of the flow in both creeks north of PGDP is effluent water from the plant, discharged through KPDES-permitted outfalls. Deer Lick, Snake Creek, and Slough Creek drain the northwestern portion of the PGDP boundary.

Discharge flow, specific conductivity, and temperature measurements were recorded at 74 main channel sites and 7 tributary sites of Bayou Creek and Little Bayou Creek on August 15 and 16, 1989. Discharge for Bayou Creek during this time varied from 0.30 ft^3/s at the farthest upstream site to 5.8 cubic feet per second (ft^3/s) at the farthest downstream site. Tributary inflow along Bayou Creek was measured to be 5.7 ft^3/s. Discharge for Little Bayou Creek varied from 0.65ft^3/s at the farthest upstream site to 1.8 ft^3/s at the farthest downstream site. Total tributary inflow along Little Bayou Creek was 0.38ft^3/s. Specific conductivity values recorded in Bayou Creek ranged from 208 to 489 microSiemens per centimeter (μS/cm) and water temperature ranged between 20.0°C and 32.6°C. Specific conductivity values recorded in Little Bayou Creek ranged between 211 and 272 μs/cm, and water temperature ranged between 14.5°C and 24.9°C. Both Bayou Creek and Little Bayou Creek appear to lose stream volume to shallow groundwater south of PGDP but gain stream volume from shallow groundwater north of the plant (CH2M HILL 1992).

The U.S. Geological Survey (USGS) maintains gauging stations on Bayou Creek 4.1 and 7.3 miles from the Ohio River and a station on Little Bayou Creek 2.2 miles upstream from its confluence with Bayou Creek. The mean monthly discharge at Bayou Creek varies from 6.53 to 60.7 ft^3/s at the downstream station and 6.53 to 60.7 ft^3/s at the upstream station. The mean monthly discharge on Little Bayou Creek ranges from 0.89 to 33.5 ft^3/s.

Man-made drainage-ways receive stormwater and effluent from PGDP. The plant monitors 17 outfalls, which have a combined average daily flow of approximately 4.9 million gallons per day (Mgd) (Clausen et al. 1992b). The North-South Diversion Ditch flows through the WAG 6 area. The northern portion of the North-South Diversion Ditch continues to receive stormwater and treated plant effluents. The southern section of the ditch that is located due north of WAG 6 is now dry except during precipitation events due to the North-South Diversion Ditch Remedial Action. The plant ditches are generally considered to be located in areas where the local groundwater table is below the bottoms of the ditch channels. Therefore, the ditches probably function as influent (losing) streams most of the time, resulting in some discharge to the subsurface.

Surface-water bodies in the vicinity of PGDP include the Ohio River, Metropolis Lake (located east of the Shawnee Steam Plant), and several small ponds, clay and gravel pits, and settling basins scattered throughout the area. There is a marshy area just south of the confluence of Bayou Creek and Little Bayou Creek. The smaller surface-water bodies are expected to have only localized effects on the regional groundwater flow pattern.

Regional Groundwater. The Jackson Purchase Region is characterized by several hundred feet of unconsolidated Cretaceous through Holocene sediments deposited on an erosionally truncated Paleozoic surface. The flow system in the vicinity of PGDP primarily exists within unconsolidated sediments. Information presented herein regarding the groundwater setting at PGDP was derived from the *Report of the Paducah Gaseous Diffusion Plant, Groundwater Investigation Phase III* (Clausen et al. 1992b). The regional hydrogeology discussion is intended to provide a general overview of the groundwater flow regime for PGDP.

The regional groundwater flow system occurs within the Mississippian Bedrock, Cretaceous McNairy Formation, Eocene Sands, Pliocene Terrace Gravel, Pleistocene LCD, and UCD. Terms used to describe the hydrogeologic flow system are the McNairy Flow System, Eocene Sands, Pliocene Terrace Gravel, the RGA, and the Upper Continental Recharge System (UCRS). Specific components have been identified for the regional groundwater flow system and are defined in the following paragraphs.

Paleozoic Bedrock Aquifer. Limestone, believed ~~to be~~ the Mississippian-aged Warsaw Limestone subcrops beneath PGDP. Groundwater production from the bedrock aquifers comes from fissures and fractures and from the weathered rubble zone near the top of the bedrock. The bedrock aquifer was not encountered during the WAG 6 RI.

McNairy Flow System. Formerly termed the "deep groundwater system," this component consists of the interbedded and interlensing sand, silt, and clay of the Cretaceous McNairy Formation. Regionally, the sand in the McNairy Formation is an excellent aquifer in the southeastern part of the Jackson Purchase Region. The McNairy Formation grades from mostly sand in those areas to containing significant amounts of silt and clay near PGDP (Clausen et al. 1992a). Regionally, the McNairy recharges along areas of outcrop in the eastern part of the region, near Kentucky Lake and Lake Barkley (Davis et al. 1973). Water movement is north and northwest toward discharge areas in Missouri and along the Ohio River.

The McNairy Formation subcrops beneath the plant at depths ranging from approximately 70 to 100 ft. Sand facies account for 40 to 50% of the total formation thickness of approximately 225 ft. In areas where the RGA overlies the McNairy Flow System and where the RGA is in direct hydraulic connection with coarser-grained sediments of the McNairy Formation, the McNairy flow is coincident with that of the RGA.

Davis et al. (1973) reported values of hydraulic conductivity for the McNairy Flow System ranging from 1.4×10^{-8} to 4.7×10^{-2} centimeters per second (cm/s). During the WAG 6 RI, values of hydraulic conductivity were measured from 8.2×10^{-8} to 1.1×10^{-3} cm/s. The range of 5 orders of magnitude difference is due to depositional heterogeneity between the sand and clay of the McNairy Formation.

Pliocene Terrace Gravel and Eocene Sands. Pliocene-aged gravel deposits and Eocene-aged reworked sand and gravel overlie the Paleocene Porters Creek Clay in the southern portion of PGDP. However, in the central portions of the plant site, which includes the WAG 6 area, the units do not exist and were therefore not encountered during the RI.

Regional Gravel Aquifer. The RGA consists of the gravel facies of the LCD. The RGA is the most prominent gravel facies beneath PGDP and is the primary local aquifer. The RGA consists of a Pleistocene gravel deposit overlying an erosional surface. The RGA is found throughout the plant area and to the north, but pinches out to the south, southeast, and southwest along the slope of the Porters Creek Terrace. Regionally, the RGA includes the Holocene-aged alluvium found adjacent to the Ohio River.

The RGA is the dominant aquifer within the local flow system. Fig. 3.5 shows the hydraulic gradient within the flow system (Davis et al. 1973). Differences in permeability and aquifer thickness affect the hydraulic gradient, which is reflected in the spacing of the potentiometric contours on Fig. 3.5. Toward the southern part of PGDP, the RGA is either truncated or thins and grades laterally into the Porters Creek Terrace. The restriction results in a high gradient and probably causes groundwater discharge to adjoining streams. In the north-central portion of the plant site, the lower gradients are a result of the thickened Pleistocene sequence containing higher fractions of coarse sand and gravel. Northward, near the Ohio River, the hydraulic gradient increases as a result of either a thinner section of RGA or low-permeability bottom sediments in the Ohio River.

Regional groundwater flow within the RGA trends north-northeast toward base level represented by the Ohio River. The hydraulic gradient varies spatially but is on the order of 1×10^{-4} to 1×10^{-3} ft/ft (Clausen et al. 1992b). Clausen et al. (1992b) report hydraulic conductivities for the RGA ranging from 10^{-4} to 1 cm/s. During the WAG 6 RI, values of hydraulic conductivity were measured from 1.8×10^{-7} to 9.4 cm/s. The range of 8 orders of magnitude is due to depositional heterogeneities within the silt, sand, and gravel of the RGA.

Upper Continental Recharge System. The UCRS consists of the surface alluvium and UCD. The UCRS consists of clayey silt with lenses of sand and occasional gravel. PGDP hydrogeologists have differentiated the UCRS into 3 general horizons:

- Hydrologic Unit 1 (HU1) - an upper silt and clay interval,
- HU2 - an intervening sand and gravel interval, and
- HU3 - a lower silt and clay interval.

These horizons are highly subjective, but there are clear features that stand out throughout the plant area. "UCRS" generally refers to the sand and gravel lithofacies of the HU2. The HU2 appears relatively discontinuous in cross-section but may be more connected in three dimensions. The HU2 permeable units are only seasonally saturated and may be considered perched groundwater rather than a regional aquifer. The UCRS groundwater flows downward into the RGA, hence the term "recharge system." Because it is defined as a recharge system, the UCRS not only includes the more permeable units in the HU2, but also the silty clay of the HU3 that confine the uppermost water-saturated units.

Regionally, the UCRS thickness ranges from 0 ft to 50 ft. In a study by Clausen et al.(1992a) UCRS hydraulic conductivity values ranged from 10^{-8} to 10^{-2} cm/s. During the WAG 6 RI, values of hydraulic conductivity ranged from 3.2 to 1.7×10^{-8} cm/s. The range of 8 orders of magnitude is due to depositional heterogeneities within the sand, gravel, silt, and clay of the UCRS.

3.8 WAG 6 SURFACE WATER, GEOLOGY, AND HYDROGEOLOGY

Geologically, the focus of the WAG 6 RI was the geologic strata ranging in age from Cretaceous to Holocene or Recent. Borings drilled during this investigation ranged in depth from 1 to 137 ft bgs. Fig. 3.6 presents the WAG 6 RI sample locations, SWMU locations, and sector boundaries. The sampling station locations within the sectors are listed in Appendix A. The local geology at the plant has been characterized based on information from soil and characterization borings, monitoring wells, and information from previous studies.

3.8.1 WAG 6 Surface Water

The plant is drained by Bayou Creek, Little Bayou Creek, their tributaries, and man-made drainage ditches that flow northward to the Ohio River. The North-South Diversion Ditch flows through the WAG 6 area. The northern portion of the North-South Diversion Ditch continues to receive stormwater and treated plant effluents. The southern section of the ditch that is located due north of WAG 6 is now dry except during precipitation events due to the North-South Diversion Ditch Remedial Action. The surface water and drainage sediment was not sampled during the WAG 6 RI.

3.8.2 WAG 6 Geology

The units encountered during the WAG 6 sampling activities consisted of unconsolidated strata at depths within 137 ft bgs. Deeper units, such as the Paleozoic bedrock or "rubble zone," were not encountered during this investigation. As shown in the generalized regional cross-section (Fig. 3.7), the WAG 6 site is located north of the Porters Creek Terrace, the Porters Creek Clay, and the Eocene Sands, none of which exist in the investigation area. The McNairy Formation directly underlies the Continental Deposits. Therefore, the scope of the WAG 6 RI focused on surface soil/loess/fill, the Continental Deposits, and the McNairy Formation. Figures 3.8 through 3.13 represent cross-sections developed from the information gathered during the WAG 6 RI.

McNairy Formation. The Upper Cretaceous McNairy Formation is the oldest unit investigated during the WAG 6 RI. The McNairy Formation subcrops beneath the WAG 6 area at depths ranging from 80 to 100 ft. The average elevation of the top of the unit is 289 ft amsl.

Eleven borings were drilled to characterize the upper 50-ft section of the McNairy Formation in the WAG 6 area. The top of the unit marks an erosional surface caused by regional uplift in the late Eocene. As shown in the cross-sections (Fig. 3.8 through 3.13), minor elevation changes occur on the top of the McNairy Formation. The unconformable surface exhibits east-west trending steps or terraces at recognizable erosional surfaces (Olive 1980). As shown on Fig. 3.13, the top of the McNairy Formation in Boring 400-207 is approximately 8 ft lower than those of Borings 400-215 and 400-047. The difference is probably not attributable to a distinct terrace feature but rather represents evidence of a scour channel caused by high-energy streams of the Pleistocene that deposited the overlying LCD.

The dominant lithology of the McNairy Formation is stiff, firm, light bluish-gray to dark gray clay with bluish-green mottling and interbedded lenses of silt and very moist, fine-grained, yellowish-brown sand. Common features are dark gray pyritic and lignitic clay with thinly laminated clay and silt zones showing ripple features. Wood fragments and dense featureless intervals were also observed. The clay is indicative of the coastal marine environment.

Erratic intervals of very fine-grained micaceous sands were observed during the WAG 6 RI. The sand was deposited in a near-shore marine environment and is probably deposited in tidal channels. As shown in the cross-sections (Figs 3.8 through 3.13), the sands are of limited extent. The north-south cross-sections (Figs. 3.11 and 3.13) show the sand channels to be oriented north and south. The sand is thickest (25 ft thick) near the southeast corner of the C-400 Building (Boring 400-038).

Lower Continental Deposits. Twenty borings were drilled to characterize the Pleistocene LCD. The most prominent gravel facies beneath PGDP is the Pliestocene fluvial gravel facies of the LCD. The much coarser-grained sediment unconformably overlies the finer-grained Cretaceous McNairy Formation. As shown in the cross-sections (Figs. 3.8 through 3.13), the base of the LCD is an erosional surface with minor elevation changes, probably due to scour channels. The coarser-grained LCD are distinguished from the overlying finer-grained UCD by grain size. The contact between the LCD and UCD is gradational in places. The elevation of the top of the LCD in the WAG 6 area is approximately 322 ft amsl. The LCD range in thickness from 25 to 32 feet.

The dominant lithology of the LCD is poorly sorted, yellowish-brown gravel. Grains range from angular to rounded and range in size from clay particles to almost 3-inch-diameter cobbles. Gravel consists predominantly of chert with some quartz pebbles with evidence of reworked gravel. Common features noted are beds showing vertical gradation of grain sizes from coarse to fine and from fine to coarse. Most of these zones within the LCD appear to be trending east-west, but generally did not correlate from boring to boring. Therefore, different horizons have not been delineated.

A coarse-grained gravel interval that does correlate throughout the WAG 6 area was consistently encountered at approximately 85 ft bgs (295 ft amsl). The coarsest-grained sediments found during the WAG 6 RI were measured in the 80- to 90-ft-bgs interval. Coincidentally, this same zone was found to have the highest hydraulic conductivity and levels of TCE contamination within the study area.

Intervals of sand and silt in the LCD were reported in almost all borings. These units appear to be erratic and of limited extent, as shown in the cross-sections (Fig. 3.8 through 3.13). The sand and silt appear to represent east-west trending lobes that were deposited in stream channels.

Upper Continental Deposits. The UCD consist primarily of finer-grained material that differentiates the UCD from the underlying, coarser-grained LCD. The UCD represent valley fill deposits that comprise a thick fining upward sequence. The UCD constitute a heterogeneous unit consisting of interbedded clay, silt, sand, and gravel. As shown in the cross-sections (Figs. 3.8

through 3.13), the layers of clay, silt, sand, and gravel grade laterally into adjacent units throughout the UCD.

During the Pleistocene, rivers draining glaciated areas became choked with sediment. This sediment dammed valleys and created a slackwater lake in the area of PGDP. Widespread lacustrine sedimentation in these lakes resulted in deposition of predominantly fine-grained sediments, including the HU3, a layer of clay at the base of the UCD. The thickness of the HU3 clay is presented in Fig. 3.14.

Sand and silt are the predominant lithology of the HU3 interval in areas that are not clay. Generally, the occurrence of relatively permeable sand in the HU3 interval may have allowed groundwater and contaminants to flow to the underlying LCD.

Other layers in the UCD (i.e., HU2 and HU1) represent periods of lacustrine deposition followed by periods of erosion related to stages of glaciation. Generally, the HU2 consists of sand, gravel, and silt and overlies the HU3 interval (see Figs. 3.8 through 3.13). The thickest section of HU2 sand and gravel exists east of the C-400 Building in Boring 400-048 (see Fig. 3.10). The HU1 consists of silt and clay and overlies the HU2. As shown in the cross-sections (Figs. 3.8 through 3.13), the contacts between the HU1, HU2, and HU3 are gradational and the units cannot always be correlated from boring to boring.

Surface Soil/Loess/Fill. Loess deposits overlie the UCD throughout the PGDP area. The loess deposits were not always distinguishable from lacustrine sediments of the UCD. Therefore, loess was not delineated.

The surface deposits found in the WAG 6 area are predominantly gravel fill and fill material along utility corridors. Gravel fill consists primarily of reddish-brown sandy gravel. As shown in the cross-sections (Figs. 3.8 through 3.13), the gravel fill was used to backfill the C-400 Building construction site and surrounding area during construction activities. The gravel fill was 8 ft thick in the borings located inside the C-400 Building (400-019 and 400-020). The thickest gravel fill (11 ft) was found east of the C-400 Building in Boring 400-048 (see Fig. 3.10).

Fill material used to backfill utility corridors, sumps (SWMU 40 and SWMU 203), and excavations are predominantly composed of clayey silt or silty clay and range in color from yellowish-brown to brownish-gray or tan. Differentiation of the fill from the UCD is difficult. Occasionally, fill was saturated with water, especially along utility corridors and adjacent to the sump at SWMU 40.

3.8.2.1 Summary of Geology by Sector

As discussed in Section 1.4.2, the WAG 6 area has been divided into 9 sectors. The following is a summary of the geologic units encountered within each of the sectors.

Sector 1 – Four borings were drilled to investigate Sector 1 (Fig. 3.6). Two were drilled inside the C-400 Building and 2 were drilled at an angle underneath the building. Total depths of the soil borings drilled inside the building were both at 48.0 ft. Slant Boring 400-040 was drilled to 105 ft bgs in vertical depth, and 400-041 was drilled to 112 ft bgs in vertical depth (note: all slant hole depths are referenced to true vertical depth). Both borings were drilled at approximately 30° angle from horizontal (see Vertical Deviation Log in Appendix G).

During drilling activities within Sector 1, four units were encountered: fill, UCD, LCD, and the McNairy Formation. Table 3.2 summarizes the average thickness, elevation, and lithology of the units encountered during drilling.

Sector 2 – Twenty-three borings were drilled to investigate Sector 2 (Fig. 3.6). Total depths of the borings ranged between 10 ft and 93.5 ft bgs. The surface area is predominantly covered by concrete, and topography ranges between 376 ft and 379 ft amsl. During drilling activities within Sector 2, four geological units were encountered: fill, UCD, LCD, and the McNairy Formation. Table 3.3 presents the average thickness, elevation, and lithology of the units encountered during drilling.

Six additional soil borings were drilled in the UCRS to a depth of 10 to 30 feet bgs in April 1998 to determine if a release had occurred or was occurring from the C-403 tank in Sector 2.

Sector 3 – Thirteen borings were drilled to investigate Sector 3 (Fig. 3.6). Total depths of the borings ranged between 13 ft and 96 ft bgs. The surface area is predominantly covered by gravel, and topography ranges between 377 ft and 379 ft amsl. During drilling activities within Sector 3, four geological units were encountered: fill, UCD, LCD, and the McNairy Formation. Table 3.4 presents the average thickness, elevation, and lithology of the units encountered during drilling.

Sector 4 – Thirty-seven borings were drilled to investigate Sector 4 (Fig. 3.6). Total depths of the borings ranged between 11 ft and 147 ft bgs. The surface area is predominantly covered by concrete, and the topography ranges between 378 ft and 380 ft amsl. During drilling activities within Sector 4, four geological units were encountered: fill, UCD, LCD, and the McNairy Formation. Table 3.5 presents the average thickness, elevation, and lithology of the units encountered during drilling.

Sector 5 – Thirty-four borings were drilled to investigate Sector 5 (Fig. 3.6). Total depths of the borings ranged between 8 ft and 142 ft bgs. The surface area is predominantly covered by concrete, and grass and the topography ranges between 375 ft and 379 ft amsl. During drilling activities within Sector 5, four geological units were encountered: fill, UCD, LCD, and the McNairy Formation. Table 3.6 presents the average thickness, elevation, and lithology of the units encountered during drilling.

Sector 6 – Ten borings were drilled to investigate Sector 6 (Fig. 3.6). Total depths of the borings ranged between 2.3 ft and 92 ft bgs. The surface area is predominantly covered by gravel and grass, and topography ranges between 375 ft and 378 ft amsl. During drilling activities within Sector 6, four geological units were encountered: fill, UCD, LCD, and the McNairy Formation. Table 3.7 presents the average thickness, elevation, and lithology of the units encountered during drilling.

Sector 7 – Twenty-four borings were drilled to investigate Sector 7 (Fig. 3.6). Total depths of the borings ranged between 8 ft and 136 ft bgs. The surface area is predominantly covered by gravel and concrete, and topography ranges between 374 ft and 379 ft amsl. During drilling activities within Sector 7, four geological units were encountered: fill, UCD, LCD, and the McNairy Formation. Table 3.8 presents the average thickness, elevation, and lithology of the units encountered during drilling.

Sector 8 – Fifteen borings were drilled to investigate Sector 8 (Fig. 3.6). Total depths of the borings ranged between 7.5 ft and 137 ft bgs. The surface area is predominantly covered by grass, and topography ranges between 373 ft and 377 ft amsl. During drilling activities within Sector 8, four geological units were encountered: fill, UCD, LCD, and the McNairy Formation. Table 3.9 presents the average thickness, elevation, and lithology of the units encountered during drilling.

Sector 9 – Eight borings were drilled to investigate Sector 9 (Fig. 3.6). Total depths of the borings ranged between 92 ft and 137 ft bgs. The surface area is predominantly covered by grass and gravel, and topography ranges between 377 ft and 380 ft amsl. During drilling activities within Sector 9, four geological units were encountered: fill, UCD, LCD, and the McNairy Formation. Table 3.10 presents the average thickness, elevation, and lithology of the units encountered during drilling.

3.8.3 WAG 6 Hydrogeology

Hydrogeologically, the scope of the WAG 6 RI focused on the McNairy Flow System, RGA, and UCRS. Other regional aquifers in the WAG 6 area were not encountered during the RI.

McNairy Flow System. The dominant lithology of the McNairy Formation in the WAG 6 area is clay. Laboratory geotechnical analysis (see Appendix H) indicates average hydraulic conductivity of the McNairy Flow System of 2.9×10^{-4} cm/s. Comparison of the hydraulic conductivity with the overlying units (Fig. 3.15) shows that the clay lithology of the McNairy is much less permeable and thus serves as a confining layer to downward flow of groundwater. This is a very important factor of the hydrogeology at the WAG 6 site and greatly influences the flow of contamination, particularly a DNAPL such as TCE (see Section 4).

Zones of coarser-grained sediments exist within the McNairy. Fine-grained sands, which are thickest in the southeast corner of the C-400 Building, exist throughout the WAG 6 area (see Figs. 3.8 through 3.13). The sands are oriented north-south but appear to be of limited extent. The cross-sections also show that thick clays, typical of the confining layer, underlie these sand zones. A complex inter-relationship exists between the RGA and the coarser-grained sediments of the McNairy. In areas where coarse-grained McNairy sediments occur adjacent to the RGA, groundwater flow in the McNairy is coincident with flow in the RGA, and the contiguous McNairy is included within the RGA.

Regional Gravel Aquifer. The major pathway of groundwater flow at WAG 6 is within the RGA, which dominates the flow regime. The RGA is the only regional aquifer present in the investigation area. In the WAG 6 RI, values of hydraulic conductivity were measured from 1.8×10^{-7} to 9.4 cm/s (see Appendix H). As illustrated in Fig. 3.16, the average hydraulic conductivity measured in the RGA is greater than the overlying and underlying sediments. The range of 8 orders of magnitude is due to depositional heterogeneities within the sand and gravel of the RGA.

Lobes of sand and silty sand were found within the RGA in many of the borings drilled at WAG 6, but appeared to be erratic and of limited extent. Locally, these sands and silts create zones of low permeability that impede the groundwater flow.

In the summer of 1994, a surfactant solubility test was conducted on the TCE contamination at SWMU 11 (Intera, Inc. 1995). The test involved pumping 5,000 gal of a solution of 1% surfactant and 99% potable water into MW-156, which is an RGA well.

The CSL analyzed for the percentage of surfactant in the RGA groundwater samples during the WAG 6 RI (see Appendix J). As expected, surfactant was found in the RGA groundwater northeast of MW-156 in Boring 400-048 (300 ft NE of MW-156) and traces were found in 400-053 (900 ft NE of MW-156) and 400-052 (725 ft NE of MW-156). Unexpectedly, surfactant was not detected to the north (400-039) but was detected to the west (400-213) and south (400-215). Based on this information, the local groundwater flow at the C-400 Building appears to divide at Boring 400-038 and a portion flows to the northeast, as expected, and a portion flows to the northwest. The sampling team reported an unusually slow recharge from the RGA in Boring 400-038 designating the presence of a zone of low permeability.

The RGA potentiometric surface (see Fig. 3.17) is relatively flat, with indications of a mound at the C-400 Building. The gradient measured regionally is 0.004 ft/ft (Clausen et al 1992). The indicated flow, based on from water levels in the WAG 6 area is generally to the north and northeast toward the Ohio River. RGA hydraulic heads (see Fig. 3.16) are less than those of the overlying UCRS, indicating recharge conditions over most of the flow system.

Hydrographs of the RGA water levels from August through January show a decline during the summer and fall months. Based on the data presented in Table 3.1, the decline in RGA water level is probably due to decreased precipitation and subsequent infiltration and runoff (AFIRO) that is expected during the summer and fall months. The 3 monitoring wells installed for the WAG 6 RI (MW-341, MW-342, and MW-343) were installed at the end of the investigation. Thus, the water level data are insufficient to develop a hydrograph for these wells.

Upper Continental Recharge System. The other water-saturated unit encountered during the WAG 6 RI is the UCRS. The UCRS generally and formally refers to the HU2. The HU2 consists of lenticular sands that are only occasionally saturated. As indicated on Figs. 3.8 through 3.13, the units do not always correlate from boring to boring and the recognition of the HU1, HU2, and HU3 intervals is highly subjective.

Although the flow direction in the UCRS is predominantly vertical, flow is also dependent upon the presence of a clay semi-confining layer in the HU3. The local thickness of the HU3 clay is shown in Fig. 3.14. Semi-confining clay layers of the HU3 that are located beneath permeable water-saturated sand layers within the HU2 impede the vertical flow of groundwater and promote lateral flow. Additionally, areas underlain by a thin HU3 clay layer may represent windows of higher recharge to the RGA. The clay layers of the HU3 appear to trend east-west and are thickest to the north and south of the C-400 Building. The clay pinches out in the area immediately adjacent to the building.

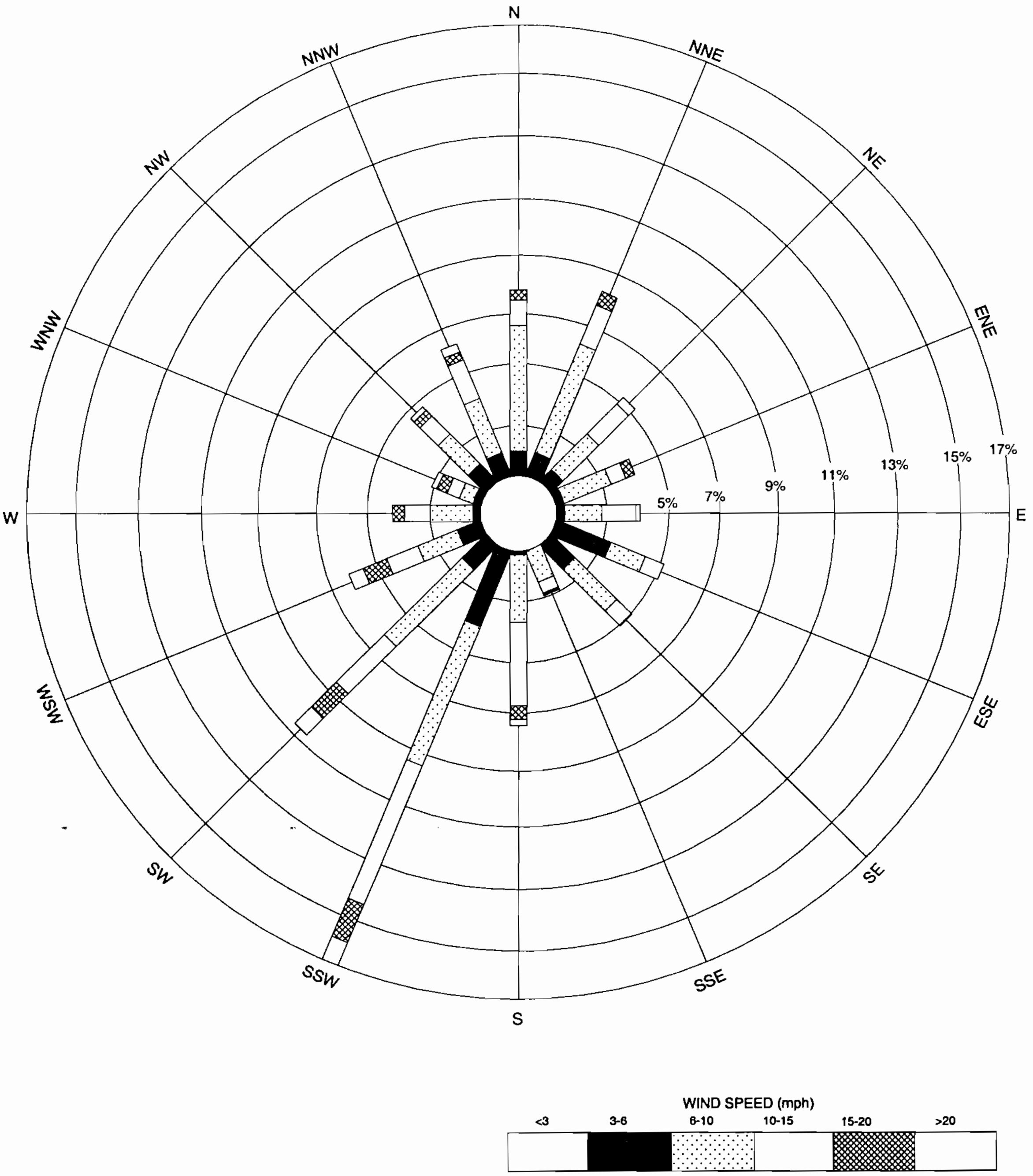
Vertical hydraulic head differences between the UCRS and RGA indicate downward flow potential (Fig. 3.16). The hydraulic heads of 4 clusters of piezometers/monitoring wells (at least 1 well with screen in the RGA and a piezometer/well with screen in the UCRS) were measured and compared to evaluate the downward flow potential. Based on this comparison, a head difference of approximately 23 ft exists east of the C-400 Building, and a 12.5 ft difference exists west of the building. The lowest downward flow potential is located northeast of the C-400 Building (head difference of 23.2 ft). These results are, however, probably skewed by a leaking water main located adjacent to the UCRS piezometer (040-001). In addition, the presence of the HU3 clay semi-confining layer may promote more lateral flow in the UCRS. The highest downward flow potential was found west of the C-400 Building (head difference of 12.5 ft). The absence of the semi-confining clay layer in the HU3 in this area may promote more vertical flow.

Figure 3.18 represents the potentiometric surface developed from measurements of the UCRS piezometers. The UCRS potentiometric surface generally shows flow toward the C-400 Building. This flow may be affected by several factors. For example, the "windows" in the HU3 clay semi-confining layers promote vertical flow, which would probably cause a depressed UCRS water table. In addition, the recharge of the UCRS may be lessened in the C-400 Building area by a buffering effect caused by the concrete and C-400 Building structure, thus preventing infiltration and recharge to the UCRS water-saturated units.

Figure 3.18 also presents the hydrographs of water levels measured in the UCRS piezometers from September to January. The screened intervals of the piezometers were set at the same subsurface elevation and several were found to be dry, indicating that saturation of the UCRS is not continuous. The water levels that were measured in the UCRS generally show a slight decline or "flattening out" over this period and there is only minor fluctuation between 1 to 8 ft. Clausen et. al. (1992b) found the UCRS hydrographs to peak between March and June and decline in the summer and fall indicating that the UCRS water level is dependent upon precipitation events. UCRS water levels in Piezometer 040-001, however, show a rise over this period. Midway through the RI, a water main burst in Sector 2 and water actually flowed up through the concrete pavement on the surface. Piezometer 040-001 is located adjacent to the water main leak and the rise in the UCRS water level is due to water recharge from the leaking water main. In addition, the water level measured in piezometer 040-001 is unusually higher in comparison to the water levels of the other piezometers, which may also be attributed to the leaking water main.

Occasionally, gravel fill or fill material was saturated with surface runoff. Whenever this saturated fill material was encountered, and the zone produced enough water, a water sample was collected. For example, the gravel fill was saturated adjacent to the C-403 Neutralization Tank (SWMU 40) located in Sector 2. The water recharge in the gravel fill can be attributed to the leaking water main. In addition, it is possible that the tank acts similar to a sink in which the depth of the tank and thickness of underlying/surrounding backfill acts as an infiltration gallery and causes water to accumulate in the gravel fill.

The presence of underground utilities and facility drainage systems can affect the local hydrogeology, particularly within the UCRS. Figure 3.19 shows the locations of buried utilities and building drainage systems within WAG 6.



NOTE: CENTER OF DIAGRAM CORRESPONDS
TO WIND SPEEDS OF <3 MPH

URCE: National Oceanic and Atmospheric Administration, Barkley Field, 1987.
"Wind Rose Diagram." Communication from PGDP.

fig3-1.wor - 4/12/89

Fig. 3.1 Wind rose diagram.

fig3-2.wor - 4/12/99

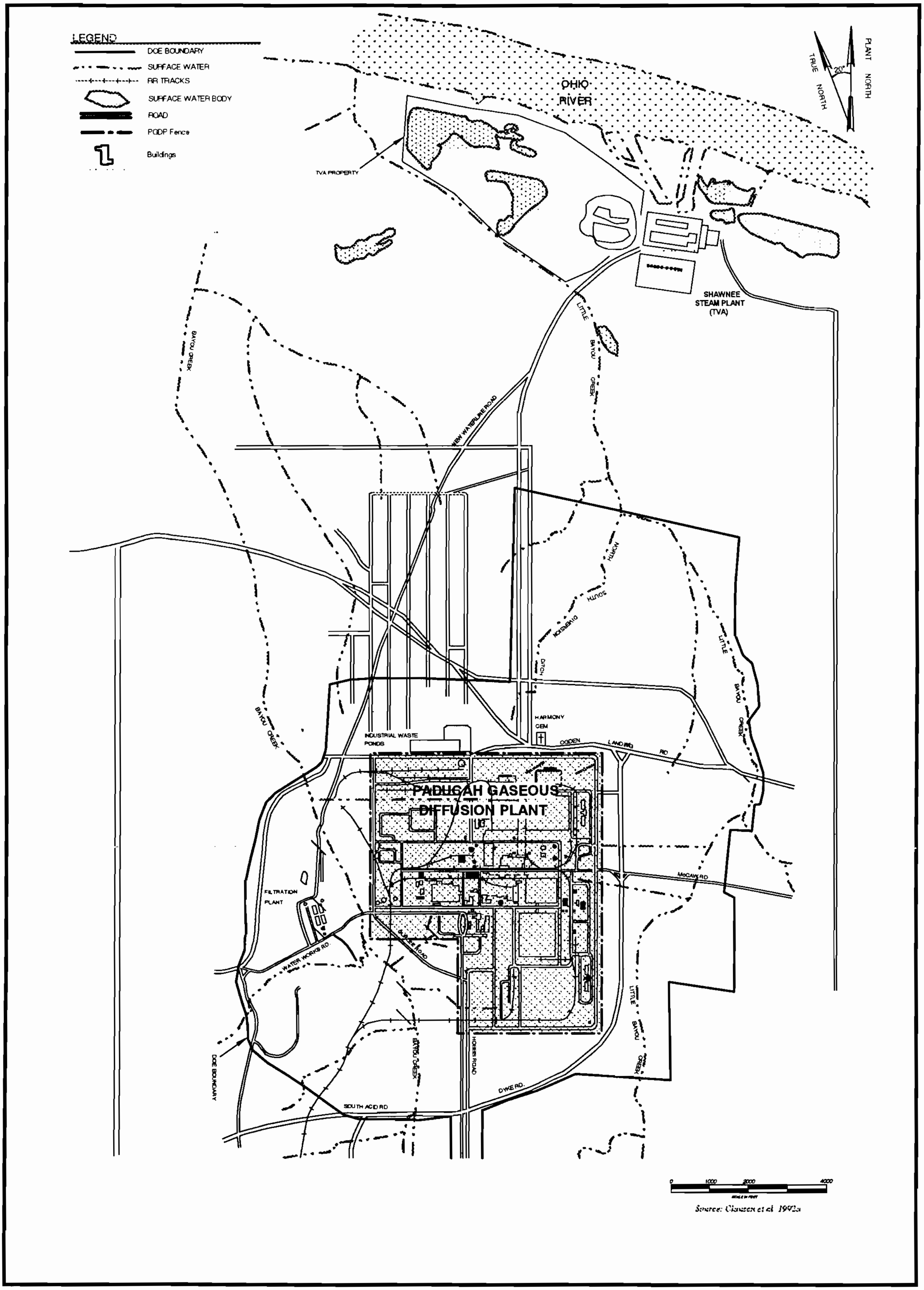
Fig. 3.2. Physiographic provinces map for PGDP

SYSTEM	SERIES	FORMATION	THICKNESS IN FEET	DESCRIPTION	HYDROGEOLOGIC SYSTEMS
Quarternary	Pleistocene and Recent	Alluvium	0-40	Brown or gray sand and silty clay or clayey silt with streaks of sand	Upper Continental Recharge System (UCRS)
	Pleistocene	Loess		Brown or yellowish-brown to tan to gray unstratified silty clay	
	Pleistocene	Continental Deposits	3-121	Upper Continental Deposits (clay Facies) Orange to yellowish brown to brown clayey silt, some very fine sand, trace of fine sand to gravel. Often micaceous.	
Tertiary	Pliocene(?)			Lower Continental Deposits (Gravel Facies) Reddish-Brown silty and sandy gravel, silt and clay.	Regional Gravel Aquifer
	Eocene	Eocene Sands (Undiff)	0-100	Red brown, or white fine to coarse grained sand. Beds of white to dark gray clay are distributed at random.	McNairy Flow System
				White to gray sandy clay, clay conglomerate and boulders, scattered clay lenses and lenses of coarse red sand. Black to dark gray lignitic clay, silt, or fine grained sand.	
	Paleocene	Porters Creek Clay	0-200	Dark gray, slightly to very micaceous clay. Fine grained clayey sand, commonly glauconitic in the upper part. Glauconitic sand and clay at the base. A Gravel layer ("Terrace Gravels") present atop the clay terrace, 2-8 feet thick	
		Clayton and McNairy Formations	200-300	Grayish white to dark micaceous clay, often silty, interbedded with light gray to yellowish brown very fine to medium grained sand. The upper part is mostly clay, the lower part is predominantly micaceous fine sand.	
Cretaceous		Tuscaloosa Formation	?	White, well rounded or broken chert gravel with clay.	
Mississippian		Mississippian Carbonates	500+	Dark gray limestone and interbedded chert, some shale.	

Adapted From:
Finch, W.L., 1967 Geological Map of part of the Joppa Quadrangle, McCracken County, Kentucky. U.S. Geological Survey GQ-652
Olive, W.W., 1966 Geological Map of part of the Heath Quadrangle, McCracken and Ballard Counties, Kentucky. U.S. Geological Survey GQ-561

fig3-3.wor - 4/12/99

Fig. 3.3. Lithostratigraphic column of the Jackson Purchase Region.



Source: Clausen et al. 1992a

fig3-7.wor - 7/8/98

Fig. 3.4. Surface water features in the vicinity of PGDP.

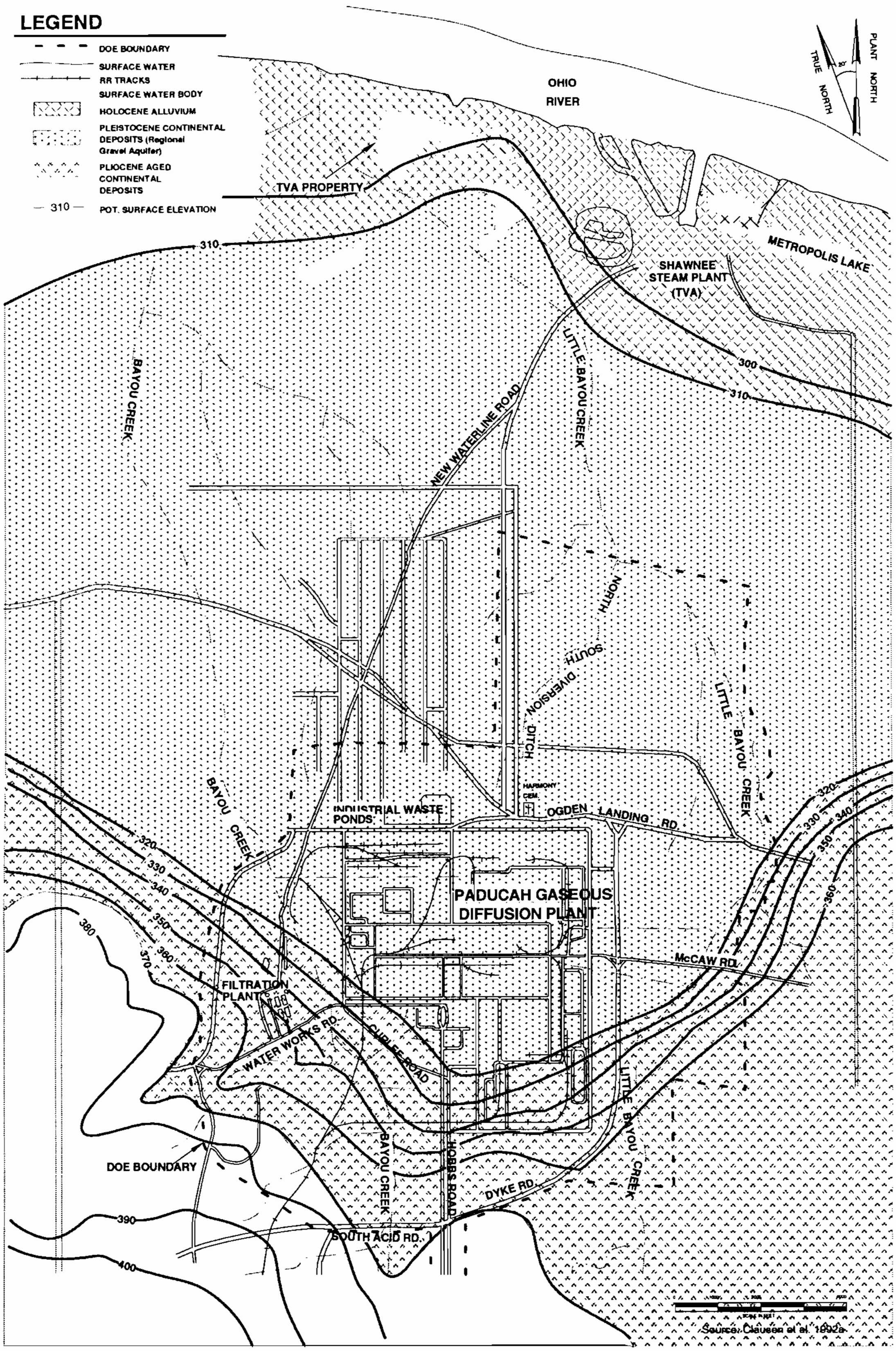


fig3-8.wor - 7/9/98

Fig. 3.5. Water level elevations and geologic components of the regional groundwater flow system in the vicinity of PGDP

Table 3.1. Monthly average precipitation, temperature, potential evapotranspiration, estimated actual evapotranspiration, and infiltration and runoff: 1969-1989

Month	Precipitation (in.)	Temperature (°F)	Potential evapotranspiration (in.)	Estimated actual Evapotranspiration (in.)	AFIRO[a] (in.)
January	2.99	29.9	0.00	0.00	2.99
February	3.84	36.5	0.11	0.11	3.74
March	4.68	47.6	1.00	1.00	3.67
April	5.16	58.1	2.29	2.29	2.87
May	4.91	66.5	4.06	4.06	0.86
June	4.14	75.2	5.60	5.38	0.00
July	4.57	79.0	6.67	5.65	0.00
August	3.43	77.2	5.92	4.10	0.00
September	3.67	70.3	3.90	3.62	0.00
October	3.37	58.8	2.17	2.17	0.00
November	4.90	47.5	0.79	0.79	2.50
December	4.65	38.2	0.19	0.19	4.41
Monthly Average	4.19	57.1	2.73	2.45	1.75
Total	50.31		32.70	29.36	21.04

[a] AFIRO = Available for infiltration or surface runoff.

Source: National Climatic Data Center, Asheville, North Carolina (from CH2M HILL 1992).

Table 3.5. Sector 4 geology summary

Units	Avg. Depth (bgs)	Avg. Thick (ft)	Top Elev. (amsl)	Lithology
Fill	-	15.5	-	Reddish-brown sandy gravel, brown clay, and yellowish-brown silt
UCD	15.5	32	364	Heterogeneous consisting of interbedded layers of clay, silt, sand, and gravel
LCD	58	33	321	Medium to coarse-grained, sub-angular to sub-round, wet, yellowish-brown gravel
McNairy	91	-	288	moist, firm, fine to medium-grained, well to poorly sorted, light gray to brown sand with minor amounts of clay

Table 3.6. Sector 5 geology summary

Units	Avg. Depth (bgs)	Avg. Thick (ft)	Top Elev. (amsl)	Lithology
Fill	-	10.5	-	Reddish-brown sandy gravel and clay
UCD	10.5	32	373	Heterogeneous consisting of interbedded layers of clay, silt, sand, and gravel
LCD	62	32	326	Medium to coarse-grained, sub-angular to sub-round, wet, yellowish-brown gravel
McNairy	94	-	283	moist, firm, dark yellowish-brown clay with some mottling

Table 3.7. Sector 6 geology summary

Units	Avg. Depth (bgs)	Avg. Thick (ft)	Top Elev. (amsl)	Lithology
Fill	-	11	-	Yellowish-brown moist, stiff, clay and moist, firm, brown sandy gravel
UCD	11	46	366	Heterogeneous consisting of interbedded layers of clay, silt, sand, and gravel
LCD	57	30	320	fine to coarse-grained, yellowish-brown gravel
McNairy	87	-	290	very moist, plastic, yellowish-brown clay with bluish-green mottling

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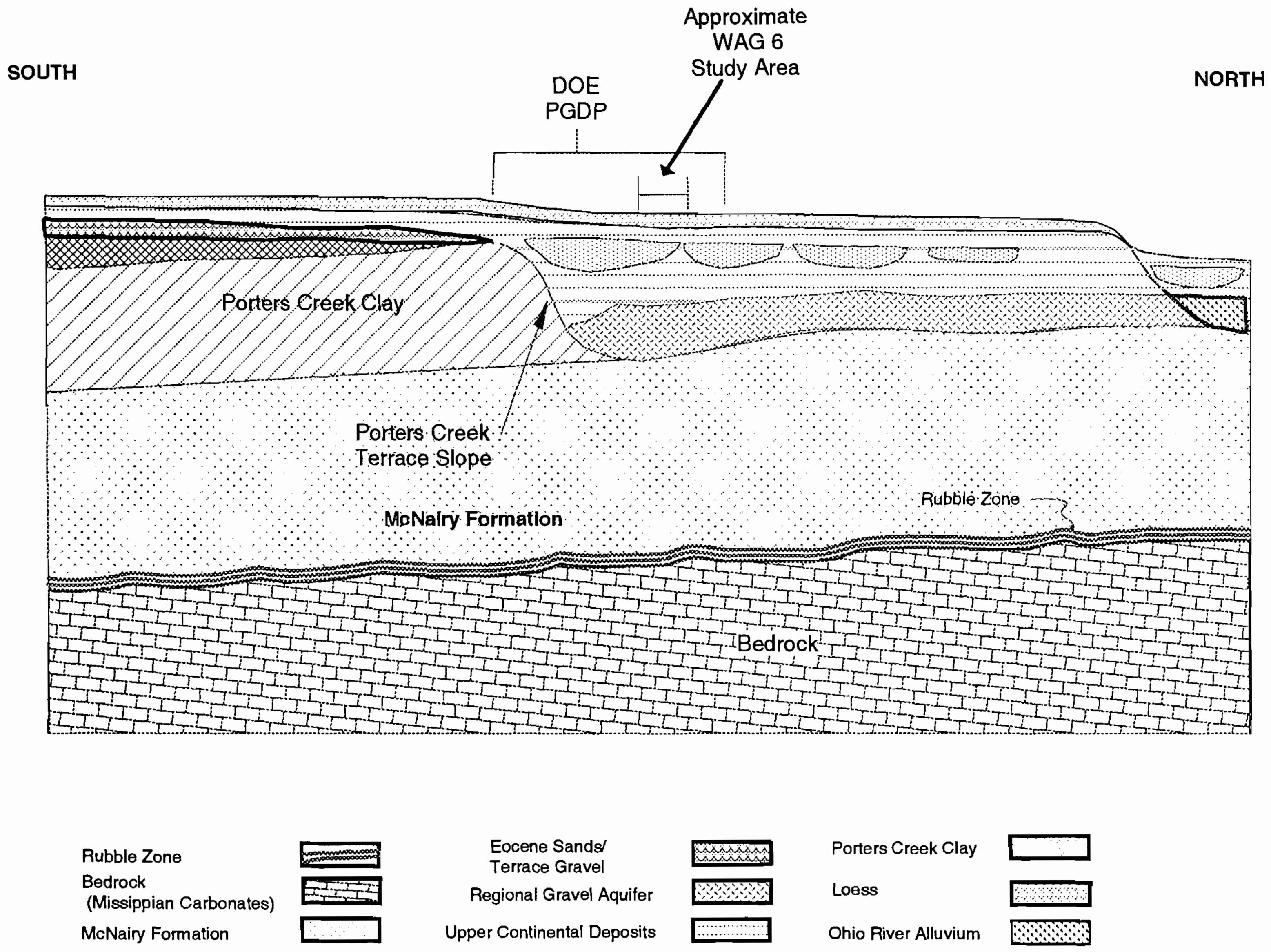

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Fig. 3.7. Regional stratigraphy for PGDP area.

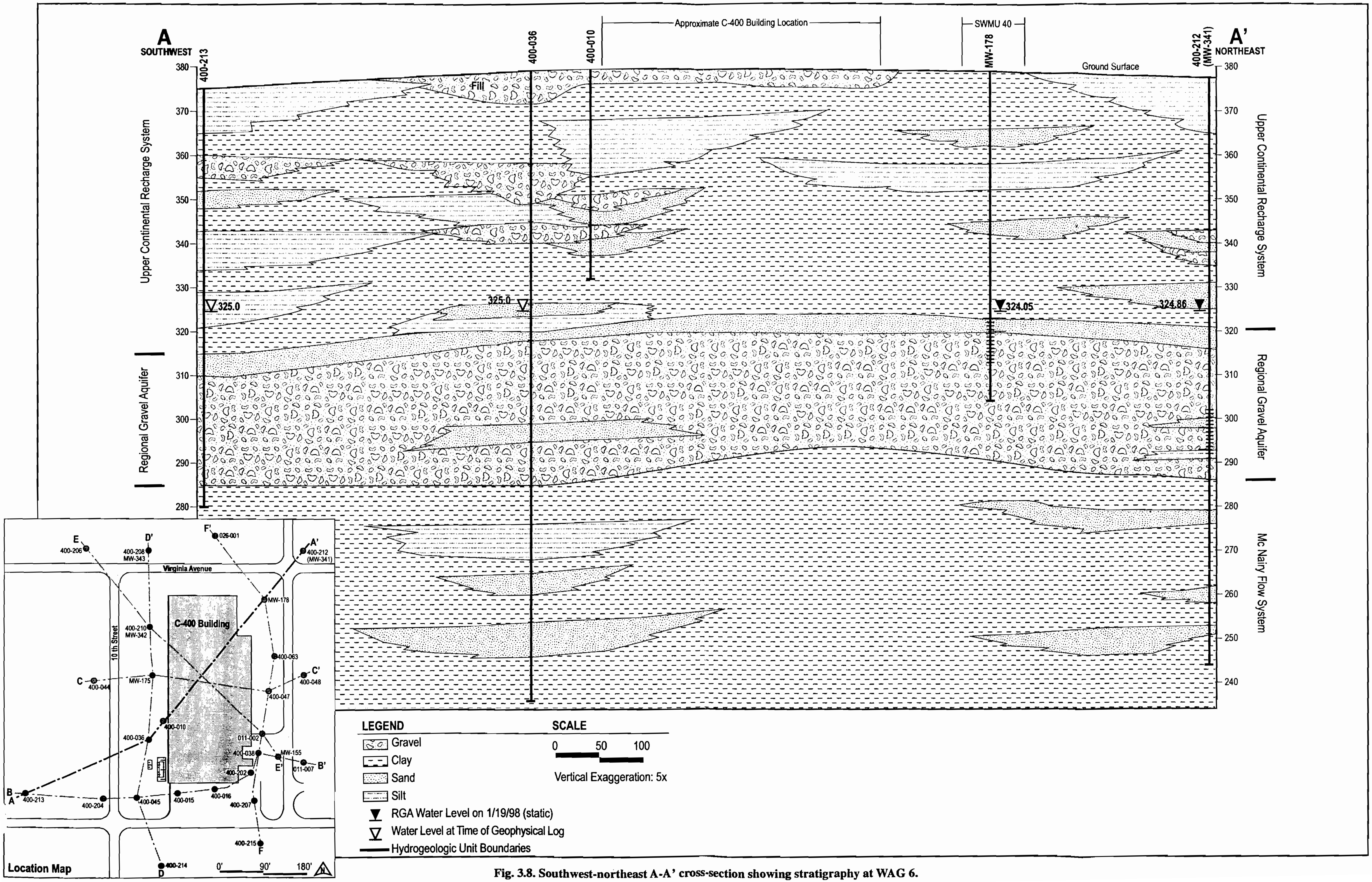

Fig. 3.8. Southwest-northeast A-A' cross-section showing stratigraphy at WAG 6.

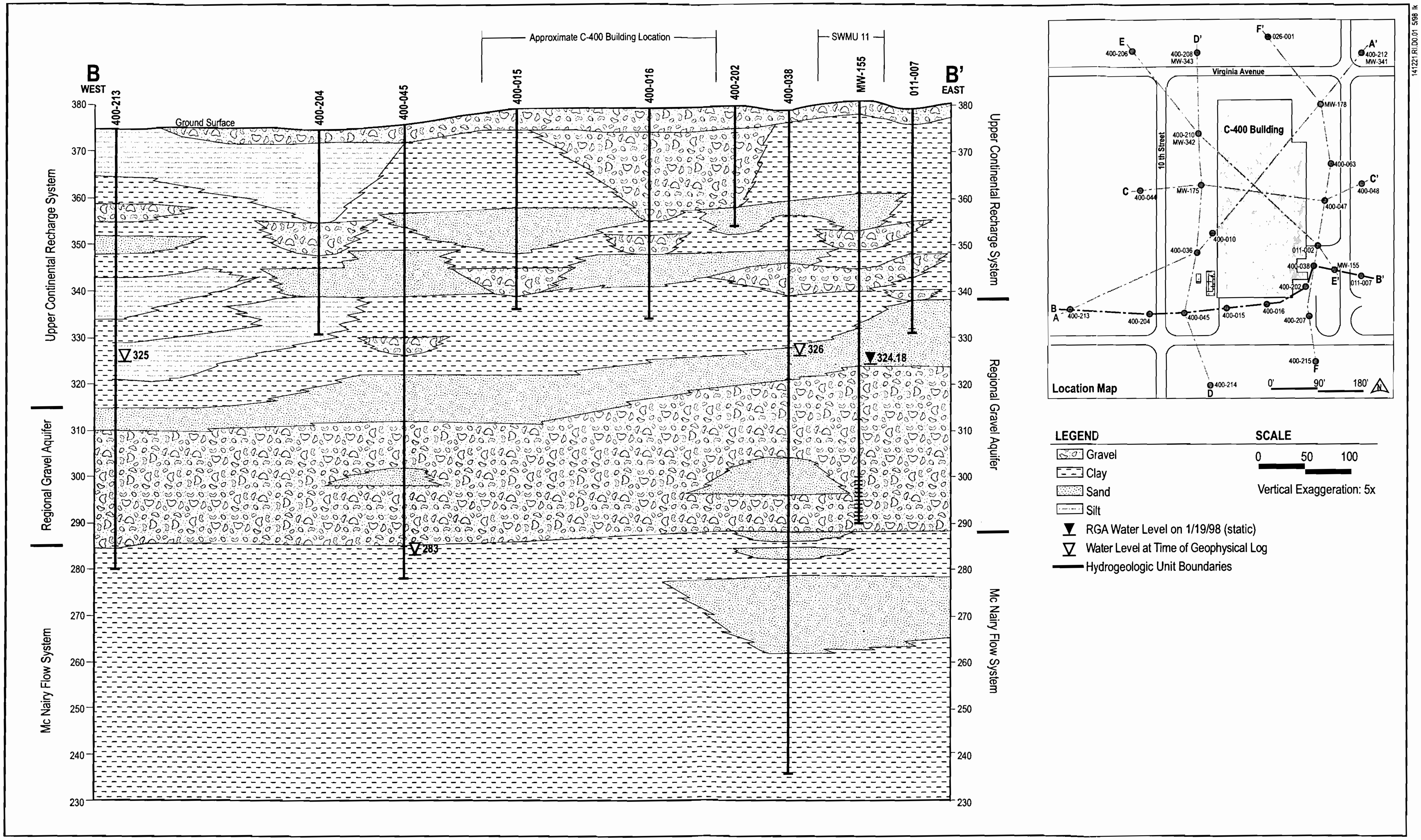

Fig. 3.9. East-west B-B' cross-section showing stratigraphy at WAG 6.

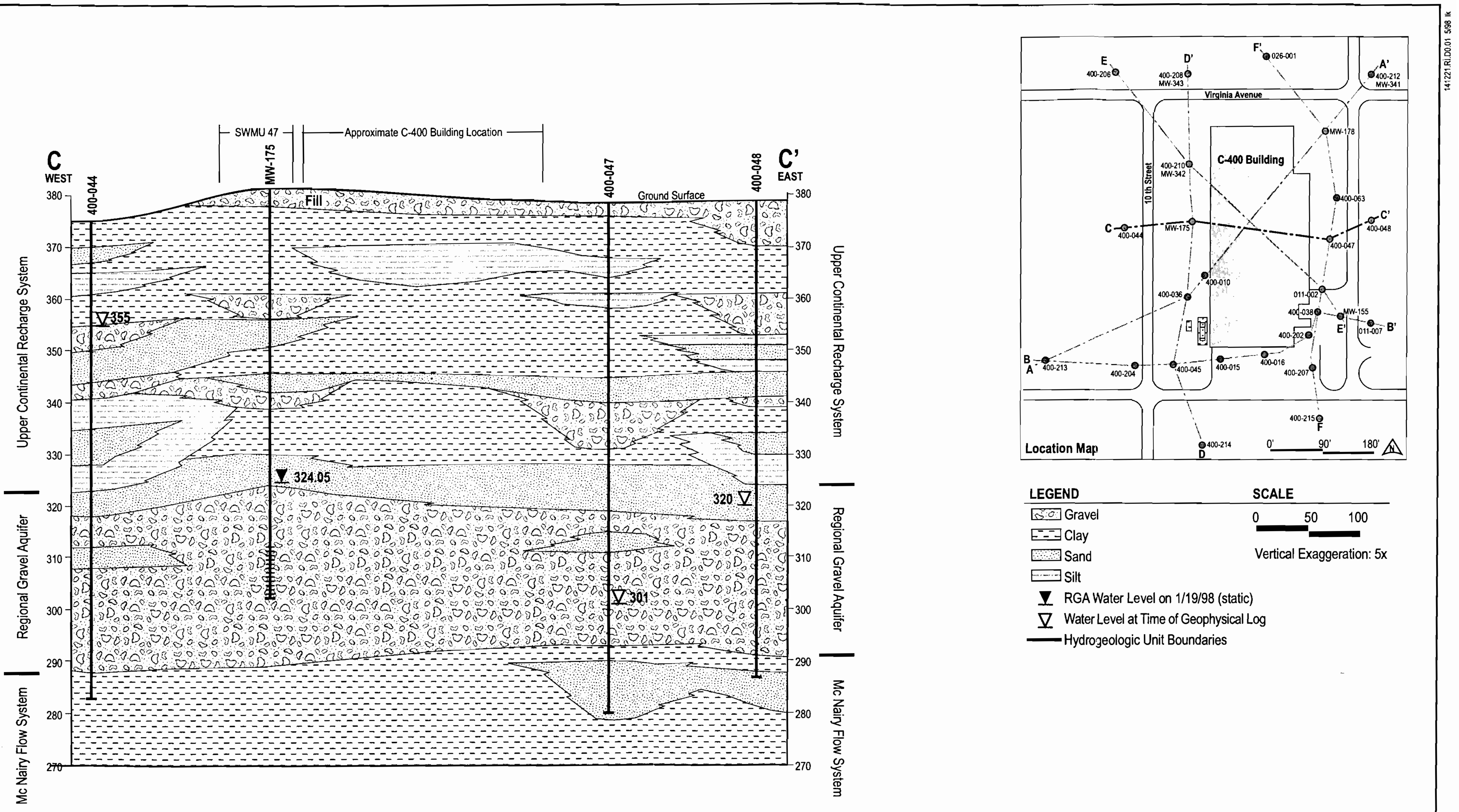

Fig. 3.10. East-west C-C' cross-section showing stratigraphy at WAG 6.

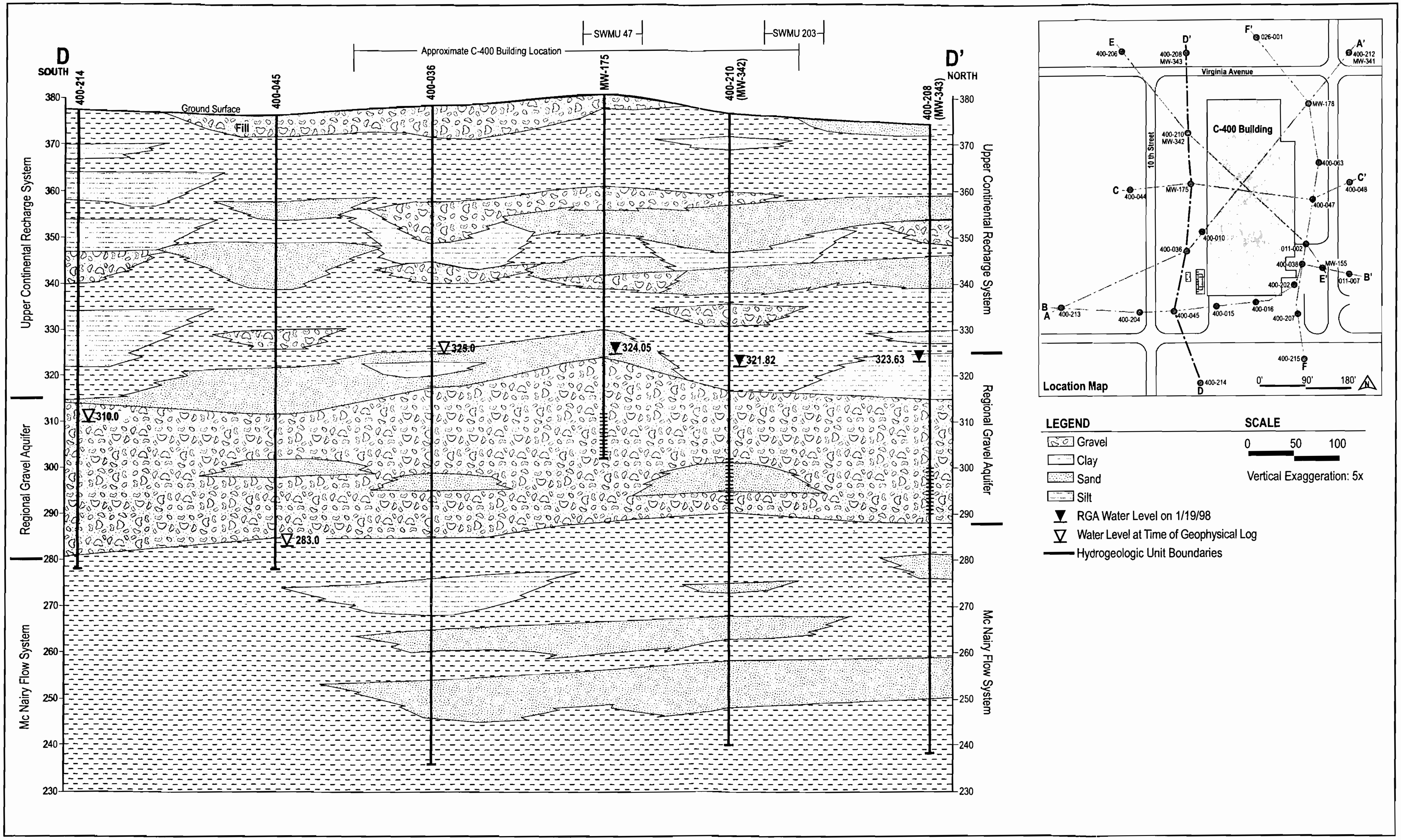

Fig. 3.11. North-south D-D'cross-section showing stratigraphy at WAG 6.

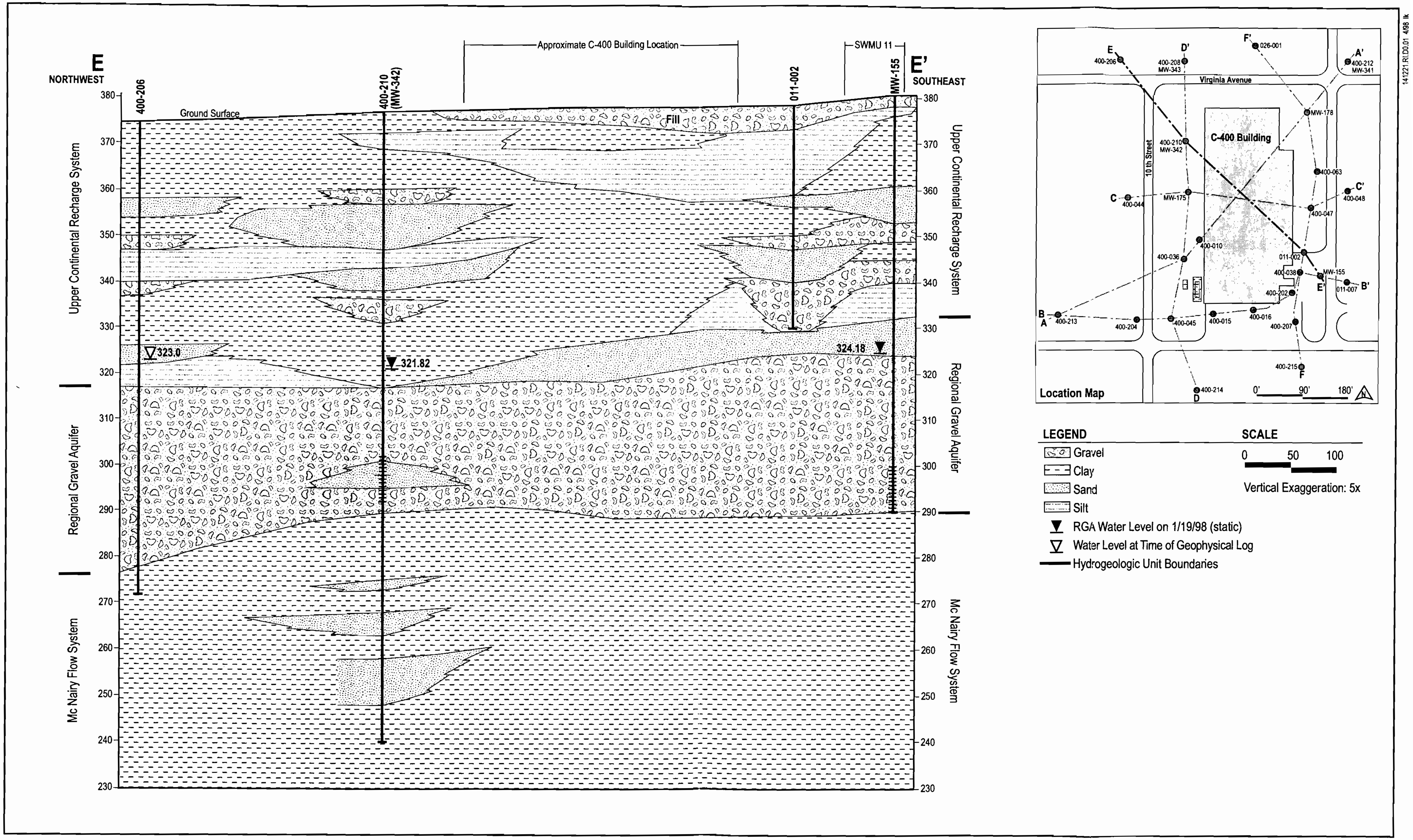

Fig. 3.12. Northwest-southeast E-E' cross-section showing stratigraphy at WAG 6.

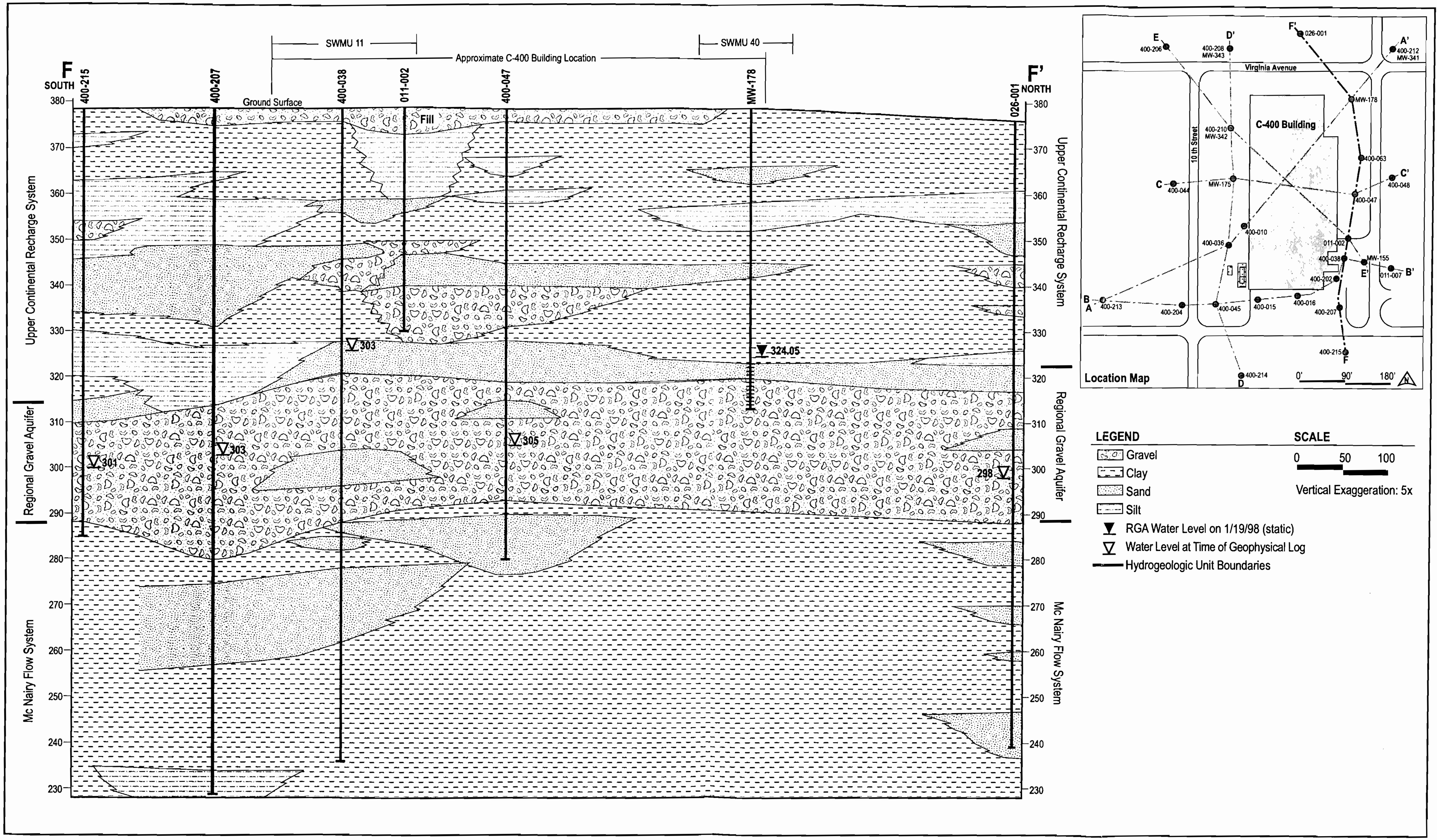

Fig. 3.13. North-south F-F' cross-section showing stratigraphy at WAG 6.

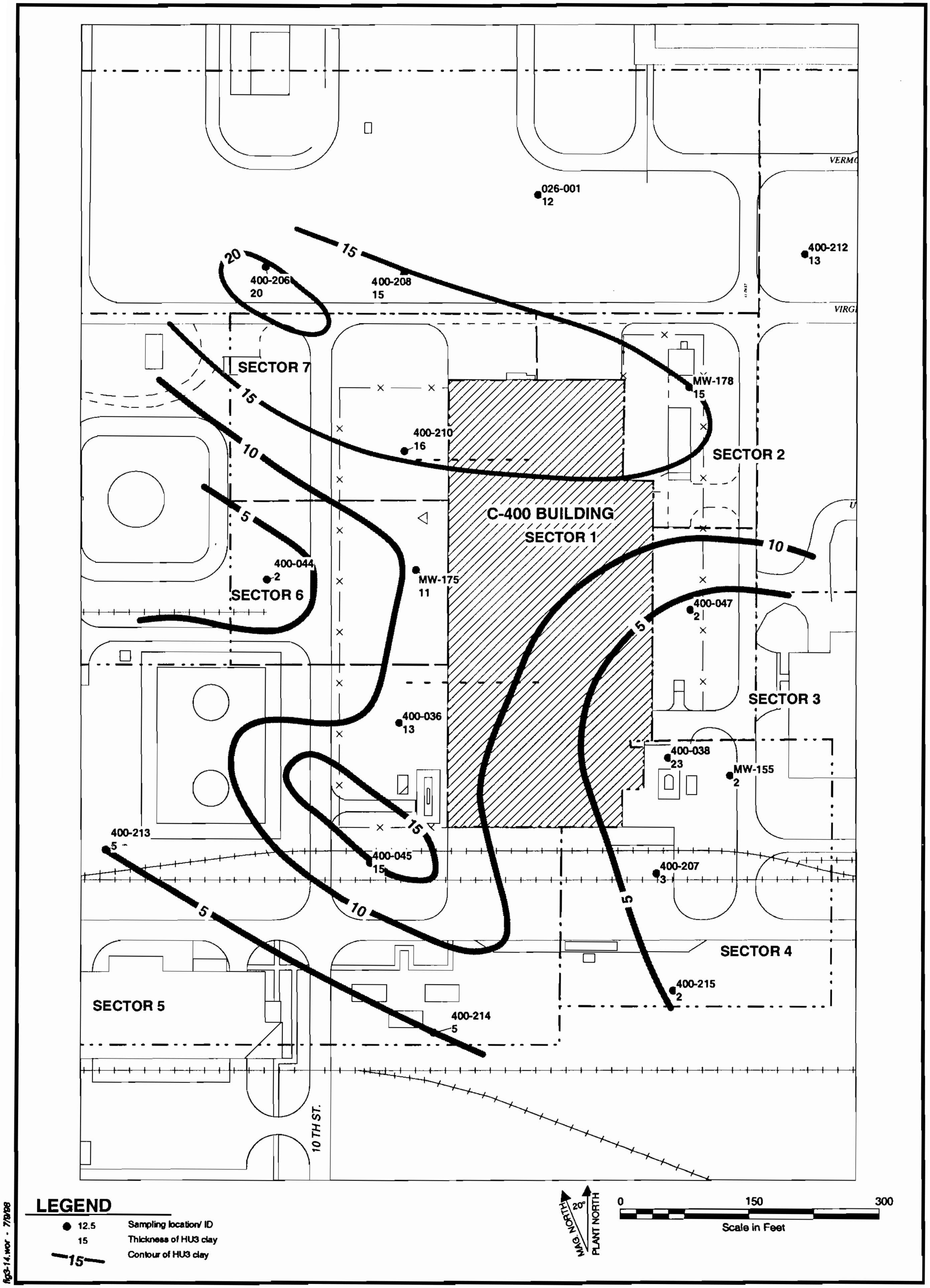

Fig. 3.14. Isopachous map of HU3 clay at base of UCRS.

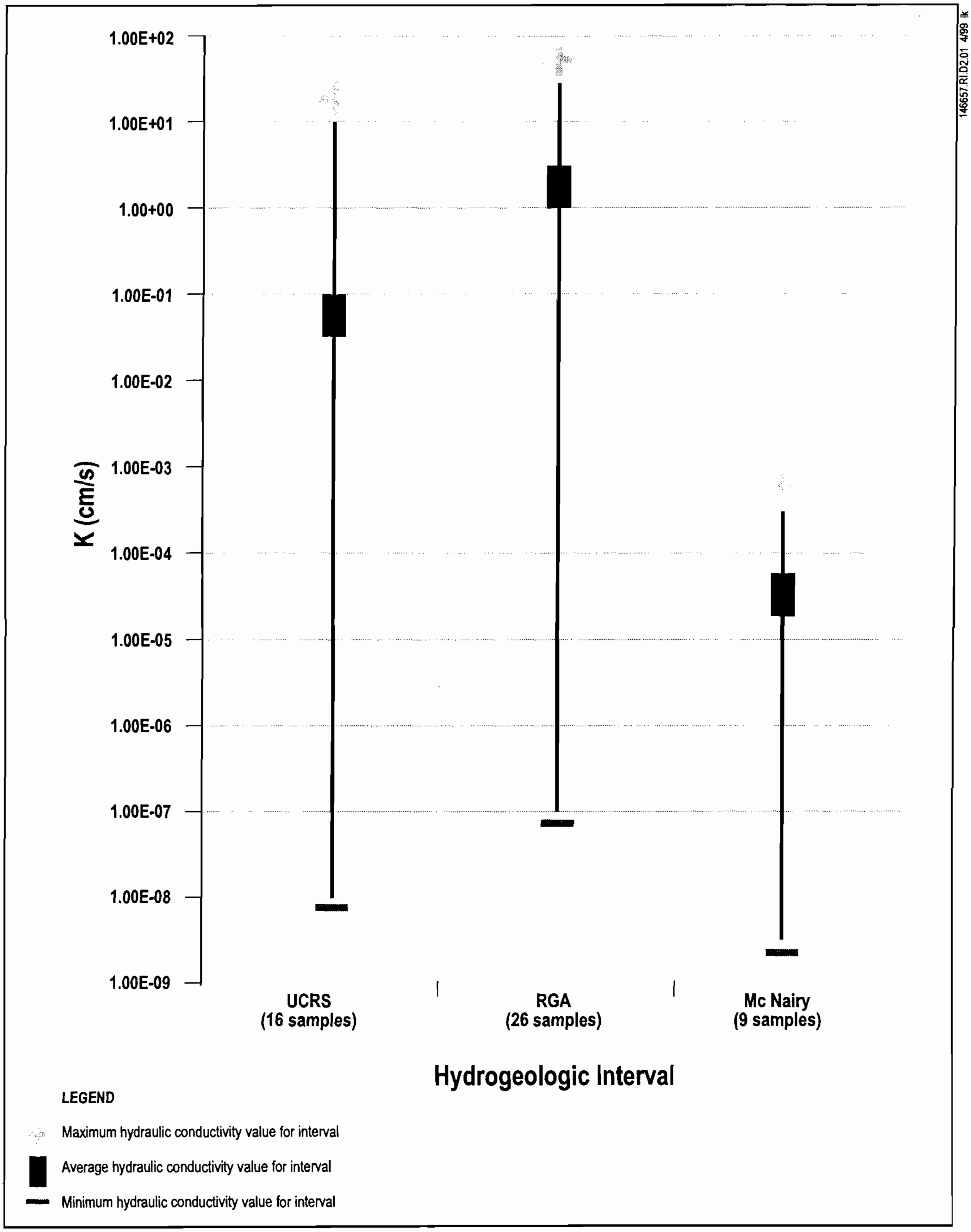

Fig. 3.15. Ranges of hydraulic conductivity (K) from WAG 6 RI laboratory results.

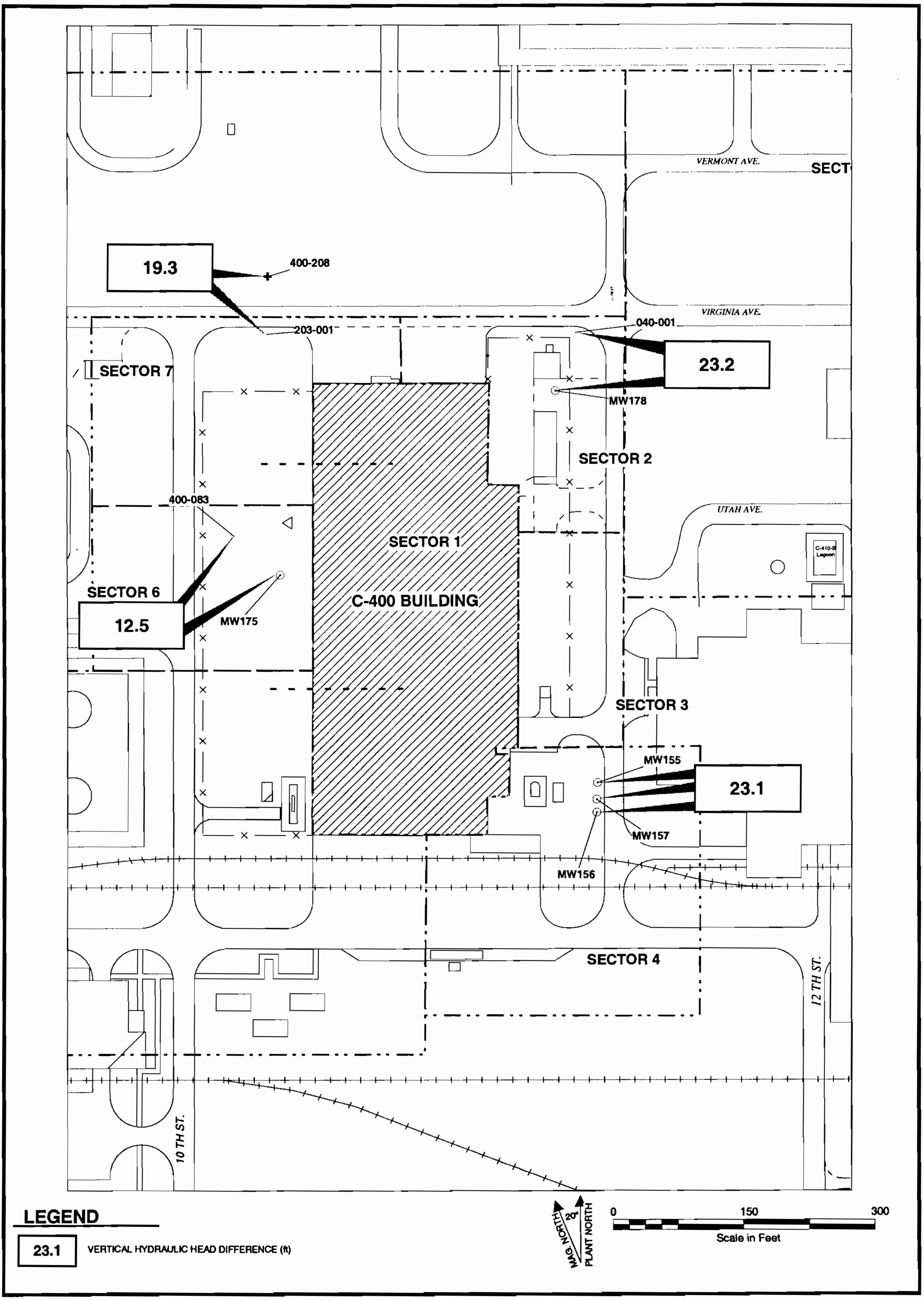

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Fig. 3.16. Vertical hydraulic differences between USRC and RGA.

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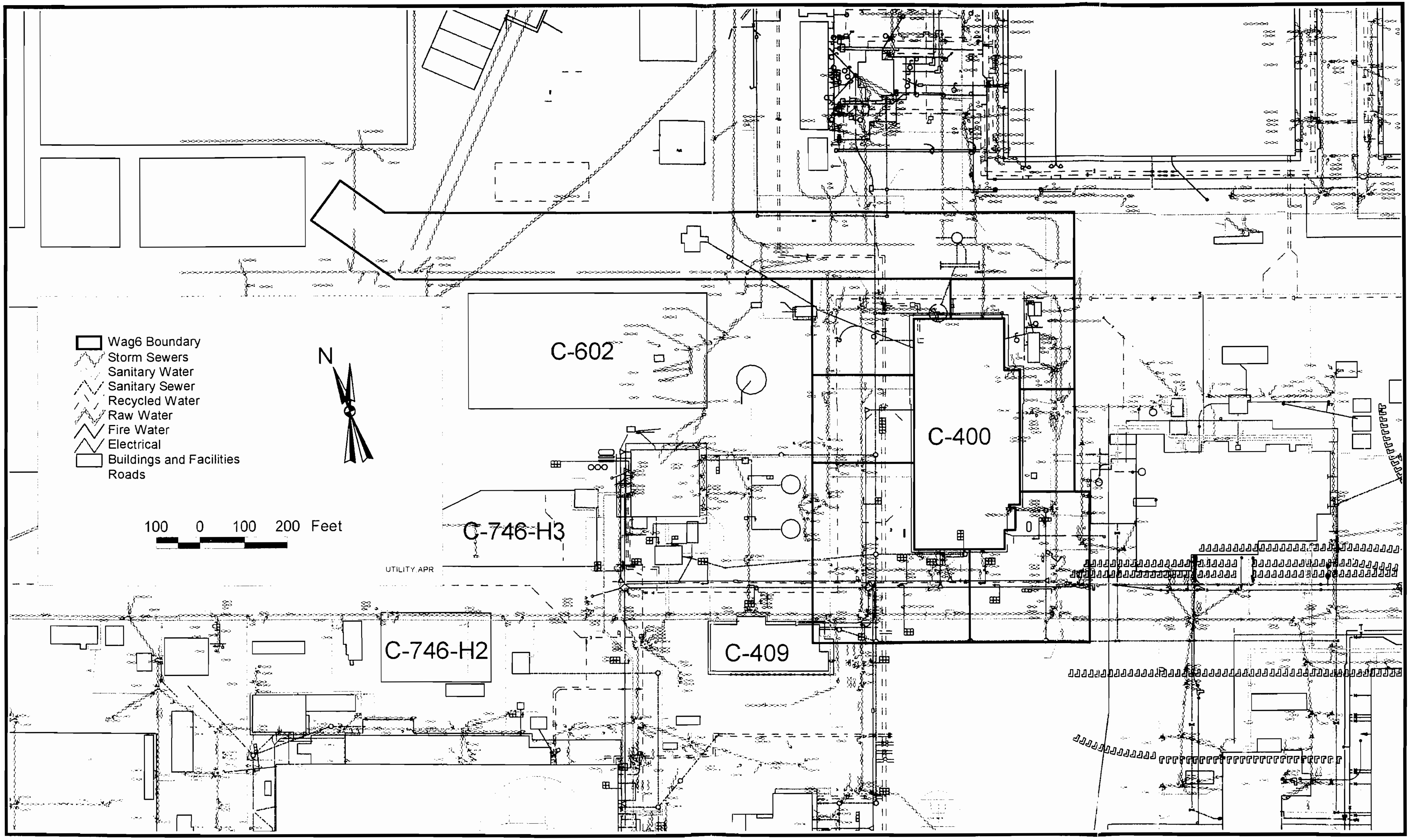

Fig. 3.19. Underground utilities at WAG 6.

4.0 NATURE AND EXTENT OF CONTAMINATION

4.1 INTRODUCTION

Environmental data from each sector investigated during the WAG 6 RI field activities have been compiled, screened, and evaluated to assess the nature and extent of site-related contamination. Summary tables containing analytical results for each of the nine sectors are included in this section. A complete report of analytical results for all samples collected during this investigation is provided in Appendix J (Volume 4). Also contained in Appendix J is a complete list, by sample identification number, of all samples analyzed during the WAG 6 RI. The data set in Appendix J contains information concerning which of the five analytical groups (VOAs, SVOAs, PCBs, metals, or radionuclides) were tested for in each sample.

The extent of contamination discussed in this report was based on the presence of site-related contaminants in surface or subsurface soils and groundwater. The PGDP site remedial action priorities are to mitigate imminent threats, control hot spots as they are discovered, and address source units followed by final actions for groundwater and surface water (DOE 1995a). To remain consistent with this existing characterization and remediation strategy, the RI activities did not include an investigation of the complete extent of potential groundwater contamination. Data collected from the WAG 6 RI will be used as a basis for remedial decisions concerning the groundwater OU.

4.1.1 Screening Process

The data screening process used in this RI was critical for determining when analytes represented site-related contaminants as opposed to laboratory contaminants or constituents that occur naturally in the soil or groundwater. Additionally, due to the volume of data, screening was used as a tool to focus the discussion of the nature and extent of contamination on those constituents that are most likely to have a potential for impact to human health and the environment. The screening process is described in the following paragraphs.

Screening of the inorganic constituent and radionuclide data was accomplished by comparing data collected during this RI with historical data representative of naturally occurring conditions and concentrations in the surface soil, subsurface soil, and groundwater at the PGDP site (i.e., background data). Detections of metals and radionuclides in concentrations above these historical backgrounds were considered indicative of potential soil contamination. No additional project-specific background data were collected during the WAG 6 RI.

Table 4.1 presents the background values used for site screening. Background values for analytes in groundwater were obtained from DOE (1994); background values for surface soil and subsurface soil were obtained from DOE (1997). To facilitate an understanding of the WAG 6 concentrations reported from a health-based risk perspective, Table 4.2 provides a comprehensive list of preliminary remediation goals (PRGs) for substances detected within the WAG 6 sampling effort.

Organics such as VOAs, SVOAs, and PCBs are all considered man-made and do not occur naturally and, therefore, were not screened against background data. However, analytical results for all organic compounds were screened for six constituents determined to be laboratory contaminants (see Sect. 2.8.5.3). The organic compounds determined to represent laboratory contamination and not site contamination were methylene chloride, carbon disulfide, acetone, bis (2-ethylhexyl) phthalate, butyl benzyl phthalate, and di-n-butyl phthalate. Thus these compounds are not included in the summary analytical tables presented in this section.

During the data evaluation process, it became apparent that the discussion should focus on data representing significant, site-related contaminants and that—due to the volume of data generated during this RI—additional screening would be required. This additional screening process was not intended to eliminate any compounds or analytes as potential contaminants of concern, but as a tool to focus the discussion of nature and extent on those compounds/analytes that are site-derived and have had significant impact on the WAG 6 soil or groundwater. These key constituents are listed in Table 4.3. This list was derived from a table of risk-based chemicals of concern at PGDP (see Sect. 6, Table 6.2) and was used to focus the sector characterizations on those chemicals or compounds that will probably be the drivers for remediation. Additionally, the following assumptions were made for purposes of this discussion:

1. The widespread occurrence of low polycyclic aromatic hydrocarbon (PAH) concentrations in surface and shallow subsurface soil samples across the PGDP facility is probably the result of coal-fired combustion operations of the PGDP and the TVA (RI Report for WAGs 1 and 7, LMES 1995).
2. The relatively widespread distribution of low concentrations of radionuclides does not represent a single release of contaminants at WAG 6, but is probably related to plantwide activities.
3. Analytes that occur only in small quantities, below the Standard Quantitation Limit (SQL), represent little risk for significant impact to the site media.

4.2 WAG 6 SOILS

To determine the nature and extent of contaminant groups found within the nine sectors of WAG 6, samples of groundwater and surface and subsurface soils from each sector were collected. These samples were analyzed for suites of compounds in the chemical groups of VOAs, SVOAs, PCBs, inorganics, and radionuclides.

Following a general introduction and description of the entire WAG 6 area, each of the nine sectors that comprise the area is characterized individually. The discussion of each sector begins with an introduction that provides a summary of the sector's history, including site conditions for each sector. An accompanying sector base map depicts soil sample locations, facility structures, transportation pathways (e.g., roads and railroad tracks), and utility lines. The utility lines (stormwater, sanitary water and sewer, recirculation water, and perimeter drain waste collection) and other pipes are extensive in some sectors. However, due to their potentially important role in contaminant dispersion, the utility lines are depicted on sector maps.

Descriptions of the known processes within each sector that may have contributed to contaminant impact follow the paragraphs that characterize the site's physical properties.

For example, common processes are the storage or transport of chemicals from tanks through sumps and pipes that may have caused releases due to ruptures along joints.

In addition to size, topography, and man-made features, the location of the physical boundaries of the sector, previous sampling events, and relevant historical data for the sector are summarized. In Sector 4, a contaminant removal activity was performed and a description of this activity is included in the Sector 4 discussion.

The nature and extent sections begin with an overview of the number and type of samples collected from each sector during WAG 6 RI activities. Tables that summarize analytical results for the sector as well as a table showing the detected analytes and their frequency of detection are referenced.

The base maps show the locations of the soil borings and provide a general overview of the lateral distribution for the selected contaminant groups: VOAs, SVOAs, PCBs, inorganics, and radionuclides. These maps were compiled for each sector based on the distribution of the constituents listed in Table 4.3 that were detected in concentrations or at activities above the SQL.

The Summary of Findings for each sector provides a synopsis of the analytical results, including interpretations. The area or areas of concern within each sector, the constituents involved, and the probable source or sources are described. However, specific data (sample locations, depths, and analytical results) are mentioned here only if required, as these are discussed in detail below.

Following the Summary of Findings, the text focuses on a sector-specific description based on all analytical results above the PGDP background screening values. The text in this section includes the following information:

- Depth range from which samples were collected
- Number of locations within each sector from which samples were collected (including figure references)
- Number and nature of individual constituents of each particular chemical group that were encountered
- Frequency of detection
- Description of analytical results

The written descriptions are accompanied by one or more maps that show the distribution of selected contaminants for each sector. Interpretations are excluded from the data description section, because these have been included in the Summary of Findings for each sector.

C-400 Area History

Location and Physical Description

The C-400 Area is located near the center of the industrial section of PGDP, bounded by 10th and 11th Streets to the west and east, respectively, and Virginia and Tennessee Avenues to the north and south, respectively. The C-400 Building rests on a 16-in. concrete floor designed with four main pits/sumps and an east-side basement area. The east-side basement includes a plenum/fan room system to ventilate the building.

Floor drains found throughout the building empty into interior and exterior building sumps or directly into storm sewer lines. Sumps for wastewater treatment and/or disposal are located northeast (SWMU 40) and northwest (SWMU 203) of the C-400 Building. Many buried utilities service the C-400 Building and/or pass under the area. Drawings and construction photographs suggest that the building floor overlies approximately 10 ft of gravel backfill.

Practices and Release Description

Cleaning (clothes laundry and machinery parts), disassembly of cascade components, and testing of cascade components are the primary activities for which the building was designed. The building has also housed many other activities, including recovery of precious metals and treatment of radiological waste streams.

Suspected sources of releases and spills at the C-400 Area that may have contaminated area soil and groundwater include (1) process equipment (e.g., cleaning tanks), (2) drains and sewers, (3) the east-side plenum/fan room system, (4) tanks and sumps outside the building, and (5) various first floor processes. These sources have resulted in contamination of soil and groundwater by volatile organics (degreasing chemicals) and radionuclides. Contamination by metals and SVOAs is also possible.

Three SWMUs associated with other WAGs are located in proximity to the C-400 Building. The C-410 feed plant is located across 11th Street from the C-400 Area, the North-South Diversion Ditch is located just north of the C-400 Building, and the C-405 incinerator is located across 10th Street. These are also considered potential sources of soil or groundwater contamination.

Location and Results of Previous Sampling

Regionally, two plumes of VOA (notably TCE) and the radionuclide ^{99}Tc in groundwater extend parallel from PGDP several miles to the north. Locally at PGDP, one plume is migrating in a northeast direction while a second plume is trending toward the northwest. A groundwater investigation (Garner, Morti, and Smuin 1995) confirmed the C-400 Area as the primary source of the Northwest Plume contaminants. The C-400 Area has also been suspected to be a contributing source of contaminants to PGDP's Northeast Plume. Potentiometric trends in the upper aquifer and in well-flow measurements confirm divergence of groundwater flow under the C-400 Area (DOE 1997), as indicated by the geometry of the two plumes.

Dissolved concentrations of VOAs in the C-400 Area are indicative of the presence of TCE as a dense, nonaqueous-phase liquid (DNAPL) both in the vadose zone and in groundwater. Past processes performed at the C-400 Building and the extent of the groundwater contamination suggest that a DNAPL zone is present in the subsurface. The highest dissolved TCE concentrations (approaching the solubility limit) were found southeast of the C-400 Building at the SWMU 11 Trichloroethene Leak Site (CH2M HILL 1992). Delineation of the horizontal and vertical extent of DNAPL was a primary objective of the WAG 6 RI.

Some of the highest ^{99}Tc activities observed in groundwater at PGDP occur near the C-400 Building. Likely sources include the C-403 Neutralization Tank (SWMU 40), the Technetium Storage Tank (SWMU 47), the Waste Discard Sump (SWMU 203), and the North-South Diversion Ditch. Another objective of the WAG 6 RI was to define the contribution of each of these sources and determine whether others exist in the C-400 Area.

4.2.1 Sector 1 (C-400 Building)

4.2.1.1 Site History

Cleaning (laundry and machinery parts), disassembly, and testing of specialized facility equipment are the primary activities within the building. The building has also housed many other activities, including recovery of precious metals and treatment of radiological waste streams.

Suspected sources of releases and spills in the C-400 Building that may have contaminated area soil and groundwater include (1) process equipment (e.g., cleaning tanks), (2) drains and sewers, (3) the east-side plenum/fan room system, and (4) various first floor processes.

4.2.1.2 Nature and Extent of Contaminants

Two borings were drilled and sampled inside the C-400 Building (Fig. 4.1). At both boring locations, the concrete floor of the building was core drilled before sampling could begin. Subsurface soils were collected between 4 and 48 ft below the top of the building floor. Twenty-one samples, including one duplicate, were analyzed for VOAs. Four samples (including one duplicate) were analyzed for SVOAs, and five samples (including one duplicate) were analyzed for metals. Twenty samples (including one duplicate) were also analyzed for radionuclides. The results of these analyses are summarized in Tables 4.4 to 4.6. In addition, Table 4.7 (frequency of detection) provides information about the analyses conducted on soils in Sector 1.

Summary of Findings

Two borings were drilled inside the C-400 Building to collect soil samples from below the building that would help to characterize the backfill and shallow soils below the building and to confirm and define the area of TCE soil contamination that is the source for the recognized off-site groundwater plumes. TCE was detected from the soils collected from both borings; however, the concentrations were much greater in Boring 400-020. In Boring 400-020, two discrete zones of elevated TCE were reported between 12 and 48 ft bgs. A maximum concentration of TCE of 2900 micrograms per kilogram (μg/kg) was detected near the base of the UCRS vadose zone and may be related to a widespread zone of TCE contamination detected at the southeast side of the building in Sector 4.

Analytical Results–Surface and Subsurface Soils

<u>Organics</u>

VOAs. Small quantities of toluene and chloroform were reported from the subsurface of Sector 1. Of these compounds, chloroform was detected only once and neither chloroform nor toluene was found at concentrations that exceeded the SQL. TCE was detected in two borings. At Boring 400-019, the maximum was 13 μg/kg in a sample collected from 28 ft bgs.

In Boring 400-020, TCE ranged from 17 µg/kg to 2900 µg/kg between 16 and 48 ft bgs. The maximum concentration was near the base of the UCRS. In addition to the high TCE at the base of the UCRS, a second zone of elevated TCE containing 700 µg/kg was detected at approximately 20 ft bgs in this boring.

SVOAs. No SVOAs were reported from the Sector 1 subsurface soils.

Inorganics

Five metals were detected above background concentrations in the subsurface soils collected below the C-400 Building. Antimony and thallium were detected only at concentrations below the SQL. Iron and cadmium were reported at concentrations only slightly above background levels. The most widespread inorganic substance was the common rock-forming element, sodium.

Radionuclides

Small quantities of two radionuclides were detected above screening levels from the subsurface soils of Sector 1. The soil samples contained ^{137}Cs at a maximum activity of 0.5 pCi/g and ^{237}Np at 0.3 pCi/g. These two radionuclides were reported from both Borings 400-019 and 400-020 at depths between 8 and 44 ft bgs.

4.2.2 Sector 2 [C-403 Neutralization Tank (SWMU 40)]

4.2.2.1 Site History

Location and Physical Description

The C-403 Neutralization Tank is located at the northeast corner of the C-400 Cleaning Facility. It consists of a 25-ft-square by 26-ft-deep, in-ground open-top tank constructed of concrete and lined with two layers of acid brick. Influent from C-400 Building was received from an 8-in.-diameter Duriron acid waste line. The C-403 Neutralization Tank was connected to the C-402 Lime House by a 4-in.-diameter Duriron transfer line.

Practice and Release Description

The C-403 Neutralization Tank was used for the storage and treatment (i.e., neutralization) of acidic, uranium-bearing waste solutions generated during cleaning operations in the C-400 Building. During treatment, a lime slurry was added to the wastewater from the C-402 Lime House to raise the pH and precipitate out the uranium in the form of a low-level radioactive sludge. Once the pH was raised to the proper level (10 to 12), the effluent was discharged to the C-404 Holding Pond where the sludge was allowed to settle out of the solution. In 1957, the discharge from the C-403 Neutralization Tank was routed to the North-South Diversion Ditch, where it flowed to the Little Bayou Creek. In the late 1970s, the flow from the North-South Diversion Ditch was routed into the C-616-F Full Flow Lagoon, and direct discharge to Little Bayou Creek was subsequently discontinued. Drawings for C-403 show that a 15-in. vitreous-clay pipe was installed between the C-403 Neutralization Tank and the C-410-B Neutralization Lagoon. This pipe was constructed utilizing part of an existing stormwater line. The intended purpose of this line is unknown. The C-410-B Neutralization Lagoon was used for the neutralization of hydrogen fluoride cell electrolytes.

The C-403 Neutralization Tank was not used to neutralize waste solutions from the C-400 Cleaning Facility after 1957, because treatment equipment was installed in the C-400 Building to complete the neutralization process. Although neutralization was no longer carried out at C-403, low-level, uranium-bearing wastewater continued to be discharged to C-403 until 1990. These discharges included UF_6 cylinder hydrostatic-test water, overflow and runoff from cleaning tanks, discharge from floor drains, and other unknown sources.

Location and Results of Previous Sampling

The C-403 Neutralization Tank was investigated during the Phase II SI completed in 1991 and 1992. Field activities completed during the Phase II SI included the installation of two groundwater monitoring wells (MW-177 and MW-178) south of C-403. Five composite soil samples were collected during the drilling of the borehole for MW-178 at depths ranging from 14 to 44 ft bgs. Soil samples were analyzed for TCL VOA, SVOA, pesticides/PCBs, TAL metals, cyanide, dioxins and furans, and selected radioisotopes including ^{235}U, ^{238}U, ^{99}Tc, ^{239}Pu, and ^{230}Th. No contamination was detected in any of the samples collected from MW-178. No soil samples were collected from the MW-177 borehole.

In late 1989 and early 1990, PGDP pumped the standing water from C-403. The C-403 Neutralization Tank was covered with a Hypalon plastic cover after the removal activities were completed in an unsuccessful attempt to prevent water from entering the pit. In 1993, nine water and three sediment samples were collected from the C-403 tank. These samples reported TCE concentrations between 17 and 1300 µg/L [parts per billion (ppb)]. TCE concentrations in the three sediment samples ranged from 35 to 6700 ppb. In addition to TCE, PCBs and uranium also were detected. During the WAG 6 RI field investigation, a water line located near the C-403 Tank broke, and subsurface water apparently flowed into the tank where one of the still extant fill lines enters the tank. Approximately 10 to 12 ft of water accumulated in the tank. Samples of the water from the tank were analyzed during November 1997 and found to contain as much as 21,000 ppb TCE and a gross beta activity of 43,750 pCi/L. Re-sampling in January 1998 indicated that the TCE content of the tank had dropped to 5600 ppb and that the beta activity was only 4430 pCi/L.

No spills or releases are known to have occurred within Sector 2. Previous sampling activities and process knowledge indicate that the processes described above represents potential sources for several organic, inorganic, and radiological contaminants, including TCE, uranium, ^{99}Tc, and PCBs.

4.2.2.2 Nature and Extent of Contaminants

Sampling at Sector 2 (SWMU 40) was conducted to determine whether or not releases of contaminants into the soil and groundwater had occurred and to define the extent of any identified contamination. Much of the sector is covered by man-made structures, and only limited surface soil is exposed. Shallow (15-ft) borings were drilled along utility lines to assess these corridors as potential migration pathways. At the C-403 Neutralization Tank, soil beneath influent and effluent lines was also investigated to check for the possibility of line releases. Several deep borings were drilled in proximity to the tank and near the C-400 Building to assess whether processes at either the C-403 Neutralization Tank or the C-400 Building had resulted in undiscovered releases of contaminants to the surrounding environment.

Six surface soil samples were collected from Sector 2. Three of the samples were collected due west of the C-403 Neutralization Tank (SWMU 40), and three sampling sites were located on the west and south side of the C-402 Limehouse. Thirty-three subsurface soil samples, including two duplicates, were collected from 19 locations in Sector 2 (Fig. 4.2). The samples were collected between 5 and 49 ft bgs and were analyzed for VOAs, SVOAs and metals. Twelve samples were selected for isotopic analyses. Twenty-two of the samples were screened for PCBs. The results of these analyses are summarized in Tables 4.8 through 4.11. In addition, information concerning the frequency of detection is given in Table 4.12.

Summary of Findings

Contamination related to spills and releases was identified in both the surface and subsurface soil samples within Sector 2. Three distinct areas have been defined that appear to have been impacted.

A small area of surface soil between the C-402 Building and the C-400 Building was found to be impacted with moderate concentrations of several common PAH compounds. The extent of contamination appears to be confined both vertically and horizontally to the surface soil surrounding Boring 400-005. The source for the identified SVOA contaminants is unknown, but these compounds could have been derived from any number of one-time surface releases associated with the operation of an industrial facility.

A second area of contamination is associated with the floor drain collection line on the outer perimeter of the C-400 Building. Low levels of several radionuclides were detected between 15 and 40 ft bgs along this line.

A third area of contamination is associated with the C-403 Neutralization Tank and the former storm sewer. Subsurface soil collected adjacent to the tank backfill at a depth of 30 ft bgs was found to be impacted by several radionuclides. Based upon available data, the extent of contamination around the C-403 Neutralization Tank appears to be limited to the area of the tank backfill. Elevated radioactivity was also detected at a few locations along the former storm sewer utility line that connects the C-403 Neutralization Tank to the HF Lagoon. High concentrations of two metals, silver and antimony, were associated with the area of elevated radioactivity detected along this line. Both metals were used in the plating process that was performed within the C-400 Building.

Sporadic occurrences of contamination along the utility corridor suggest that leaking joints or cracks provided isolated point sources for contaminant introduction into the subsurface.

Analytical Results–Surface and Subsurface Soils

Organics

VOAs. Only small quantities of four VOAs were reported for soils from Sector 2, and these were found at concentrations below the SQL.

SVOAs. Seventeen SVOAs, most of which are PAH compounds, were reported from the six surface soil samples from Sector 2. The only samples that contained SVOAs in concentrations above the SQL (Fig. 4.3) were the sample collected at Boring 400-005 between the C-400 Building and the C-402 Limehouse and the sample from 400-008 collected south of the Limehouse. The sample from 400-005 had the maximum concentrations of all 17 detected

SVOAs, including fluoranthene at 8285 μg/kg and pyrene at 7853 μg/kg. Sample 400-008 contained only one SVOA, fluoranthene, at a concentration above the SQL. Subsurface soil samples did not contain significant quantities of SVOAs.

PCBs. Four surface soil samples and 18 subsurface soil samples collected from 11 locations within Sector 2 were analyzed for PCBs. Only PCB 1260 at 43 μg/kg in sample 400-008 was reported at a concentration above the SQL.

Inorganics

Fifteen metals were reported at concentrations that exceeded PGDP background levels; however, most were only slightly above background. Two of the metals, silver and antimony, both used in the processes performed at the C-400 Building, exceeded the PGDP background levels by approximately 2 and 22 times, respectively. The single exceedance for silver of 4.28 mg/kg was from the 10- to 14-ft-bgs sample of Boring 400-059. The same sample contained 4.7 mg/kg of antimony.

Radionuclides

Seven isotopes were detected above screening levels. The radiological constituents generally were found in two areas. One location was from samples collected at Borings 400-007 and 400-008, between the C-402 Building and the C-400 Building. At these locations, activities of less than 5 pCi/g of ^{99}Tc, ^{230}Th, ^{234}U, ^{235}U, and ^{238}U were detected in the surface soil sample and low activities (less than 2 pCi/g) of ^{230}Th and ^{241}Am were detected in the subsurface samples collected at 9 to 12.5 and 35 to 42 ft bgs, respectively.

A second area of radiological contamination was located around the C-403 Tank and along the adjacent storm sewer line. Most of the detected isotopes in this area are found below 7 ft bgs and at low levels of ^{237}Np, ^{241}Am, ^{230}Th, ^{99}Tc, ^{234}U, ^{235}U, and ^{238}U. Uranium-238 had the highest activity of any of the radionuclides at 20.2 pCi/g. The distribution of ^{238}U within Sector 2 is shown in Fig. 4.4.

No ^{238}U radionuclide activity was detected in the sample from Boring 040-005, which was collected at approximately 15 ft bgs along the storm sewer line between Borings 400-056 and 400-061, both of which contained reportable activities of ^{238}U. This observation suggests that this storm sewer line had probably leaked along pipe joints during its many years of operation.

Supplemental Sampling

During April of 1998, six borings were drilled near the C-403 Neutralization Tank. All borings were drilled into the backfill of the tank pit to determine if the elevated radiological activity and TCE that was detected in the C-403 tank may have been sourced from water contained in the backfill of the tank pit. Seven water and 28 soil samples were collected and analyzed for gross alpha/beta and TCE and TCE degradation products. Analytical data from this sampling event are contained in the Addendum to Appendix J, found at the end of the SWMU 40 data set in Appendix J (Volume 4). The maximum soil alpha activity was 62.2 pCi/g and maximum soil beta activity was 243 pCi/g from soil samples collected between 20 and 24 ft bgs immediately adjacent to the tank. TCE or TCE degradation products were not detected in the soil samples.

The maximum alpha activity for water was 4910 pCi/L and maximum beta activity was 860 pCi/L from samples collected between 10 and 30 ft bgs. Only very small concentrations of TCE, trans-1,2 DCE, and vinyl chloride were detected in the water samples.

4.2.3 Sector 3

4.2.3.1 Site History

Sector 3 consists of the east side of the C-400 Building and several buried utility lines that parallel 11th Street. It does not contain a SWMU, and no spills or releases are known to have occurred in Sector 3.

Sector 3 is a relatively flat area lying between Sector 4 (SWMU 11) to the south and Sector 2 (SWMU 40) to the north. Several small paved areas and buried utilities are present in the sector. Access to the sector is limited on the east side by the presence of an 8- to 10-ft-high security fence. Surface drainage is into storm sewer drains along 11th Street. As part of the Phase I SI (CH2M Hill 1991) and Phase II SI (CH2M Hill 1992), a deep boring was drilled in the southern part of the sector. TCE was first detected at a depth of 50 ft bgs in this boring. PAHs occurred from the surface to total depth. Radionuclides were reported only from the near-surface soils.

4.2.3.2 Nature and Extent of Contaminants

Surface and subsurface soil samples were collected throughout Sector 3 in order to assess the nature and extent of site-related contaminants. Sampling locations within Sector 3 are shown in Fig. 4.5. Three surface soil samples were analyzed for SVOAs, three for metals, and two each for radionuclides and PCBs. The subsurface samples were collected from 10 borings at depths between the surface and 50.5 ft bgs. Thirty-six samples were analyzed for VOAs, 33 for SVOAs, and 37 (including one duplicate) for radionuclides. Thirty-two soil samples (including one duplicate) were analyzed for metals, and 16 samples were analyzed for PCBs. Shallow borings to approximately 15 ft bgs were drilled adjacent to buried utilities that parallel 11th Street and adjacent to the feeder lines that connected to storm drains within the sector. Several deep borings were also drilled near the C-400 Building to assess whether any unknown releases had occurred as a result of the processes performed in the building. Analytical results for samples collected from Sector 3 are summarized in Tables 4.13 to 4.16. Additional information about the analytical results can be found in Table 4.17 (frequency of detection).

Summary of Findings

Several small areas were identified in Sector 3 where the soil has been impacted due to localized spills or releases. The most significant area of contamination occurs in the surface and subsurface of Boring 400-011, which was drilled adjacent to the C-400 Building beside the exterior floor drain collection line. In this boring, TCE was found at elevated levels from near the surface to the total depth of 41 ft. The high TCE concentrations found at this location appear to be associated with a point source release near the C-400 Building. Elevated concentrations of arsenic, SVOAs, and PCBs were found in the surface and shallow subsurface soils at this location. TCE-impacted soil was found at depth in Boring 011-001 and may be contiguous with soil where elevated TCE was found in 400-011. A second release of contaminates at the surface is indicated by surface soil containing PCBs and radionuclides at 400-046. This area of elevated

PCB contamination may be related to the explosion of a transformer on the southwest side of the C-410 Building.

The widespread occurrences of low concentrations of VOAs, SVOAs, PCBs, and radionuclides in the Sector 3 soil represent minor surface spills or isolated releases from the buried utilities that pass through the sector and the results of daily plantwide operations.

Analytical Results–Surface and Subsurface Soils

Organics

VOAs. Three VOAs were reported from the analyzed samples: TCE, toluene, and cis-1,2-dichloroethene. Toluene was detected only in the northern half of the sector between 8 and 23 ft bgs. The two highest detections occurred in 400-062 (260 µg/kg) and 400-063 (270 µg/kg) at 15 ft bgs. Boring 400-062 was drilled along the storm drain that parallels 11th Street. Boring 400-063 was drilled to sample the bedding material adjacent to the sanitary water line. No deeper samples were collected from either of these two borings. Toluene was not detected in any of the samples collected north of Sector 3.

TCE was detected 14 times, including a detection in one duplicate sample, from five locations. One of the most significant concentrations of TCE encountered was in Boring 400-011. The TCE content of the soil at this location was equal to or greater than 1800 µg/kg at depths between 5 and 41 ft bgs, which was the deepest soil analyzed at that location. In addition to TCE, the two shallowest soil samples from 400-011 also contained a small (less than 20 µg/kg) amount of cis-1,2-dichloroethene.

Another high detection of TCE (14,000 µg/kg) was found at 47 to 51 ft bgs at Boring 011-001. This boring was drilled between a storm drain and the building perimeter Floor Drain Collection Line. Only very small quantities (<20 µg/kg) of TCE were reported from the shallow depths of 15 and 30 ft bgs in 011-001.

SVOAs. Sixteen SVOAs (mostly PAHs) were identified in Sector 3 soil samples. SVOAs were most prevalent in the three surface soil samples (Fig. 4.6). The surface sample at 400-011 generally had the highest concentration for each of the detected PAHs, with 887 µg/kg of benzo(a)pyrene, 1642 µg/kg of fluoranthene, 1269 µg/kg of phenanthrene, and 1566 µg/kg of pyrene.

Small quantities of eight PAHs were also detected one or more times in the subsurface soils. SVOAs at concentrations above the SQL were not found in the subsurface.

PCBs. PCB-1260 (Aroclor-1260) was detected at four locations in Sector 3 (Fig. 4.7). The highest concentration was 3300 µg/kg at the surface at Boring 400-046. Boring 400-011 also contained 47 µg/kg Aroclor-1260 at the surface. One sample collected near the storm drain at Boring 400-098 and one sample collected from 400-064 near the sanitary water line each had a low concentration of Aroclor-1260.

Inorganics

Sixteen metals were detected at concentrations that exceeded background levels. The most frequently reported metals were the common soil-forming minerals, aluminum, sodium, and magnesium. An elevated arsenic occurrence of 18.1 µg/kg was reported from 8 ft bgs at Boring 400-011.

Radionuclides

Low activities of several radiological isotopes were reported from the surface soils in Sector 3. The surface sample collected at Boring 400-046 contained the most radioisotopes and the highest activities for all of the detected isotopes. Among the highest detections were ^{99}Tc at 3.5 pCi/g, ^{230}Th at 4.2 pCi/g, ^{234}U at 7.1 pCi/g, and ^{238}U at 9.1 pCi/g. Several radionuclides with activities below 2 pCi/g were reported from the subsurface. Figure 4.8 shows the distribution for detected activities of ^{238}U and ^{137}Cs, two of the COCs identified for Sector 3 soils.

4.2.4 Sector 4 [Trichloroethene Leak Site (SWMU 11)]

4.2.4.1 Site History

The Trichloroethene Leak Site (SWMU 11) is located at the southeast corner of the C-400 Building, along 11th Street and Tennessee Avenue. It contains an area of known contamination that was caused by release of effluent from a leaking subsurface pipe carrying discharge from a sump in the C-400 Building to the storm sewer. A previously unidentified TCE spill source was discovered in Sector 4 during the WAG 6 RI. Apparently, a pump station (and associated piping) used to off-load TCE from tank cars into the aboveground storage tank had broken several times in the past and released an unknown, yet significant quantity of TCE into the subsurface soils. Based on the distribution and concentration of TCE in the soils, the off-loading pump station is now suspected to have been the primary source for TCE introduction into the WAG 6 subsurface.

Practices and Release Description

A sump in the TCE degreaser pit basement (SWMU 98) inside the C-400 Building inadvertently released TCE, along with wastewater, to the storm sewer line east of the C-400 Building. Before discovery of the leak, it was not known that the basement sump discharged directly to the storm sewer. The sump was thought to discharge to the C-403 Neutralization Tank (SWMU 40). The leak was discovered during construction of a discharge line from the truck unloading dock containment sump to the 11th Street storm sewer line. During excavation, TCE was discovered leaking from the joints of the storm sewer line. Although the actual duration of the leak is unknown, it is believed that TCE may have been discharged to the storm sewer as early as the 1950s. Once the leak was discovered, the discharge line from the basement sump was disconnected from the storm sewer, material from the sump was routed to 55-gal drums, and TCE-contaminated soil was excavated from the area of the leak.

The main excavation area measured approximately 20 ft wide (east to west) by 40 ft long (north to south). A 10-ft-wide trench, centered on the storm sewer, was dug 16 ft deep to expose the pipe, which lay 13 ft below original grade. The remainder of the excavation was 7 ft deep. Concern for the stability of nearby structures limited the extent and depth of the excavation. Not all contaminated soil could be removed. Forty 55-gal drums were used to containerize excavated contaminated soil.

In Sector 4, a TCE off-loading pump station was located southwest of SWMU 11 adjacent to the railroad track. The pump station was used to transfer TCE from tank cars into a day holding tank. According to employees, the pump and associated pipes leading into the subsurface to the TCE tank underwent numerous repairs in past years due to releases.

Location and Results of Previous Sampling

TCE concentrations as high as 700,000 μg/kg were reported in soil samples collected adjacent to and below the storm sewer line during removal of the contaminated soil in 1986 (EDGe 1989). Approximately 9200 ft^3 of contaminated soil and bedding material were excavated, containerized, and stored as hazardous waste for future treatment and disposal. Some of the contaminated soil is known to have been left in place because of concerns about the structural integrity of 11th Street and the TCE Tank Pad, located to the west between the spill site and the C-400 Building (CH2M HILL 1992). The excavated area was backfilled with clean fill material and capped with a layer of clay after excavation activities were completed.

Four borings were drilled adjacent to the excavated area to better define the lateral and vertical extent of soil contamination. A boring was drilled north and south (storm sewer downgradient) and two were completed east of the excavated area. TCE contamination was detected at depths of 22 to 28 ft bgs in the soils from the borings drilled north and south of the excavated area at 11.3 and 47.6 μg/kg, respectively. TCE concentrations were below detection limits (<2 μg/kg) in the 22- to 28-ft bgs interval in the two borings east of the excavation.

The Trichlorethylene Leak Site (SWMU 11) was investigated under the Phase I and Phase II SIs completed between 1989 and 1991 (CH2M HILL 1991, 1992). The field activities for Phase I consisted of drilling a deep boring within the leak area and collecting groundwater samples from MW-68 through MW-71. All samples were analyzed for TCL VOA, SVOA, pesticides/PCBs, TAL metals, and selected radionuclides, including ^{238}U, ^{235}U, ^{99}Tc, ^{230}Th, ^{239}Pu, as well as gross alpha activity and gross beta activity. The analytical results for the soil samples collected from the deep boring showed that TCE was detected in the soils at concentrations throughout the interval sampled (4 to 93 ft bgs) and that the highest concentration was from the sample collected at approximately 55 to 60 ft bgs. Technetium-99 was detected at 10 to 15 ft bgs (at 6.6 pCi/g). No other compounds or analytes were detected in any of the samples analyzed.

During the Phase II SI field activities, a well cluster consisting of MW-155, MW-156, and MW-157 was installed in the area of the leak to assess groundwater quality in the lower RGA, upper RGA, and UCRS, respectively. Two deep borings were drilled north of the leak site to evaluate soil contamination near the C-400 Building Basement Sump (SWMU 98).

4.2.4.2 Nature and Extent of Contaminants

To assess the nature and extent of the contamination within Sector 4, three surface soil samples were analyzed for SVOAs and inorganic constituents, and two surface samples were collected to assess the PCB content and radionuclide activity. Thirty-four borings were drilled (Fig. 4.9). A total of 169 subsurface samples (with 5 duplicates) were analyzed for VOAs, 150 (with three duplicates) for SVOAs, 21 (with one duplicate) for PCBs, 131 (with 2 duplicates) for metals, and 142 (with 5 duplicates) for radionuclides. The analytical results above PGDP background levels are summarized in Tables 4.18 through 4.21. Table 4.22 provides additional information about the frequency of detection.

Summary of Findings

Sector 4 contains a widespread TCE-impacted area located between the C-400 Building and 11th Street and north of Tennessee Ave. In that area, a large zone of shallow soil contains greater than 225,000 µg/kg TCE, indicating that the chlorinated solvent is present as a DNAPL. Figs. 4.10a, b, and c show horizontal slices through a computer-generated three-dimensional representation of the vertical and horizontal extent of the TCE-impacted soil in Sectors 4 and 5.

TCE and its degradation products were found in the vadose zone from the surface down to the water table. The highest concentrations were 8,208,600 µg/kg from a sample collected immediately below the excavated area and 11,055,000 µg/kg from a sample collected to the southwest of the excavation, adjacent to the TCE off-loading pump. Vertical migration of TCE to the groundwater in this area is a continuing threat to groundwater quality.

A shallow zone of soil containing high TCE concentrations that extends south of the off-loading pump station is probably due to TCE that has been transported along bedding material of a nearby sanitary sewer line (see North-South cross-section in Fig. 4.11a).

In deeper soils, TCE and associated contaminants extend northeast across 11th Street into Boring 011-006 (see East-West cross-section in Fig. 4.11b). TCE in this boring is found only in small quantities down to 40 ft bgs, but reaches 7800 µg/kg at 48 ft bgs. On the western edge of the sector (south of the C-400 Building) subsurface soil contains almost 2000 µg/kg of TCE, suggesting that the margin of the TCE contamination in Sector 4 extends into Sector 5.

Soil samples from borings drilled northwest of the area of maximum TCE impact (along the southeast corner of the C-400 Building) also exhibit high TCE concentrations (>100,000 µg/kg) at depths of 40 ft or more bgs. This suggests that the TCE is primarily migrating to the northwest in the deep subsurface.

SVOA analytical results show that PAHs are found at low concentrations in the same area as the TCE, but that the SVOAs are confined to the very shallow subsurface soils.

Analytical Results–Surface and Subsurface Soils

Organics

VOAs. Nineteen VOA compounds were documented in the samples collected from Sector 4. Several compounds were detected only once, including 1,2-dichloroethene, 2-hexanone, bromodichloromethane, chloromethane, iodomethane, trichlorofluoromethane, and vinyl acetate. TCE and its associated degradation products, cis- and trans-1,2-dichloroethene and vinyl chloride, were not only the most common VOAs found with 69%, 46%, 12%, and 15% frequency of detects, respectively (see Table 4.18), but also were detected at the highest concentrations. The maximum TCE content, 11,055,000 µg/kg, was detected at Boring 400-200 at 9 ft bgs. This boring is located adjacent to the TCE off-loading pump station and transfer/feeder line that was used to off-load TCE from tank cars into the day holding tank. Soil from Boring 011-005, which is located approximately 70 ft northeast of 400-200, contained TCE at a concentration of 8,208,600 µg/kg at 31.5 ft bgs. This sample was collected below the base of the SWMU 11 excavation backfill material. As shown in Fig 4.12, all soil samples collected from borings between the two locations that contained the highest TCE concentrations and the southeast corner of the C-400 Building exhibited TCE levels above 100,000 µg/kg.

In addition to the heavily impacted area adjacent to (and below) the excavated area at SWMU 11, concentrations of 67,000, 40,500, and 17,200 µg/kg TCE were found in soil samples between 9 and 20 ft bgs in Borings 400-103, 400-163, and 400-092, respectively. All three of the samples were collected along the sanitary sewer line south of the excavation. Based on the soil samples taken between 12 and 48 ft bgs from Boring 400-163, high TCE concentrations probably occur from the near surface to a depth of at least 44 ft bgs all along this line.

Two borings, 400-134 and 011-006, that were drilled northeast of the center of the highly impacted area, contained elevated TCE concentrations of 8200 µg/kg (at 16 ft bgs) and 7800 µg/kg (at 48 ft bgs), respectively. Boring 400-016, located south of the C-400 Building and adjacent to Sector 5 to the west, contained TCE at concentrations between 1500 and 1900 µg/kg from 20 to 34 ft bgs. No samples were collected below 34 ft bgs from this boring.

SVOAs. Two of the 3 surface samples and 41 of the 150 subsurface samples collected within Sector 4 that were analyzed for SVOAs were found to contain between 1 and 19 constituents. Most of the detected SVOAs, primarily PAHs, were below the SQL. Those PAH results above the SQL were found only in shallow subsurface soils between 0 and 4 ft bgs in borings located between the utility corridor and the C-400 Building (400-016, 400-202, 400-014, 400-211, 011-003, and 400-163) (Fig. 4.13). The maximum reported PAH concentrations in Sector 4 were from Boring 400-211 and were as follows: benz(a)anthracene at 2300 µg/kg, benzo(a)pyrene at 2400 µg/kg, benzo(b)fluoranthene at 2900 µg/kg, and dibenz(a,h)anthracene at 460 µg/kg.

PCBs. Only one surface sample and one shallow subsurface sample of the 23 soil samples analyzed for PCB within Sector 4 contained this contaminant. PCB-1262 (Aroclor-1262) was reported at 38 µg/kg for surface soil collected from Boring 400-038, and PCB-1254 (Aroclor-1254) was found at 730 µg/kg from 5 ft bgs in Boring 400-200.

Inorganics

Nineteen metals were detected at concentrations above PGDP background levels in Sector 4 soils. Although several inorganics were frequently detected, many of these, including calcium and sodium, are common rock-forming minerals that were detected only slightly above the background screening levels. Several metals were detected at higher concentrations. Cobalt was detected in a soil sample collected from 40 ft bgs in Boring 011-006 at 126 mg/kg, or at almost 10 times its PGDP background screening level. The same sample contained 82.5 mg/kg of lead, which is 3.6 times background. The maximum concentration for magnesium was 27,200 mg/kg (3.5 times the background level) from the surface soil from Boring 400-016.

Although antimony was found frequently (in 37 of 134 samples analyzed) and at concentrations up to 20 times the PGDP background value, the analytical results were all below the SQL.

Radionuclides

Americium-241, ^{137}Cs, ^{237}Np, ^{239}Pu, ^{99}Tc, ^{230}Th, and the three uranium isotopes were detected in the soil samples collected from 27 soil borings. Activity for the isotopes ^{241}Am, ^{137}Cs, ^{237}Np, and ^{239}Pu remained less than 0.7 pCi/g, which is slightly above screening levels.

The highest activity for ^{99}Tc was 4.7 pCi/g in a shallow subsurface sample from Boring 400-211. Technetium-99 was detected in only 3 of the 144 samples. Thorium-230 (with 7 detections out of 144 analyses above background) was detected at a maximum activity of 1.8 pCi/g in soil collected from 20 ft bgs at Boring 400-009. The 8-ft-bgs sample from Boring 011-005 contained the highest ^{234}U (one detection) and ^{235}U (one detection) activities of 3.5 and 4.3 pCi/g, respectively. Uranium-238 was detected in 10 of 144 samples at a maximum activity of 4.3 pCi/g. Among the radioisotopes with the highest activities, no systematic distribution was detected.

4.2.5 Sector 5

4.2.5.1 Site History

Location and Physical Description

Sector 5 is located on the southwest corner of the C-400 Building and is bordered by Sector 4 to the east and Sector 6 to the north. It extends 450 ft west of the building, to include three borings west of 10th Street, and continues south of the building. Most borings are located north of Tennessee Avenue and east of 10th Street, with the highest density located along utility lines and the two sets of railroad tracks.

Several utility lines (recirculated water and stormwater) extending north-south are located east of and parallel to 10th Street; another set of utilities extending east-west is located north of Tennessee Avenue. One sanitary line exits the C-400 Building and extends due west between Borings 400-010 and 400-172, and a second sanitary line exits the building and extends south between Borings 400-142 and 400-089 to the main line. Two parallel sets of railroad tracks are located immediately south of the C-400 Building. Aboveground structures include a high tower on a concrete pad west of the C-400 Building and aboveground steam lines.

Practice and Release Information

No practices or processes within Sector 5 are known to have led to past contamination of the soils. Migration of contamination from the adjoining Technetium Storage Tank (SWMU 47) in Sector 6 to the north and the Trichlorethylene Leak Site (SWMU 11) in Sector 4 was considered to have the largest impact potential. Therefore, utility corridors and other migration pathways were the target for the RI sampling activities within this sector. Sector 5 has not been sampled previously.

4.2.5.2 Nature and Extent of Contaminants

To evaluate the condition of the soil within Sector 5, seven surface soil samples were analyzed for SVOAs, three for PCBs, six for inorganic constituents, and four for radionuclides. Subsurface soil samples from several shallow and deep borings were collected to a depth of 48 ft bgs. One-hundred-six of these were analyzed for VOAs, 85 for SVOAs, 8 for PCBs, 54 for metal constituents, and 68 for radionuclides. Fig. 4.14 is a map of Sector 5 showing the position of the

28 locations sampled. The results of the analyses are summarized in Tables 4.23 through 4.26. A frequency of detection table (Table 4.27) presents summary information concerning the analytical results.

Summary of Findings

The sampling in Sector 5 was aimed at evaluating the impact of possible spills within the C-400 Building and assessing whether the buried utilities or utility corridors either released contaminants or served as a pathway for the migration of contaminants into surrounding soils. Two general areas of soil contamination were identified.

The first area, which has been impacted by high concentrations of VOAs, is located on the southwest corner of the C-400 Building. Fig. 4.12 shows the maximum TCE content in the Sector 5 soils. Several vadose zone samples collected between 4 and 48 ft bgs contained low to high concentrations of TCE and its degradation products. The vertical extent of the soil contaminated by TCE is defined by deeper borings which contained no VOAs. Data from several soil boring samples to approximately 48 ft bgs were used to assess the depth of the impacted area. One deep soil boring located near the center of the impacted area contained TCE throughout the vertical extent, including high values at its end depth of 43 ft bgs. High TCE concentrations in Sector 5 soils suggest that TCE is present as DNAPL. A release of a considerable quantity of TCE in the immediate vicinity of Boring 400-015 near the southwest corner of the C-400 Building appears to have occurred. This boring was drilled adjacent to the building perimeter drain waste collection line, which transports various process wastes from inside the building to the Waste Discard Sump at SWMU 203.

A second area of contamination is located in the northwestern portion of Sector 5 (west of the C-400 Building). This area has been impacted by a myriad of constituents including VOAs, SVOAs, metals, and radionuclides. Surface samples from this area exhibit some of the highest SVOA concentrations from WAG 6. Antimony and arsenic at concentrations above background, as well as low radionuclide activity, also were detected in shallow subsurface samples collected from several soil borings within this area. TCE and cis-1,2-dichloroethene were detected at low concentrations in a sample from a total depth of 47 ft bgs. Releases from the building perimeter drain collection line or a sewer line leading from the C-400 Building may have resulted in this multi-contaminant impact.

Surface and Subsurface Soils

__Organics__

VOAs. A total of 11 VOAs were detected in the samples collected between 0 and 48 ft bgs from 28 locations. Only five of the VOAs were detected in quantities above the SQL. These were carbon tetrachloride, TCE, and its degradation products, vinyl chloride and cis- and trans-1,2-dichlorethene. Only one sample contained carbon tetrachloride. This sample was collected from 47 ft bgs in Boring 400-010 immediately west of the C-400 Building and also contained TCE and cis-1,2-dichlorethene at concentrations of 110 and 130 µg/kg, respectively. VOAs were not detected in the other soil intervals sampled in this boring.

In the southern portion of Sector 5, the maximum reported TCE soil content was 168,200 µg/kg in a sample collected at 23 ft bgs from Boring 400-015. As shown on the East-West cross-section in Fig. 4.11b, this boring exhibited high TCE concentrations throughout its vertical extent, with 94,000 μg/kg at 32.5 ft bgs and 28,000 μg/kg in soil at the end depth of 43 ft bgs. Soil samples collected at 10 ft bgs in Borings 400-045 and 400-089 contained 18,200 and 12,000 μg/kg TCE, respectively. Similarly, the North-South cross-section (Fig. 4.15) shows TCE concentrations of 2900 and 3000 μg/kg between 8 and 18 ft bgs in Borings 400-073 and 400-087, respectively. Soil samples collected from this cluster of borings on the southwest corner of the C-400 Building (400-113, 400-159, 400-204, 400-074, 400-114, and 400-072) exhibited no VOAs.

At the eastern edge of Sector 5, TCE-contaminated soil in Boring 400-089 is contiguous with TCE-contaminated soil that originates from Sector 4.

Deep subsurface soil samples containing less than 25 μg/kg TCE were collected from Boring 400-145 at 44 ft bgs, from Boring 400-192 at 48 ft, and Boring 400-194 at 44 ft bgs. These delineate the TCE soil contamination as defined by a 100-μg/kg contour in Fig. 4.12 and on the cross-sections in Figs. 4.11.b and 4.15. TCE's degradation products follow very similar trends.

SVOAs. Six surface samples contained SVOA constituents. Most of the 21 SVOA constituents detected above the SQL in Sector 5 were PAHs (Fig. 4.16). The maximum total SVOA concentration was 153,774 μg/kg for surface sample Boring 400-010 (a few feet west of the C-400 Building). Surface soils from Borings 400-041, 400-009, and 400-036 contained total SVOA concentrations of 63,800, 49,070, and 43,938 μg/kg, respectively, with fluoranthene (9,900 μg/kg) and pyrene (7,300 μg/kg) contributing most to the analytical results. Samples 400-017 and 400-045 had much lower total SVOA values, and most individual PAH constituents were below the SQL.

Only one subsurface soil sample contained SVOAs above the SQL. This sample was collected from Boring 400-041 at a depth of 30 ft bgs and contained 5000 μg/kg of diethyl phthalate, an SVOA constituent not found in any surface soil analyses.

PCBs. Three surface samples from Sector 5 were analyzed for PCBs and contained between 3 and 38 μg/kg of PCB-1260. No PCBs were detected in the subsurface samples.

<u>Inorganics</u>

Soil was sampled for metals analysis from 28 borings within Sector 5 between the depths of 0 and 47 ft bgs. Several of these soil samples (including all surface samples) contained one or more of the 13 detected metals at concentrations that slightly exceeded background levels.

Four metals—antimony, arsenic, silver, and thallium—exceeded PGDP subsurface concentrations by a factor of two or more. The highest concentration of arsenic was 25.8 mg/kg (3.3 times background) from Boring 400-088 at 10 ft bgs. Silver concentrations in two samples exceeded the SQL. The highest detected silver concentration was 25.1 mg/kg (9.3 times background) in Boring 400-192 at 8 ft bgs. Antimony was found above the SQL at a concentration of 7.5 mg/kg (36 times background) only in a soil sample collected from 6 ft bgs at Boring 400-010. This soil sample also contained 7.48 mg/kg of silver. Thallium (1.6 mg/kg, 4.7 times background) exceeded the SQL in only one soil sample that was collected at 20 ft bgs from Boring 400-145. The deepest soil samples contained concentrations of these metals that were below background levels, which can be used to delineate the vertical extent of the impacted soil.

Beryllium was reported above background levels in 14 soil samples. The highest concentration was 1.05 mg/kg from 4 to 8 ft bgs in Boring 400-204 (Fig. 4.17). Most of the beryllium detections were from less than 15 ft bgs in samples collected along the railroad tracks on the southwest corner of the building.

Radionuclides

Nine isotopes were detected above background levels in the soil sampled from 15 borings that were analyzed for radionuclides. While radioisotope activity in three of the four surface samples only slightly exceeded background values, the surface sample from Boring 400-036 (Fig. 4.18) exhibited higher activities for ^{234}U (10.9 pCi/g, or 4.4 times background), ^{238}U (16.7 pCi/g, or 14 times background), and ^{99}Tc (33 pCi/g, or 13.2 times background). A subsurface sample analyzed from the same boring at 14 ft bgs contained only traces of ^{237}Np (0.2 pCi/g).

Most subsurface samples contained radionuclides only at low activities (less than 2 pCi/g). However, the shallow subsurface soil sample collected from 4 ft bgs at Boring 400-141 exhibited 7.3 pCi/g of ^{99}Tc, 2.7 pCi/g of ^{234}U, and 4.6 pCi/g of ^{238}U, while the sample from 20 ft bgs at 400-192 contained 3.1 pCi/g of ^{99}Tc.

4.2.6 Sector 6 [Technetium Storage Tank (SWMU 47)]

4.2.6.1 Site History

Location and Physical Description

The Technetium Storage Tank (SWMU 47) was located within a bermed area on a concrete pad outside of the C-400 Building, on the west side of the building. The tank was removed in 1986, but the concrete pad and berms are still present. Approximately 600 gal of residual waste was in the tank at the time of its removal. The waste was composed of approximately 200 gal of solution and 400 gal of sludge. Analytical results of samples collected during the tank removal show that Tc, Cr, U, Np, Pu, and Th were in the tank.

Practice and Release Description

The 4000-gal storage tank was used in the early 1960s to store a waste solution containing ^{99}Tc and chromium. No spills are known to have occurred from the Technetium Storage Tank.

Location and Results of Previous Sampling

The Technetium Storage Tank (SWMU 47) area was investigated during the Phase II SI conducted in 1991 and 1992. Field activities completed during the Phase II SI include the installation of two groundwater monitoring wells (MW-175 and MW-176) and one shallow soil boring. All sampling locations from the Phase II SI were located approximately 50 to 75 ft south of the former tank location, limiting the applicability of the results for source characterization.

Eight composite soil samples were collected during the drilling of the borehole for MW-175 at depths ranging from 0 to 80 ft bgs. Soil samples were analyzed for TCL VOA, SVOA, pesticides/PCBs, TAL metals, cyanide, dioxins and furans, and selected radioisotopes, including ^{235}U, ^{238}U, ^{99}Tc, ^{239}Pu, and ^{230}Th. Chromium concentrations ranged from 3.3 µg/kg at the surface to 52 µg/kg in the 15- to 20-ft-bgs interval. In addition to chromium, ^{99}Tc and ^{234}U were detected in the sample from 0 to 5 ft bgs at concentrations of 8.2 pCi/g and 2 pCi/g, respectively. The only other contaminant detected in the samples from the MW-175 boring was TCE at a concentration of 0.009 µg/kg at a depth of 5 to 10 ft bgs. No soil samples were collected from the MW-176 borehole.

One shallow soil boring was drilled within Sector 6 during the Phase II SI to collect information about the soil's radionuclide contamination. Two soil samples were collected at the 0- to 1-ft-bgs and 4- to 6-ft-bgs intervals. These samples were analyzed for selected radionuclides, including ^{99}Tc, ^{237}Np, ^{230}Th, ^{239}Pu, ^{235}U, and ^{238}U. The maximum radionuclide activities for soil samples collected during the SI field activities were reported from this shallow soil boring.

In December 1986, 13 concrete samples were collected from the concrete pad, and 16 soil samples were collected from the area surrounding the tank pad. The samples were collected over a uniform grid covering an area of 14 ft by 14 ft. Samples were analyzed for total chromium, uranium, and ^{99}Tc. Results of the analyses showed maximum concentrations of 0.5 pCi/g ^{99}Tc in the soil and 0.08 pCi/g ^{99}Tc in the concrete. Total chromium detected was 10.1 µg/kg in the soil and 17.2 µg/kg in the concrete. Uranium was detected at 165 µg/kg in the soil and at 28 µg/kg in the concrete.

4.2.6.2 Nature and Extent of Contaminants

In order to assess the nature and extent of the contaminants' impact in Sector 6, 10 surface soil samples (including one duplicate) were analyzed for SVOAs, four for PCBs, 10 (including one duplicate) for metals, and 10 for radionuclides. In addition, 11 subsurface soil samples were collected and analyzed for VOAs and SVOAs, metals, and radionuclides. Eight subsurface samples were screened for PCBs.

Most of the soil samples were collected between the C-400 Building and the C-400 Building perimeter fence (see Fig. 4.19). Results of the analyses are presented in Tables 4.28 through 4.31. Table 4.32 (frequency of detection) summarizes additional information concerning the analytical results.

Summary of Findings

The focus of soil sampling at Sector 6 was to evaluate the potential impact of the Technetium Storage Tank (SWMU 47) on surface and subsurface soils. Samples were also collected to assess the utility corridors and to assess whether previously unknown spills or releases associated with processes inside the C-400 Building may have impacted the soils in Sector 6. One area of contamination was defined from surface and subsurface soil samples collected near the bermed area around the former location of the Technetium Storage Tank (Fig. 4.19).

A small area of surface soil located immediately below the end of a pipe that protrudes from the C-400 Building toward the berm where the Technetium Storage Tank (SWMU 47) previously stood was found to be impacted with high concentrations of several PAH compounds and radionuclides. The pipe that protrudes from the building is a drain line from the dissolution process inside the C-400 Building.

In Boring 047-002 that was drilled into the deep UCRS on the west side of the berm immediately beyond the southwest corner of the Technetium Storage Tank (SWMU 47), the surface soil also contained elevated levels of PAHs and radionuclides. Shallow surface soil samples collected at 4.5 ft bgs in this boring contained the highest concentration of many of the identified radionuclides, but no PAHs. The radioactivity of the soil decreased substantially below 4.5 ft bgs.

TCE was reported at high levels between 4.5 and 29.5 ft bgs (the deepest sample collected). The level of TCE in the subsurface soils remained relatively constant from near surface to the total depth.

Other borings drilled and sampled within Sector 6 to assess the utility corridors and C-400 Area perimeter contained no constituents of concern, or exhibited only isolated occurrences of contaminant concentrations.

Analytical Results–Surface and Subsurface Soils

Organics

VOAs. Five VOAs were detected in the subsurface soil samples collected between 1 and 29.5 ft bgs for Sector 6. Toluene, although the most commonly detected VOA, was not reported at concentrations above the SQL.

In soil samples from Boring 047-002, which was drilled on the former Technetium Storage Tank site, four VOAs were detected between 12 and 29.5 ft bgs, including TCE (up to 1700 μg/kg), cis-1, 2-DCE (82 μg/kg), trans-1,2-DCE (up to 2500 μg/kg), and 2-propanol (up to 220 μg/kg). None of the subsurface samples collected at 15 ft bgs from any of the five borings that were drilled along the utility corridors within Sector 6 (400-108, 400-083, 400-148, 400-076, and 400-084) contained measurable quantities of VOAs.

SVOAs. Numerous SVOAs were reported from the soil samples submitted for analysis from Sector 6. Of the SVOAs detected above the SQL (15 PAHs and one phenol), all are closely related spatially with the bermed area around the former Technetium Storage Tank site (Fig. 4.20). Sample 400-003, the sample collected immediately below the termination of the pipeline that connected the Technetium Storage Tank to the C-400 Building, had the highest concentrations of all of the 16 SVOAs found within Sector 6. Many of the individual SVOAs were reported at some of the highest concentrations in WAG 6, including pyrene at 110,585 μg/kg and fluoranthene at 96,773 μg/kg. Samples from Borings 047-002, 047-007, and 047-010 also were impacted by several PAHs, including chrysene, fluoranthene, phenanthrene, and pyrene. SVOAs were detected only in the subsurface from one soil sample collected from Boring 047-002 at 4.5 ft bgs. Deeper soil samples, to 29.5 ft bgs, collected at this location contained no SVOAs. Detection of SVOAs in an area that had previously been paved with asphalt is not unexpected.

PCBs. Surface soil samples collected from Borings 047-002 and 047-007 exhibited PCBs above the SQL at 77 μg/kg and 960 μg/kg PCB-1254, respectively (Fig. 4.21). No PCBs were detected in the subsurface soil samples.

Inorganics

Numerous metals were detected at concentrations above the PGDP background screening levels. Most of the metal concentrations were only slightly above background levels. However, one surface soil sample from Boring 047-002 contained cadmium at 4.25 mg/kg, which is approximately 20 times the PGDP background level. Beryllium was found at concentrations slightly above background in four surface and shallow subsurface samples (Fig. 4.22), all of which were collected outside the bermed area.

Radionuclides

Nine radionuclides, ^{241}Am, ^{137}Cs, ^{230}Th, ^{237}Np, ^{239}Pu, ^{99}Tc, ^{234}U, ^{235}U, and ^{238}U, exceeded PGDP background screening levels. The maximum activities of seven of the nine isotopes were found in the surface soil sample from Boring 047-002, adjacent to the bermed area. These included 53 pCi/g of ^{99}Tc, 31.1 pCi/g of ^{234}U, 1.9 pCi/g of ^{235}U, and 39.5 pCi/g of ^{238}U. All other surface soils collected around the berm also exhibited elevated activities for various combinations of the radionuclides. Technetium and the three uranium radioisotopes were detected at activities that exceeded background in a soil sample collected from 4.5 ft. bgs at Boring 047-002. Only two isolated soil samples below 4.5 ft bgs in Sector 6 contained radionuclide isotopes with activities above background values. Uranium-238 was detected in all seven of the surface soil samples collected from the bermed area (Fig. 4.23).

4.2.7 Sector 7 [Waste Discard Sump (SWMU 203)]

4.2.7.1 Site History

Location and Physical Description

The Waste Discard Sump located at the northwest corner of the building is a convergence point for effluent from the C-400 Cleaning Facility (primarily from the west side). The unit is a 6-ft-wide × 11-ft-long × 6-ft-deep concrete pit that includes a 4-ft-diameter × 4-1/2-ft-deep sump in the floor. The concrete walls of the sump are lined with acid-proof brick. Influent to the system is discharged directly into the sump, which empties into the North-South Diversion Ditch.

Practice and Release Description

A pump discharged wastewater through the C-401 Transfer Line (SWMU 26) prior to 1957. Beginning in 1957, a drain in the sump was opened to allow gravity-fed discharge through a storm sewer line to the North-South Diversion Ditch. In the 1950s, the Waste Discard Sump handled discharges from a variety of processes in the C-400 Building. Many of these discharges were discontinued after 1957. The sump continues to collect effluent from a high-pressure water-jet system in the C-400 Spray Booth and a vacuum pump on the C-400 Lime Precipitation Unit. No contaminants are expected from the current waste streams.

Location and Results of Previous Sampling

Characterization sampling of the sump sludge and adjacent surface soil occurred in late 1994 and early 1995. The characterization included two samples of the sump sludge and one soil sample. The sludge contained TCE, PCBs, and several transuranic elements.

Approximately 6 in. of sludge covered the base of the 4-ft-diameter sump in June 1995, when a removal action was performed. Twenty-eight 55-gal drums were used to containerize the sludge and water purged from the sump.

4.2.7.2 Nature and Extent of Contaminants

Seven surface soil samples from Sector 7 were analyzed for SVOAs, 3 for PCBs, 11 for inorganics, and 4 for radionuclides. Thirty subsurface soil samples (including two duplicate samples) that were collected between 1 and 48.5 ft bgs within Sector 7 were analyzed for VOAs, 25 (including two duplicate samples) for SVOAs and inorganic constituents, 18 (including one duplicate) for PCBs, and 15 (including 2 duplicates) for radionuclides. Sampling locations in Sector 7 are shown in Fig. 4.24. The analytical results are described below and summarized in Tables 4.33 through 4.36. Additional information regarding the analytical results is presented in Table 4.37 (frequency of detection).

Summary of Findings

Sampling in Sector 7 was primarily targeted at finding any impact that processes connected to the Waste Discard Sump may have had on the surrounding soil. Surface and subsurface soils of Sector 7 showed contamination in one area associated with the Waste Discard Sump. A surface soil sample collected in the area surrounding the Waste Discard Sump contained mercury at a concentration that exceeds the PGDP background level by a factor of 41. The same sample exhibited high radioactivity from ^{99}Tc. While mercury was not detected in subsurface samples collected from approximately 15 and 32 ft bgs at this location, ^{99}Tc activity slightly exceeded the background value at 15 ft bgs. Both mercury and ^{99}Tc are probably related to spills and releases of C-400 Building effluent to the Waste Discard Sump.

TCE also was detected at 4500 mg/kg at a depth of 28.5 to 32 ft bgs in the same boring that contained elevated metals and radioactivity. The source for the TCE may be the Waste Discard Sump, but the lack of TCE at shallow depths near the sump suggests a different source. A subsurface spill or release from the northwest corner of the C-400 Building, which is located approximately 25 ft to the southeast, may have been the source for the TCE.

Only isolated low concentrations of analytes were detected in samples collected from other borings drilled within the sector to assess the utility corridors.

Analytical Results–Surface and Subsurface Soils

Organics

VOAs. Four VOAs (1,1-dichloroethene, cis-1,2-dichloroethene, toluene, and TCE) were detected in the 19 soil borings of Sector 7. Trichloroethene, found in three samples, was the only VOA detected from Sector 7 soils that exceeded the SQL. The maximum concentration of 4500 µg/kg was detected in the deepest sample collected (at 32 ft bgs) from Boring 203-003. This sample was collected adjacent to and below the SWMU 203 Waste Discard Sump.

SVOAs. Two surface and one subsurface sample from 400-004 and 400-111, respectively, contained SVOA constituents (Fig. 25). The values for all individual SVOA compounds were below the SQL.

PCBs. Only one of the 21 soil samples analyzed from Sector 7 contained detectable levels of PCBs. PCB-1260 was found at 7.9 µg/kg in soil (at 16.5 ft bgs) from Boring 203-006. This concentration is below the SQL.

Inorganics

Sixteen metals from the 24 locations sampled exhibited concentrations above PGDP background screening levels in Sector 7. Fourteen of these metals were detected only at concentrations that slightly exceeded background levels: aluminum, arsenic, beryllium, cadmium, chromium, cobalt, iron, lead, manganese, nickel, silver, sodium, thallium, and vanadium. Two metals that were reported at the higher concentrations were antimony at 9.4 µg/kg (45 times background) in the surface soil sample from Boring 400-004 and mercury at 8.3 µg/kg (42 times background) in the surface soil sample from Boring 203-003. Mercury was detected only once at a level above background, and antimony, although detected in 11 of the 36 samples, exceeded the SQL only in one sample. The distributions of beryllium and lead, two highly toxic metals, are show in Fig. 4.26.

Radionuclides

Two of the 19 samples collected from 13 locations within Sector 7 were found to contain radionuclides at concentrations above PGDP screening levels. Nine radioactive isotopes were identified: ^{241}Am, ^{137}Cs, ^{237}Np, ^{239}Pu, ^{99}Tc, ^{230}Th, ^{234}U, ^{235}U, and ^{238}U. The surface soil sample collected from Boring 203-003, located immediately adjacent to the C-203 Waste Discard Sump, exhibited an activity of 43.3 pCi/g for ^{99}Tc, which is 17 times the PGDP background screening level. This sample also contained elevated activities of six other isotopes including ^{238}U at an activity of 14.8 pCi/g (Fig. 4.27). The highest documented radioactivity in the subsurface was 3.1 pCi/g (^{99}Tc) in soil collected from 14.5 ft bgs in Boring 203-003.

4.2.8 Sector 8 [C-401 Transfer Line (SWMU 26)]

4.2.8.1 Site History

Location and Physical Description

Little is known about the construction characteristics of the C-401 Transfer Line. Available documentation of the Transfer Line pipe material provides conflicting information. The pipe material was reported as being 6-in. vitrified clay pipe and 4-in. iron pipe with leaded joints. Excavation of a small section of the pipe in 1998 showed the pipe to be made of metal, probably iron. The Transfer Line lies 3 to 5 ft bgs, parallel with Virginia Avenue and approximately 60 ft to the north toward C-404 where its course deviates to enter C-404. Blueprints document that feeder lines extend north from the C-400 Building to the Transfer Line, located across the North-South Diversion Ditch from the C-400 Area. Pumps in the C-403 Neutralization Tank and Waste Discard Sump pressurized the system during discharge periods.

Practices and Release Description

Between 1952 and 1957, the C-401 Transfer Line conveyed liquid effluent from the C-403 Neutralization Tank (SWMU 40) and Waste Discard Sump (SWMU 203) to the C-404 Holding Pond. With the development of treatment facilities within the C-400 Building, the Transfer Line was abandoned in 1957. At that time, effluent from the C-403 Neutralization Tank and Waste Discard Sump was allowed to discharge to the North-South Diversion Ditch.

No spills or releases associated with the Transfer Line have been documented or are known. Samples from the C-403 Neutralization Tank and the Waste Discard Sump are the only data available for assessing the historical pipeline contents.

Location and Results of Previous Sampling

During Phase II SI activities (CH2M HILL 1992), shallow soils in the vicinity of the C-401 Transfer Line were sampled at six locations. Detections of beryllium, chromium, nickel, and zinc above reference values and pentachlorophenol were reported from the soil samples. No consistent pattern was evident among analyte concentrations in the soil samples.

4.2.8.2 Nature and Extent of Contaminants

Two surface soil samples from Sector 8 were analyzed for SVOAs, PCBs, inorganic constituents, and radionuclides. In addition, 18 subsurface soil samples (collected from a depth of up to 48.5 ft bgs) were analyzed for VOAs, 13 for SVOAs, 8 for PCBs, 12 for inorganics, and 10 for radionuclides.

One sludge sample and one liquid sample were collected from inside the pipeline at Boring 026-020. The sludge was analyzed for VOAs, SVOAs, inorganics, and radionuclides. Due to the small volume of fluid available for collection, the liquid was tested only for VOAs.

Fig. 4.28 shows the location of the sampling points. The results are described below and summarized in Tables 4.38 through 4.41. Table 4.42 presents additional information about the analytical results and frequency of detections.

Summary of Findings

Sector 8 sampling was targeted at revealing any impact that the pipeline may have had on the surface and subsurface soils. In order to evaluate the impact, analysis of the contents within the pipeline, as well as the condition of the pipeline, was required. On October 30, 1997, a section of pipeline was excavated, and sludge and a small quantity of liquid from within the pipeline were collected. While the pipeline was exposed, a soil sample from directly beneath the pipeline was also collected for analysis.

One area of impact was identified near Boring 026-009, the exposed pipeline, and surrounding excavation area. The pipeline sludge sample was found to contain high levels of copper, nickel, and chromium. These three metals were also found in high concentrations in soil samples collected directly beneath the pipeline, and nickel and copper were detected in a soil sample collected at 7.5 ft bgs in a boring adjacent to the excavated area. Therefore, the elevated metal concentrations in samples directly adjacent to and below the pipeline reflect the same constituents found in the sludge sample collected from within the pipeline, confirming that a leaking pipeline was the source for this impact. In addition to metals, the sludge sample also contained high activity for several isotopes, namely ^{99}Tc, ^{230}Th, ^{237}Np, ^{239}Pu, ^{137}Cs, ^{234}U, and ^{238}U. Similarly, analyses of the soil collected beneath the pipeline contained high activities of ^{137}Cs, ^{99}Tc, ^{234}U, and ^{238}U, further substantiating the conclusion that a leak from the pipeline affected the soils surrounding it in this area.

A second area of impact was defined by the westernmost boring within Sector 8. A shallow soil sample collected from Boring 026-003 at 4 to 8 ft bgs exhibited an isolated occurrence of TCE and its degradation product, cis-1,2-dichloroethene, at a low concentration. These detections may be the result of an old spill in the immediate vicinity of the boring (such that VOAs in the surface soil have volatized) or from a release from the Transfer Line. The TCE may also have been sourced from the nearby C-404 facility.

This boring also exhibited high radioactivity for ^{234}U and ^{238}U in the subsurface soil (4 to 8 ft bgs). However, the surface soil did not contain elevated radionuclide activity, which implies that the impact may be the result of a subsurface release. Soil samples were not collected below 15 ft bgs at most locations along the pipeline.

Analytical Results–Pipeline Sludge and Liquid

Organics

VOAs and SVOAs. No VOAs were found in the pipeline sludge sample 026020SA003. Trace amounts of 10 PAHs were detected in the sludge sample; all were below the SQL.

Inorganics

A total of 16 inorganic constituents above the PGDP background levels were detected in the sludge sample. Several constituents were only slightly above their respective background values. Three metals (chromium, copper, and nickel) exhibited elevated values. The sludge contained 17,600 μg/kg nickel (800 times the soil background level), 9520 μg/kg copper (380 times soil background), and 0.9 μg/kg cadmium (four times soil background).

Radionuclides

The sludge sample exhibited high radioactivity for numerous radionuclides. Technetium-99 had the highest activity at 4840 pCi/g, exceeding the PGDP soil background value of 2.8 pCi/g by 1730 times. Other elevated radioactive isotopes included ^{237}Np with 52.6 pCi/g, ^{234}U with 102 pCi/g, ^{238}U with 142 pCi/g, ^{239}Pu at 11.2 pCi/g, and ^{137}Cs at 3.8 pCi/g.

Liquid

A sample of a liquid was collected from a break in the line that was discovered when the pipeline was excavated. Only a small quantity of liquid could be collected, and, therefore, the sample was analyzed for VOAs only. No VOAs were detected in the sample.

Analytical Results–Surface and Subsurface Soils

Organics

VOAs. VOA analyses of subsurface soil samples collected from 13 locations showed toluene, TCE (at 34 μg/kg), and its degradation product, cis-1,2-dichloroethene (at 15 μg/kg), to be detected in the soils. The chlorinated solvents were detected at low levels above the SQL in only one soil sample from the 4- to 8-ft-bgs interval from Boring 026-003. Two subsurface soil samples from Borings 026-005 and 026-007 that were collected from 5 to 9 ft bgs contained toluene at 320 and 310 μg/kg, respectively.

SVOAs. Small quantities of 15 SVOAs were detected in soil samples from Sector 8. Twelve of these were at concentrations below the SQL. The surface soil sample from Boring 400-043 contained fluoranthene and pyrene at 840 and 710 μg/kg, respectively. In the subsurface, one soil sample collected adjacent to the pipeline at 026-007, from 5 to 9 ft bgs, contained 823 μg/kg of the SVOA, N-nitrosodiphenylamine. The distribution of total PAHs for Sector 8 soil is shown in Fig. 4.29.

PCBs. No PCBs were detected in the surface soil samples of Sector 8. However, two of the eight subsurface samples contained PCBs above the SQL. The soil sample collected at 3.5 ft bgs directly beneath the pipeline contained PCB-1254 at a concentration of 32 mg/kg, and a soil sample from Boring 026-009 contained 63 mg/kg of PCB-1260.

Inorganics

Of the 15 metals detected, most were either below the SQL (e.g., antimony, selenium, and thallium) or slightly above the PGDP background levels. The exceptions include (1) the soil sample collected at 7.5 ft bgs from Boring 026-009, adjacent to the area excavated around the pipeline, which contained 146 μg/kg of copper compared to the background level of 25 μg/kg, and 115 μg/kg nickel compared to a background of 22 μg/kg; and (2) the soil sample collected at 3.5 ft bgs from location 026-025, immediately below the pipeline, which showed elevated concentrations of chromium (140 μg/kg), copper (390 μg/kg), and nickel (467 μg/kg). Figure 4.30 shows the distribution of beryllium, a toxic metal, that was found in Sector 8 soils.

Radionuclides

The 10 soil samples collected between 0 and 48.5 ft bgs were analyzed for radionuclides, which were detected mostly at activities that only slightly exceeded background levels. Two subsurface soil samples, however, showed elevated isotope activities. One sample collected from 026-003, at 8 ft bgs, on the western perimeter of Sector 8 exhibited an activity of 53.2 pCi/g from the ^{238}U isotope (Fig. 4.31), which is 44 times the background value. The ^{234}U activity of 7 pCi/g exceeded background by approximately three times. In addition, a sample collected at location 026-025 (directly below the pipeline) contained an activity of 265 pCi/g for ^{99}Tc (95 times the background level), 28.2 pCi/g for ^{234}U (12 times the background level), and 36.5 pCi/g for ^{238}U (30 times the background level).

4.2.9 Sector 9

4.2.9.1 Site History

Location and Physical Description

Sector 9 is a grass-covered area located to the east and northeast of the C-400 Building, north and south of Virginia Street and east of 11th Street. No facility operations or buried pipelines were assessed during the Sector 9 evaluation (investigation of bedding material associated with a portion of the pipelines running to the C-410-B Neutralization Lagoon is discussed in Section 4.2.2). Several deep borings were drilled in this area to assess the contribution of groundwater contaminants migrating from the C-400 Area to the Northeast Plume.

4.2.9.2 Nature and Extent of Contaminants

Seven surface soil samples (all analyzed for SVOAs and metals) were collected from Sector 9. Six surface soil samples were analyzed for radionuclides and PCBs. Two samples collected between 10 and 30 ft bgs from Boring 400-212 were analyzed for VOA constituents. All sampling locations within Sector 9 are shown in Fig. 4.32. Analytical results are summarized in Tables 4.43 to 4.45. Table 4.46 provides additional information, including the frequency of detection.

Summary of Findings

Sector 9 did not exhibit any areas of impact from the target contaminants. Concentrations of all organic compounds and several metals detected in Sector 9 soils were below the SQL. The remaining metals only slightly exceeded PGDP background screening levels. Isolated radionuclide activities did not exhibit a trend.

Analytical Results–Surface and Subsurface Soils

<u>Organics</u>

VOAs. No VOAs were detected in either of the two subsurface soil samples collected from Sector 9.

SVOAs. Ten PAH compounds were detected from the seven surface soil samples collected from Sector 9. The distribution of total PAHs is shown in Fig. 4.33. SVOAs were detected in only three of the seven samples and at concentrations below the SQL. No subsurface samples were analyzed for SVOA compounds.

PCBs. PCBs were detected in two surface soil samples from Borings 400-039 and 400-049. In a sample from the latter location, PCB-1254 and PCB-1260 were each reported at a concentration of 38 μg/kg. The sample from Boring 400-039 contained 5.6 μg/kg of PCB-1260. All of these values were below the SQL.

<u>Inorganics</u>

Eleven metals—aluminum, antimony, arsenic, beryllium, cadmium, chromium, copper, iron, sodium, thallium, and, vanadium—were detected at concentrations slightly above background screening levels from Sector 9. Antimony, cadmium, and thallium were reported only at concentrations below the SQL. Subsurface soils were not analyzed for metals content. Two of the metals, chromium and antimony, are extremely toxic at low levels. The distribution of these two metals is shown in Fig. 4.34.

<u>Radionuclides</u>

Radiological activity above background levels was reported from all six surface soil sampling locations in Sector 9. Sample 400-039 contained the highest activities of ^{234}U and ^{238}U, at 7.9 and 8.7 pCi/g, respectively. Fig. 4.35 shows the distribution of ^{238}U in Sector 9 soils. Technetium, another detected radionuclide, was highest at 2.9 pCi/g from the Boring 400-049, which is located just north of the C-415 Building. Americium-241 and ^{235}U were detected at low activities in several samples at Sector 9.

4.2.10 Phreatic Soils

Soil samples were collected below the water table during the drilling of RGA and McNairy borings. These phreatic zone samples (typically collected between 50 and 120 ft bgs) were used to obtain geological, geotechnical, and geochemical information about the subsurface strata at WAG 6. Seventy-eight phreatic zone soil samples were collected and some were selected for chemical analysis of VOAs, SVOAs, metals, and radionuclides. Analytical results above PGDP background levels are summarized in Tables 4.47 through 4.50. Table 4.51 provides additional information about the frequency of detection. Seventy-six soil samples were analyzed only for TCE and its degradation products. Forty-four samples were tested for a full suite of VOAs. Eleven samples were analyzed for SVOAs and inorganics, and 40 samples were analyzed for radionuclides.

Organics

VOAs. TCE was reported in phreatic soils from 8 borings. The range of detected TCE concentration was from 2.8 μg/kg to 65,000 μg/kg. TCE was the most common VOA detected. The highest TCE concentration (65,000 μg/kg) was from the duplicate sample collected from Boring 400-207, a second boring drilled immediately adjacent to the location that exhibited the highest concentration of TCE in groundwater. In general, this relationship between high TCE concentrations in the groundwater and in the phreatic zone soils was very common.

SVOAs. The concentrations of the three SVOAs detected from the 11 phreatic zone soils collected at WAG 6 were below the SQL.

Inorganics

Fourteen metals were reported at concentrations above background levels. Six of these were reported only from one or two samples of the 11 samples that were analyzed. Sodium, a common soil-forming element, was the most frequently detected metal. Beryllium exceeded background in 6 of 11 samples. Iron exceeded background in 4 of 11 samples, with a maximum concentration of 380,000 μg/kg.

Radionuclides

Low activities (less than 0.5 pCi/g) of ^{137}Cs, ^{237}Np, and ^{235}U were reported from the deep soil samples collected from WAG 6. Cesium-137 was detected four times, ^{237}Np five times, and the uranium isotope once.

4.3 GROUNDWATER

Groundwater plumes of VOAs (notably TCE) and the radionuclide ^{99}Tc extend several miles off-site to the north of PGDP. In 1995, a groundwater study confirmed the C-400 Area as the primary source of the Northwest Plume contaminants (Garner, Morti, and Smuin 1995). The C-400 Area also has been previously suspected as a contributing source of contaminants to the Northeast Plume. Potentiometric trends in the upper RGA and in well-flow measurements have confirmed a divergence of groundwater flow from under the C-400 Area toward the north, as indicated by the geometry of the plumes (DOE 1997).

Dissolved concentrations of VOAs detected in the C-400 Area have been interpreted as circumstantial evidence for the presence of TCE as a DNAPL. Additionally, the highest ^{99}Tc activities observed in groundwater at the PGDP also occurred near the C-400 Building.

One of the primary objectives of the WAG 6 RI was to assess whether a DNAPL pool of TCE exists in the vicinity of the C-400 Building and, if so, to define its horizontal and vertical extent. Another major objective was to evaluate the SWMUs around the C-400 Area that could have contributed to the elevated ^{99}Tc previously detected in the PGDP groundwater.

To achieve these objectives, grab water samples were collected from the UCRS, RGA, and McNairy groundwater flow systems. In addition, existing monitoring wells that were installed during the Phases I and II investigations were redeveloped and sampled, and three new monitoring wells were installed in the RGA. In general, the water samples collected during the WAG 6 RI were analyzed for VOAs, SVOAs, metals, and radionuclides. Other selected parameters were measured (1) to define the chemical and physical properties of the groundwater that were required to delineate the extent of contamination and (2) to be used for remedial alternative screening.

FILTERED VS UNFILTERED GROUNDWATER SAMPLES

Filtered and unfiltered water samples were analyzed for inorganic constituents (metals) during the WAG 6 RI. Comparison of the data sets indicated that the unfiltered samples generally contain from 2 to 100 times higher metals content than filtered samples. Additionally, almost all of the values from the metals analyses performed on the unfiltered samples are above the PGDP background screening levels for groundwater. The high metals content in the unfiltered water samples is a product of suspended metals-bearing clays. Therefore, these unfiltered metals results are not included in the discussion concerning the nature and extent of the WAG 6 groundwater contaminants. The complete data set (both filtered and unfiltered) is contained in Appendix J.

RESULTS OF PREVIOUS GROUNDWATER INVESTIGATIONS – PHASES I AND II

Groundwater monitoring wells MW-68 through MW-71, located approximately 200 ft south of the C-400 Building, were installed in 1986 during the Phase I SI prior to discovery of the Trichloroethene Leak Site (SWMU 11).

Elevated levels of total organic halogens, TCE, and ^{99}Tc were reported from sampling for the SI (CH2M HILL 1992). Generally, higher levels were found in MW-68, which is screened in the lower portion of the RGA. MW-71 is screened in the upper portion of the RGA. Peak concentrations of TCE and ^{99}Tc were 107 μg/L for TCE and 177 pCi/L for ^{99}Tc. The residential groundwater PRGs for TCE and ^{99}Tc, as shown in Table 4.2, are 1.4E-1 μg/L and 2.8E+01 pCi/L, respectively.

During the Phase II SI field activities, a well cluster consisting of MW-155, MW-156, and MW-157 was installed in the area of the Trichloroethene Leak Site (SWMU 11) to assess groundwater quality in the lower RGA, upper RGA, and UCRS, respectively. The highest concentrations of TCE in groundwater at the PGDP site were found in MW-156 and MW-157. Concentrations of TCE in the UCRS (MW-157) ranged from 400,000 to 890,000 μg/L. The TCE concentration in the upper RGA (MW-156) was 360,000 μg/L, whereas the concentration in the lower RGA (MW-155) ranged from 1900 to 200J μg/L. The high concentrations of TCE detected in the groundwater samples from MW-156 and MW-157 exceeded 1% of the solubility limit for TCE (i.e., 11,000 μg/L at 25°C), indicating that TCE may have been present as DNAPL in the UCRS near MW-157 and in the upper RGA near MW-156 (CH2M HILL 1992). However, attempts to recover DNAPLs from MW-156 and MW-157 using a bottom-filling bailer during the Phase II SI field activities were unsuccessful. Other contaminants detected in the wells near the Trichloroethene Leak Site (SWMU 11) included 1,1-dichloroethene; 1,2-dichloroethene; chloroform; carbon tetrachloride; perchloroethene; 1,1,2-trichloroethane; toluene; and bromodichloromethane. The highest concentrations of these contaminants were detected in the UCRS sample.

Groundwater from monitoring wells MW-156 and MW-157 collected since the Phases I and II SI continue to have high TCE concentrations. TCE analyses of MW-156 water generally range between 300,000 and 400,000 μg/L. Water samples from MW-157 contained TCE at concentrations between 100,000 and 780,000 μg/L, with most values greater than 500,000 μg/L. TCE levels in MW-155 remain relatively low, ranging from 1,800 to 2,300 μg/L. The C-403 Neutralization Tank was investigated during the Phase II SI. Field activities completed during the Phase II SI included the installation of two groundwater monitoring wells (MW-177 and MW-178) south of C-403. MW-177 is screened in the UCRS at a depth of 39.5 to 44.5 ft bgs. MW-178 is screened in the upper portion of the RGA at a depth of 62.5 to 67.5 ft bgs.

A groundwater sample was collected from each of the newly installed monitoring wells to assess contamination in the UCRS and RGA. The most significant findings from the Phase II SI were the elevated concentrations of TCE and ^{99}Tc in groundwater. The ^{99}Tc activities of 1,200 pCi/L and 1,735 pCi/L in MW-177 and MW-178, respectively, were an order of magnitude higher than those of any other monitoring wells sampled during the Phase II SI (CH2M HILL 1992).

Analyses of samples from MW-178, subsequent to the Phase II SI, document continued high levels of ^{99}Tc and TCE in the RGA at SWMU 40 Sector 2. Measured ^{99}Tc activities have been between 500 and 1,100 pCi/L, with an apparent trend of decreasing activity over time. TCE concentrations have ranged widely from 480 to 11,000 μg/L. No subsequent data are available for MW-177. Water levels in the well were too low to allow sample collection. The Technetium Storage Tank (SWMU 47) area also was investigated during the Phase II SI conducted in 1991 and 1992. Field activities completed during the Phase II SI include the installation of two groundwater monitoring wells, MW-175 and MW-176. The sampling locations during the Phase II SI were located approximately 50 to 75 ft south of the former tank location.

MW-175 is screened in the upper portion of the RGA at a depth of 75 to 80 ft bgs. MW-176 is screened in the UCRS at a depth of 32.5 to 37.5 ft bgs.

A groundwater sample was collected from MW-175 to assess contamination in the RGA. A sample could not be collected from MW-176 because the well was dry. Chromium (37.2ppb), TCE (27 ppm), and ^{99}Tc (260 pCi/L, total) were detected in the RGA.

4.3.1 UCRS

The UCRS is not an aquifer in the vicinity of WAG 6. Groundwater collected from the

UCRS during the WAG 6 project is considered transient water. The water found in the UCRS represents surface water that has percolated through the upper 50 ft of the UCRS sediments before becoming trapped above a semi-confining layer that separates the UCRS from the underlying RGA. On this semi-confining layer, the water begins to flow laterally until pooling in a low spot as perched water; it then slowly filters through the semi-confining layer or a conduit through the semi-confining layer that allows the water to flow vertically into the underlying RGA. As shown by a potentiometric map of the UCRS (see Fig. 3.18), the UCRS groundwater flows laterally toward the C-400 Building from all directions. This flow pattern is probably the result of two conditions: (1) the depression of the water table created by the large building and paved area around the C-400 Building, which prevents surficial recharge and (2) a discontinuity below the C-400 Building in the semi-confining clay layer that separates the UCRS and RGA intervals. Where this clay is absent, either due to non-deposition or erosion, a "drain" is formed between the perched UCRS groundwater and the underlying RGA. The UCRS water, while transitory, flows through contaminated UCRS soil and serves as an effective carrier for the migration of contaminants from shallow subsurface soils into the RGA.

Shallow groundwater was not encountered in many of the UCRS, RGA, and McNairy borings that were drilled during the WAG 6 RI. As a result, only four UCRS grab groundwater samples could be collected. In addition to the four grab water samples, an existing monitoring well, MW-157 (011-011) was also sampled, and, during late December and January of 1997, enough water was present in 14 of the piezometers that had been installed into the UCRS that a water sample could be collected for analysis of TCE and its degradation products. With these 14 additional piezometer sampling points, a total of 19 UCRS water samples were available for analysis. The grab water sample collected from Boring 040-009 and the piezometer sample from 040-001 are now believed to be water from a broken water line that had saturated the soils near the C-403 Neutralization Tank, and the analytical results from these samples are probably biased low. Examination of the hydrograph for piezometer 040-001 clearly shows an increase in the water level of the UCRS in October, a time when all other UCRS water levels were observed to be flat or falling. Additionally, the depth to groundwater in the grab sample of 040-009 was less than 15 ft bgs, much higher than any UCRS water level measured in areas away from the broken water line. The 14 piezometer samples, the grab sample from Boring 400-018, and the monitoring well sample from 011-011 (MW-157) were collected from approximately 40 ft bgs, near the base of the UCRS.

All 14 piezometer samples were analyzed only for TCE and its degradation products. The monitoring well samples and two of the four grab samples were analyzed for a full suite of VOAs and metals. Two grab samples were also analyzed for radiological constituents. Both the monitoring well sample and grab sample 040-009 were analyzed for SVOAs.

Organics

Tables 4.52 to 4.55 contain a complete list of all samples from the UCRS groundwater in which organic compounds were detected. Table 4.56 provides information about the frequency of detection.

VOAs. VOAs were detected in 14 of the 19 shallow groundwater samples. VOAs were not detected in three of the piezometer samples (026-002, 400-021, and 400-033) or from the samples collected from Borings 203-005 and 026-018. These five samples were collected from the north and northwest side of the C-400 Building, in an upgradient hydrogeologic position (see Fig. 4.36).

TCE was the most commonly detected contaminant and was reported in all samples in which VOAs were detected. The highest TCE concentrations were found on the southeast side of the C-400 Building in close association with the Trichloroethene Leak Site (SWMU 11) in Sector 4 (Fig. 4.36). The range of detected TCE varied in the UCRS from 2.3J μg/L at Boring 040-001 in Sector 2 (SWMU 40), to a maximum of 438,324 μg/L in MW-157, located in Sector 4 at the Trichloroethene Leak Site (SWMU 11). Samples from piezometers 011-008 and 400-016, which are located on the southeast side of the C-400 Building near the Trichloroethene Leak Site (SWMU 11), also had very elevated TCE concentrations (above 30,000 μg/L). In general, the highest TCE contents in the UCRS water samples appear to be closely associated with the high TCE soil content that is centered around SWMU 11 (see Fig. 4.12). The high concentrations in this area are an indication of the presence of DNAPL in the UCRS groundwater below Sector 4. DNAPL may also be present under the southeast corner of Sector 1 based on contouring of the TCE concentrations.

The relatively high TCE content (1,120 μg/L) of the UCRS water documented north of the C-400 Building in piezometer 400-003 may be due to the same (relatively poorly defined) TCE source that has impacted UCRS soils at Boring 203-003, adjacent to the Waste Discard Sump (SWMU 203) in Sector 7.

In addition to TCE, the UCRS groundwater samples contained TCE degradation products. Small amounts of cis-1,2-dichloroethene (3.3J μg/L) were detected in Boring 040-009. Some trans-1,2-dichloroethene (3.4J μg/L) and 1,1-dichloroethene (1.6J μg/L) were detected in 203-001. Trans-1,2-dichloroethene was reported in piezometer sample 400-016 at a concentration of 500J μg/L.

A sample from the monitoring well installed at Boring 011-011 (MW-157) and the grab samples from 040-009 and 400-018 were the only UCRS water samples that were analyzed for the full suite of VOA. In addition to the detections of TCE (and its degradation products) discussed above, the sample collected at 040-009 also exhibited a small quantity (less than the SQL) of several other VOAs.

SVOAs. Diethyl phthalate, at 4.1JH μg/L, was the only SVOA reported from either of the two UCRS water samples (011-011 and 040-009) for which these compounds were tested.

Inorganics

Three shallow groundwater samples—400-018, 011-011, and 040-009—were analyzed for metals. Three metals were detected at concentrations that exceeded background screening levels in the groundwater sample from 400-018: manganese (0.28 mg/L), zinc (0.19 mg/L), and sodium (101 mg/L).

Radionuclides

Two UCRS water samples were analyzed for selected radionuclides. The samples were collected from 400-009 and 400-018, and 12 isotopes were reported from the samples. Most of the isotopes were found at their maximum activities in groundwater from Boring 400-018. The lower radiological activities in the sample from 040-009, which was collected adjacent to the C-403 Neutralization Tank, were probably due to dilution of the sample by water from a nearby broken water main. Technetium-99 was detected only in sample 400-018, at an activity of 22 pCi/L. Several of the isotopes analyzed for (^{228}Ac, ^{214}Bi, ^{212}Pb, ^{214}Pb, ^{40}K, and ^{280}Th) were not included on the list of radionuclides for which analyses were requested from the contract laboratory. Therefore, these isotopes were rarely, if ever, analyzed for (or detected) in the overlying soils.

4.3.2 Regional Gravel Aquifer

One-hundred-sixty-two groundwater samples (including seven duplicates) were collected from the RGA during the WAG 6 RI. These samples were collected between 50 and 95 ft bgs and were analyzed for VOAs, SVOAs, metals, and radionuclides. Tables 4.57 to 4.60 summarize the detection of compounds/analytes and isotopes from the RGA. Additionally, information about the frequency of detection is presented in Table 4.61.

Organics

TCE was reported in 151 of the RGA groundwater samples. Detected concentrations ranged from slightly above 1 µg/L to a maximum of 701,184 µg/L. The maximum concentration was found at 70 ft bgs in Boring 400-037. The highest TCE values occur on the southeast side of the C-400 Building (Sector 4) in close association with the Trichloroethene Leak Site and the TCE off-loading pump station (Fig. 4.37).

Most of the high TCE values in the RGA clustered between 70 and 85 ft, which corresponds approximately to the lower half of the porous RGA sandy gravel. Vertical and lateral variations in the TCE content are pronounced. TCE concentrations were found to vary by more than 600,000 µg/L over a distance of as little as 50 ft laterally and 20 ft vertically within the WAG 6 area. Such dramatic changes in the observed magnitude of TCE concentrations reflect both the inherent nature of TCE as a DNAPL to pool in "lows" and the effect that minor stratigraphic changes (which control porosity and permeability) can have on the migration of TCE in the heterogeneous subsurface.

Contouring of the maximum TCE concentrations in the RGA indicates that one or more sources of the TCE are located in the C-400 Area. As shown in Fig. 4.37, the axis of the TCE contaminant plume trends southeast-northwest across the WAG 6 site, which is consistent with the location and orientation of the Northwest Plume. The concentrations of TCE decrease rapidly away from the C-400 Building to less than 1000 µg/L TCE to the west, south, and east as shown in Fig. 4.37. Based on a maximum TCE concentration of 701,184 µg/L, DNAPL TCE is present within the RGA at WAG 6. Using an 11,000-µg/L TCE threshold as indicative of DNAPL TCE, DNAPL could exist beneath all sectors except Sector 9 (see Fig. 4.37).

The highest TCE concentrations are located on the southeast corner of the building, slightly south of the Trichloroethene Leak Site (SWMU 11) in Sector 4.

At the UCRS level (see Fig. 4.36), the highest concentration of TCE appears to be centered directly beneath SWMU 11 and the location of the former TCE off-loading pump station. However, the zone of maximum TCE concentration appears to be offset at the RGA level. A significant factor contributing to the presence of TCE south of SWMU 11 is the release of TCE from the off-loading pump station where the solvent was pumped from tank cars to the aboveground TCE Day Storage Tank. Based on the high content of TCE in the UCRS soil near the pump station, this release appears to have been a major source for TCE migration to the subsurface. This offset is believed to be caused by TCE that has migrated to the south, away from the two major leak sites, along the sanitary sewer line bedding material (see Fig. 4.12). With time, this TCE has filtered more deeply into the subsurface until finally impacting the RGA groundwater.

Once the TCE reached the RGA, the contaminant plume split into two lobes around an apparent zone of decreased permeability centered at Boring 400-038 as the plume migrated to the north. Reduced permeability in Boring 400-038 is based on not only the lack of TCE in the boring, but also on the observation that the formation yielded little water during drilling.

A second area of high TCE concentration in the RGA was found at the northwest corner of the C-400 Building, below Sector 7 near SWMU 203. The high TCE content in the RGA observed in this area could be due to the commingling of TCE that has migrated downgradient from SWMU 11 with TCE derived from a separate, smaller source located in the vicinity of Sector 7 (SWMU 203).

VOAs. VOAs other than TCE were reported from only a few of the RGA water samples. After TCE, the most commonly encountered contaminants were TCE degradation products (trans-1,2-dichloroethene; 1,1-dichloroethene; cis-1,2-dichloroethene; and vinyl chloride). No correlation between TCE concentrations and concentrations of degradation products could be observed. Only small concentrations of a few other non-TCE-related VOAs were reported in association with the TCE groundwater plume in the RGA.

SVOAs. Seventeen RGA samples were analyzed for SVOA compounds. Only small quantities of a few compounds were detected. Phenol at 40 µg/L was the compound detected at the highest concentration and also the most commonly detected SVOA with 5 detections out of 17 analyses.

Inorganics

One-hundred-sixty-one RGA groundwater samples were analyzed for metals content. Thirteen metals were reported at concentrations that exceed the PGDP background screening levels. Several of the metals were detected in only one or two samples. Others are common soil-forming minerals that were detected at concentrations only slightly above background.

The distribution of most of those metals detected above background appears to be random within the WAG 6 investigation area. Nickel is an exception. All five of the elevated nickel detections occur along the northwest side of the C-400 Building. However, samples that exhibited these high concentrations of nickel also are interspersed both vertically and laterally with samples that contained nickel below background limits. Barium and manganese each exceed background levels in approximately 50 of the 161 samples analyzed for both metals. The highest concentrations are generally found in areas located away from the C-400 Building and also are isolated both vertically and laterally. No trend in the metals distribution was observed that would suggest that the C-400 Building was a source for the metals detected in the RGA groundwater.

Radionuclides

Twenty-one isotopes were detected at least once at activities above background screening levels. Technetium-99 was the most commonly detected isotope and was found in 28 samples from 9 of the locations. The highest reported activity was 17,000 pCi/L from the 85-ft grab water sample that was collected during the drilling of Boring 400-034. The second highest ^{99}Tc activity for WAG 6 samples was 11,600 pCi/L (also from 85 ft bgs), which was reported from nearby Boring 400-208. Fig. 4.38 shows the distribution of the ^{99}Tc in the RGA at WAG 6. As shown in Table 4.60, the highest ^{99}Tc activities generally occur near the base of the RGA, in the 75- to 85-ft-bgs interval.

Several radionuclides were reported from the RGA groundwater. ^{212}Bi, ^{210}Pb, and ^{214}Pb were detected above screening levels one time in a single sample and are likely naturally occurring. Several other radionuclides also occurred infrequently and at low activities throughout the water column. Radionuclides exhibiting high activity, such as ^{137}Cs and ^{237}Np, were detected more frequently but exhibit a random distribution. The two highest detections of ^{137}Cs were from Borings 400-039 and 400-034, which are on opposite sides of the WAG 6 site.

The high ^{99}Tc activities detected in the RGA groundwater samples north of the C-400 Building are attributed to input from the North-South Diversion Ditch and/or the C-403 Neutralization Tank. Samples collected from both of these SWMUs have (as recently as late 1997) contained ^{99}Tc activities in excess of 40,000 pCi/L. Based on the activities of ^{99}Tc in water samples collected from the most upgradient of the WAG 6 RGA sampling points, a small quantity of ^{99}Tc (approximately 100 pCi/L) is entering the WAG 6 area from an upgradient source. This conclusion is consistent with the regional distribution of ^{99}Tc within PGDP.

4.3.3 McNairy Flow System

Tables 4.62 through 4.65 list the analytes and radionuclides detected within the McNairy Formation. Additional information about frequency of detection is summarized in Table 4.66.

Organics

VOAs. TCE was the most widely encountered VOA from the McNairy groundwater samples. The highest concentration of TCE from the McNairy groundwater was 85,597 μg/L from Boring 400-037 at 96 ft bgs (Fig. 4.39). This sample was collected a few feet below the base of the RGA in a porous sandy zone in the top of the McNairy that is in direct contact, and hydrogeologic communication, with the overlying RGA gravel. In areas where coarse-grained McNairy sediments occur adjacent to the RGA, groundwater flow in the McNairy is coincident with flow in the RGA, and the contiguous McNairy is included within the RGA. A sample from Boring 400-207 collected at 107 ft bgs, 10 ft below the McNairy sample with the highest TCE content, contained only 1.2 μg/L TCE.

Rarely were TCE concentrations above 100 μg/L found in the first water samples collected at the top of the McNairy, and in all cases within 50 ft below the top of the McNairy, the TCE content was found to be 5 μg/L or less (Fig. 4.39). This observation clearly indicates that migration of TCE into the McNairy Formation is limited to porous zones in the upper McNairy that are in direct contact with overlying RGA sediments that contain high TCE content.

Small quantities of TCE degradation products and a few other VOAs, as listed in Tables 4.62 and 4.66, were also detected in the McNairy groundwater samples.

SVOAs. Three SVOAs were detected in the McNairy water samples. None were detected at concentrations above 6J μg/L.

Inorganics

Two samples from Boring 400-207, one at 107 ft bgs and another at 121 ft bgs, were analyzed for metals from the McNairy Formation. Manganese and zinc were slightly above background in both samples.

Radionuclides

Eight groundwater samples (including two duplicates) were collected from three locations in the McNairy Formation. The samples were collected between 107 and 122 ft bgs. Nineteen radionuclides were detected above screening levels. One water sample from Boring 400-036 was analyzed for a full suite of radiological isotopes including ^{228}Ac; ^{212}Bi and ^{214}Bi; ^{134}Cs; ^{57}Co and ^{60}Co; ^{210}Pb, ^{212}Pb, and ^{214}Pb; ^{238}Pu and $^{239/240}$Pu; ^{40}K; ^{226}Rd; ^{208}Th, ^{228}Th, ^{232}Th, and ^{234}Th; and $^{233/234}$U. Because the results for many of these radionuclides were supplied for RGA/McNairy groundwater samples without request by only one of the contract laboratories, most of these radionuclides were not analyzed for in the overlying groundwater or soils. Six of the isotopes were not detected. Results for the detected radionuclides are given in Table 4.65.

The maximum ^{99}Tc activity of 1.88 pCi/L from Boring 400-041 is significantly below the maximum ^{99}Tc activity of 113 pCi/L from the overlying RGA groundwater from the same boring. This is consistent with the observations associated with TCE in that the ^{99}Tc-contaminated groundwater does not appear to have infiltrated deeply into the McNairy Formation.

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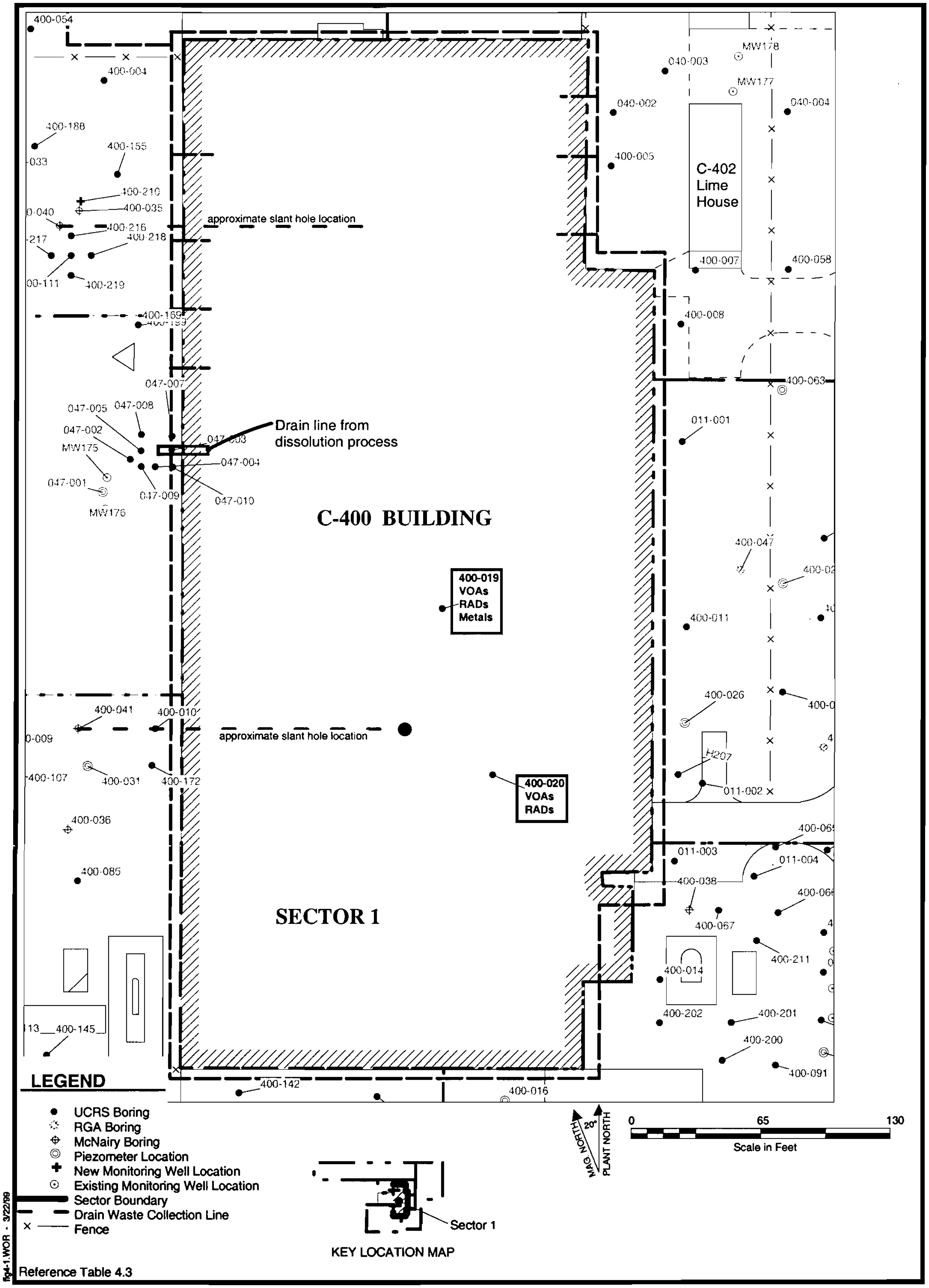


Fig. 4.1. Sector 1 site map showing contaminant groups detected in UCRS soil above SQL at each sample location.

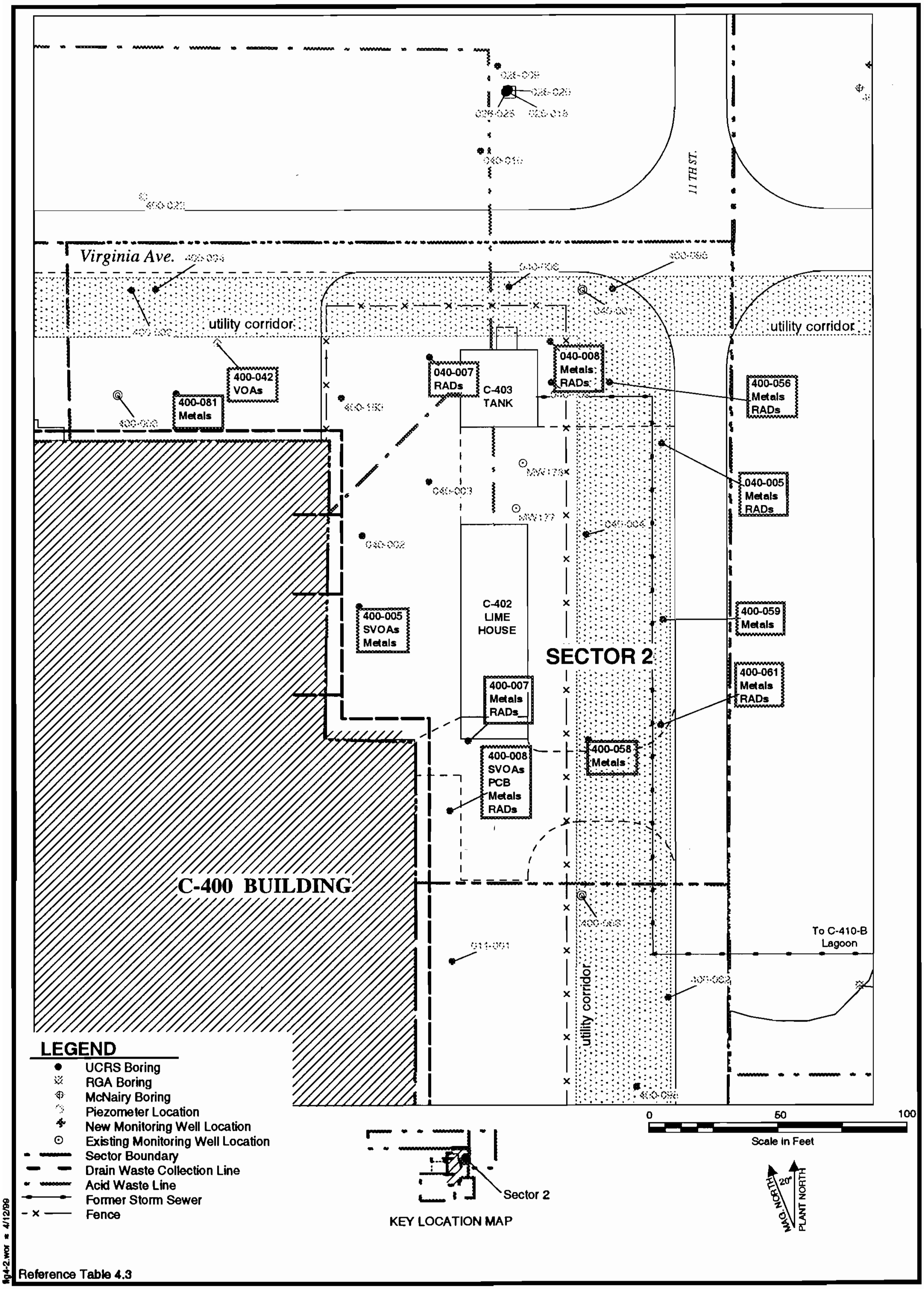
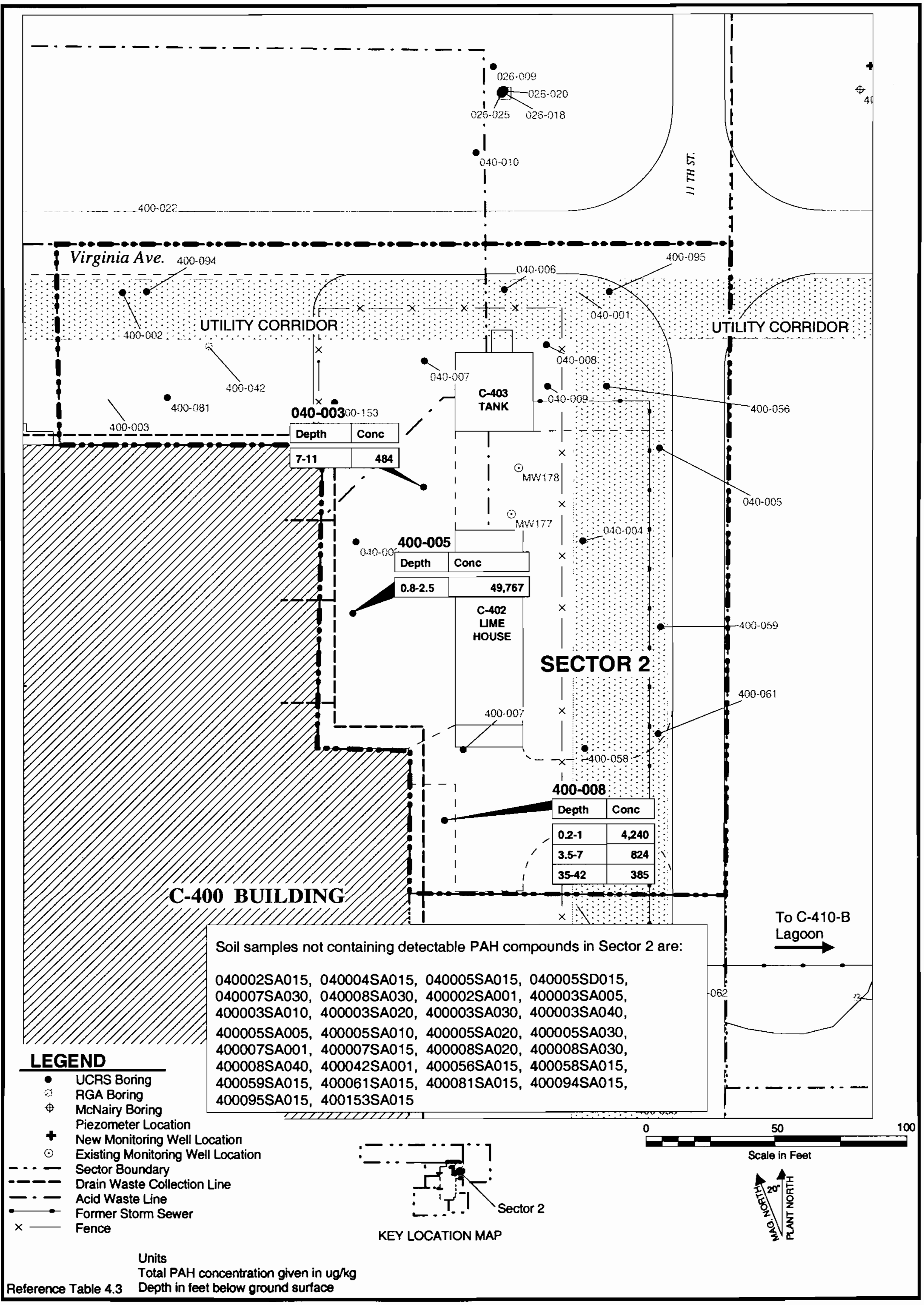


Fig. 4.2. Sector 2 site map showing contaminant groups detected in UCRS soil above SQL at each sampling location.



040-003

Depth	Conc
7-11	484

400-005

Depth	Conc
0.8-2.5	49,767

400-008

Depth	Conc
0.2-1	4,240
3.5-7	824
35-42	385

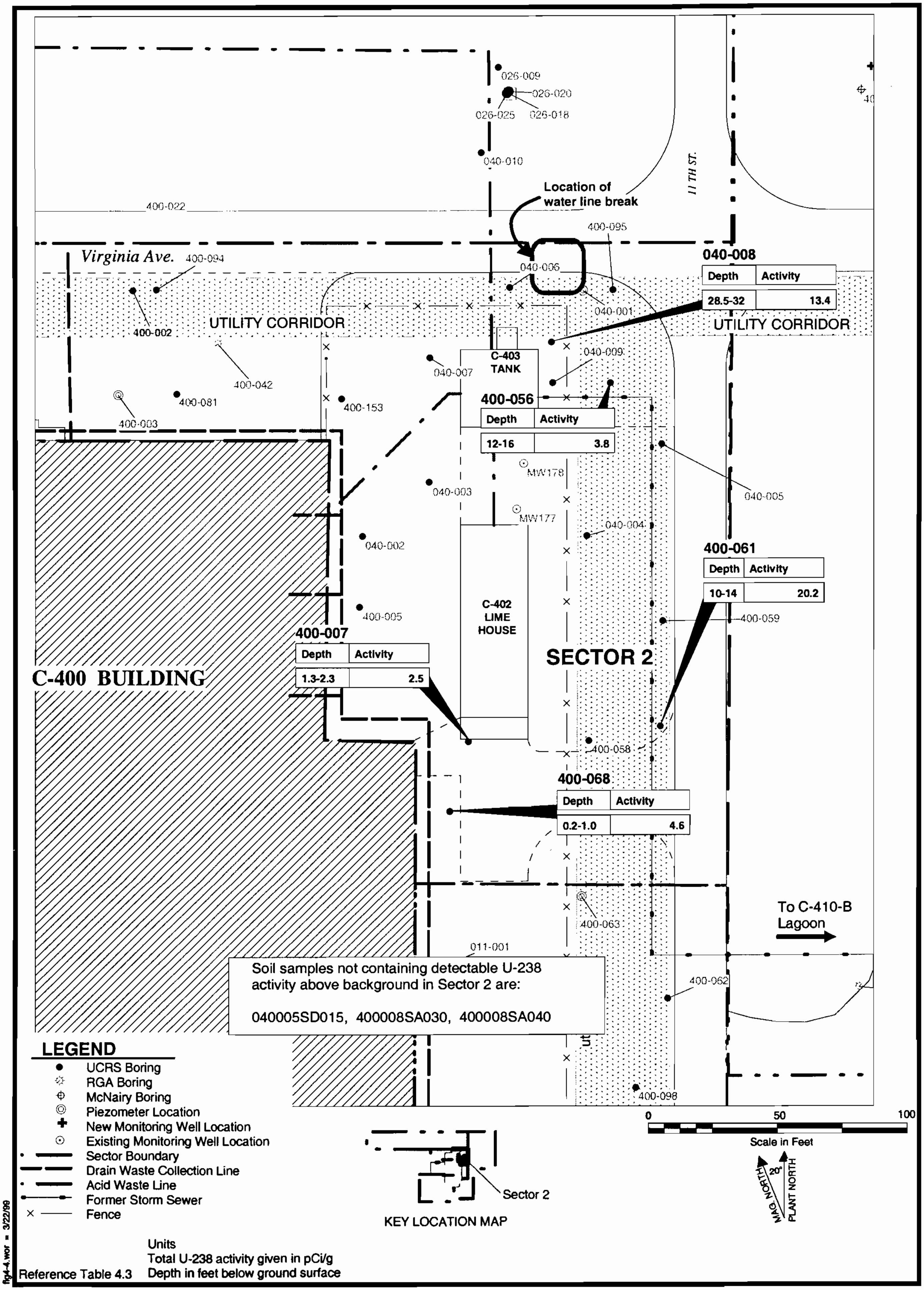
Soil samples not containing detectable PAH compounds in Sector 2 are:

040002SA015, 040004SA015, 040005SA015, 040005SD015, 040007SA030, 040008SA030, 400002SA001, 400003SA005, 400003SA010, 400003SA020, 400003SA030, 400003SA040, 400005SA005, 400005SA010, 400005SA020, 400005SA030, 400007SA001, 400007SA015, 400008SA020, 400008SA030, 400008SA040, 400042SA001, 400056SA015, 400058SA015, 400059SA015, 400061SA015, 400081SA015, 400094SA015, 400095SA015, 400153SA015

Units
Total PAH concentration given in ug/kg
Depth in feet below ground surface

Reference Table 4.3

Fig. 4.3. Map showing distribution of PAHs detected in sector 2 UCRS soil.



040-008

Depth	Activity
28.5-32	13.4

400-056

Depth	Activity
12-16	3.8

400-061

Depth	Activity
10-14	20.2

400-007

Depth	Activity
1.3-2.3	2.5

400-068

Depth	Activity
0.2-1.0	4.6

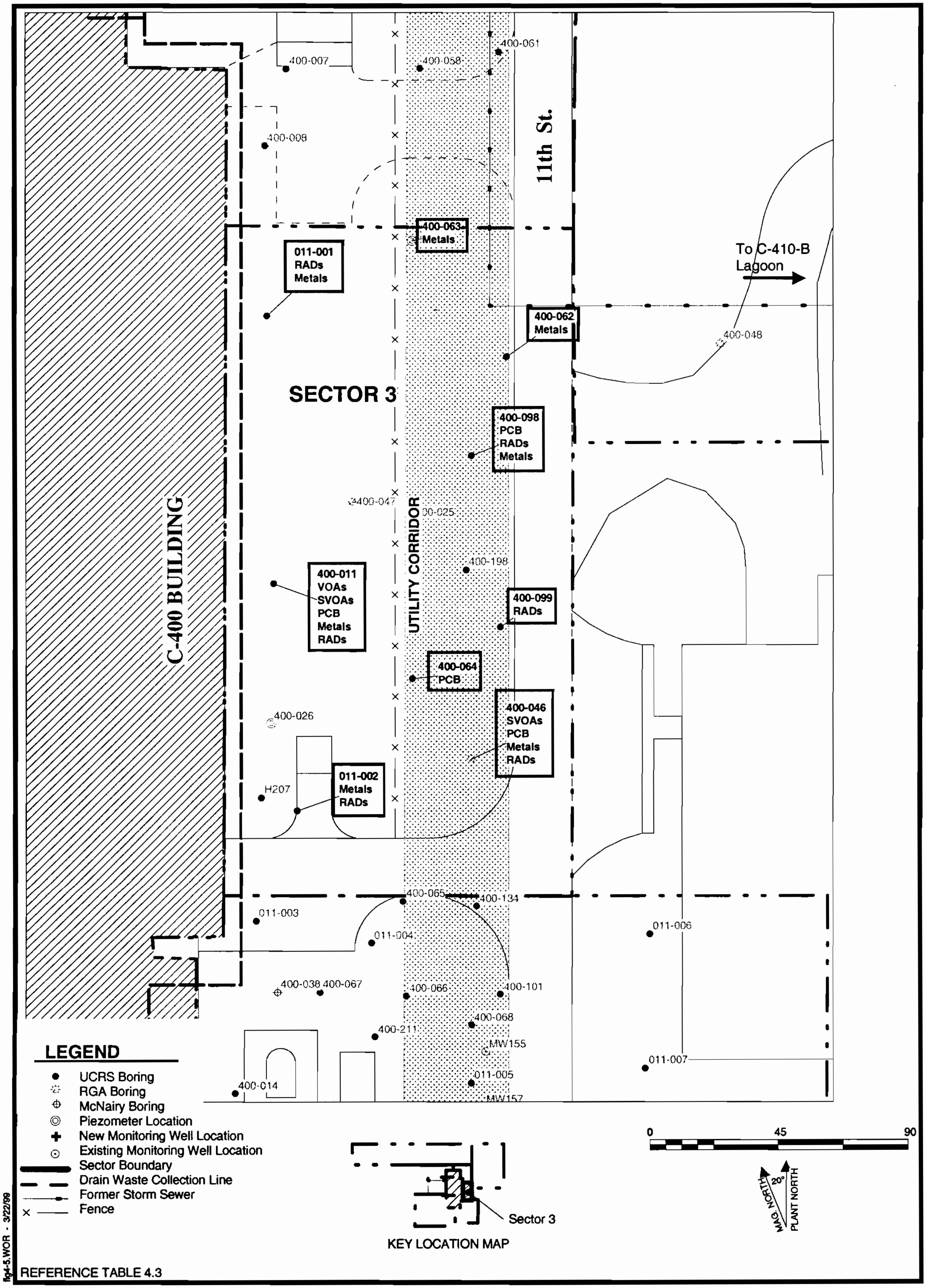
Soil samples not containing detectable U-238 activity above background in Sector 2 are:

040005SD015, 400008SA030, 400008SA040

Units
Total U-238 activity given in pCi/g
Depth in feet below ground surface

Reference Table 4.3

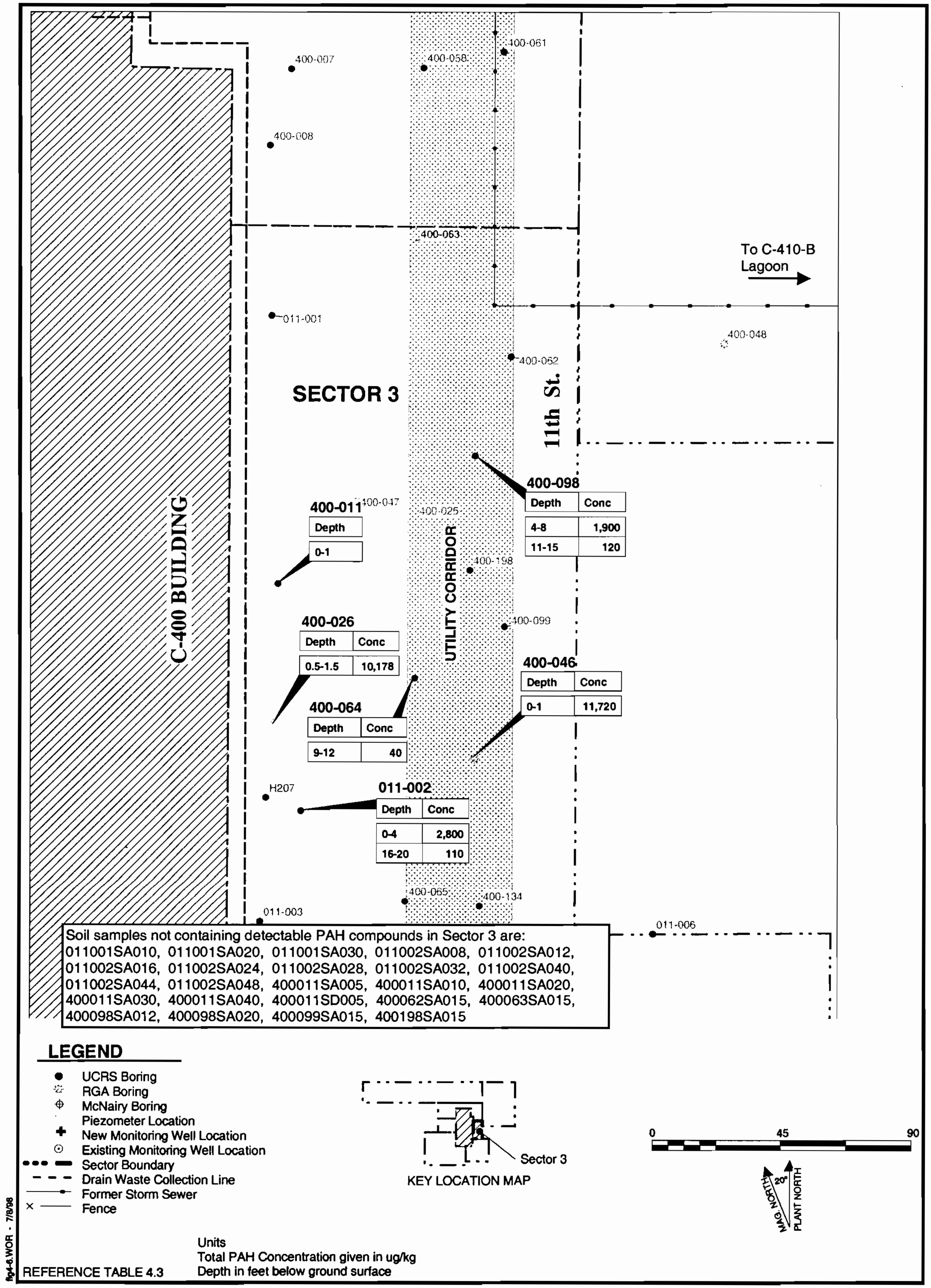
Fig. 4.4 Map showing distribution and activity of U-238 detected in sector 2 UCRS soil.



REFERENCE TABLE 4.3

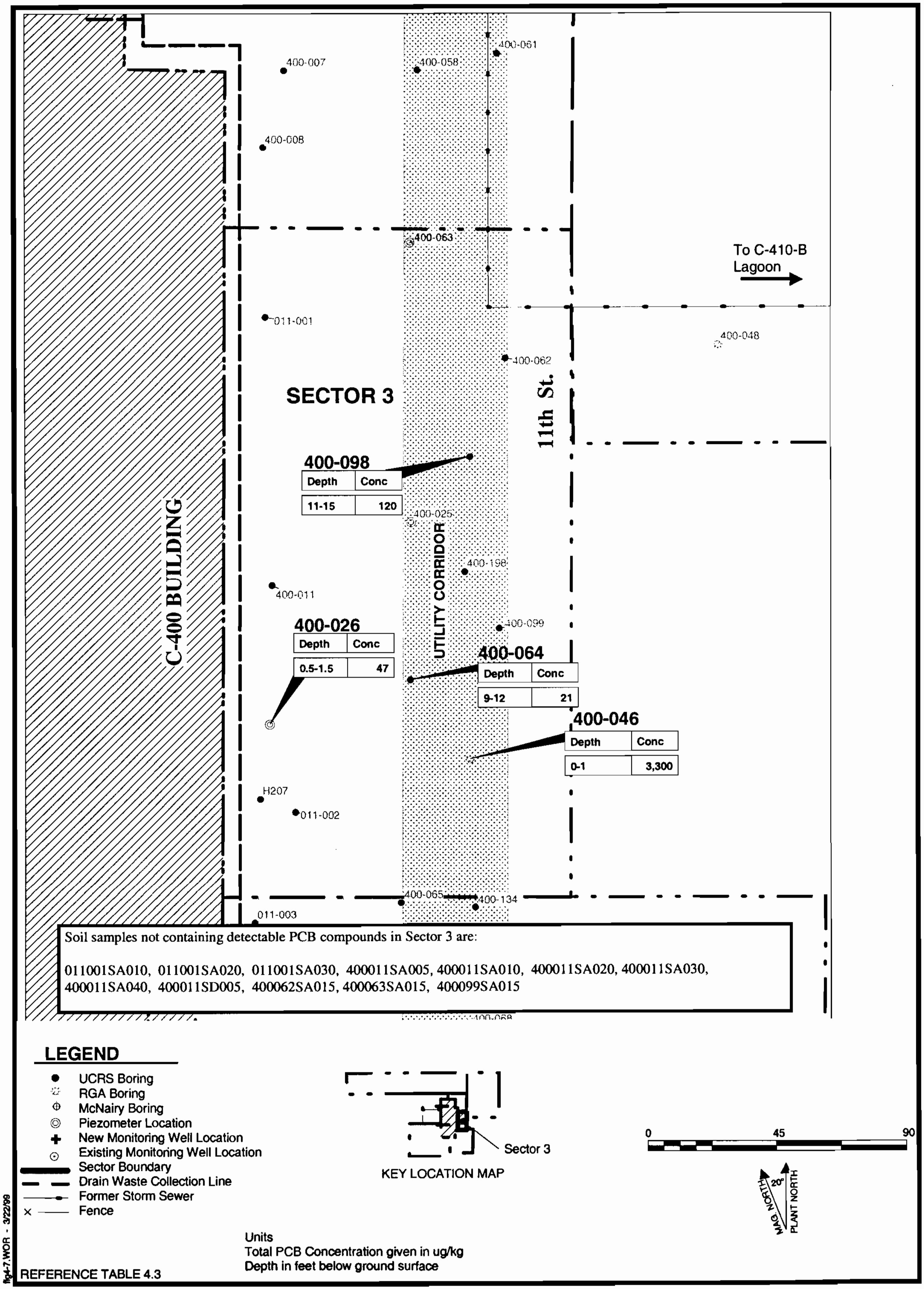
fig4-5.WOR - 3/22/99

Fig. 4.5. Sector 3 site map showing contaminant groups detected in UCRS soil above SQL at each sample location.



Soil samples not containing detectable PAH compounds in Sector 3 are:
011001SA010, 011001SA020, 011001SA030, 011002SA008, 011002SA012,
011002SA016, 011002SA024, 011002SA028, 011002SA032, 011002SA040,
011002SA044, 011002SA048, 400011SA005, 400011SA010, 400011SA020,
400011SA030, 400011SA040, 400011SD005, 400062SA015, 400063SA015,
400098SA012, 400098SA020, 400099SA015, 400198SA015

Fig. 4.6. Map showing distribution and total concentration of PAHs detected in sector 3 UCRS soil.

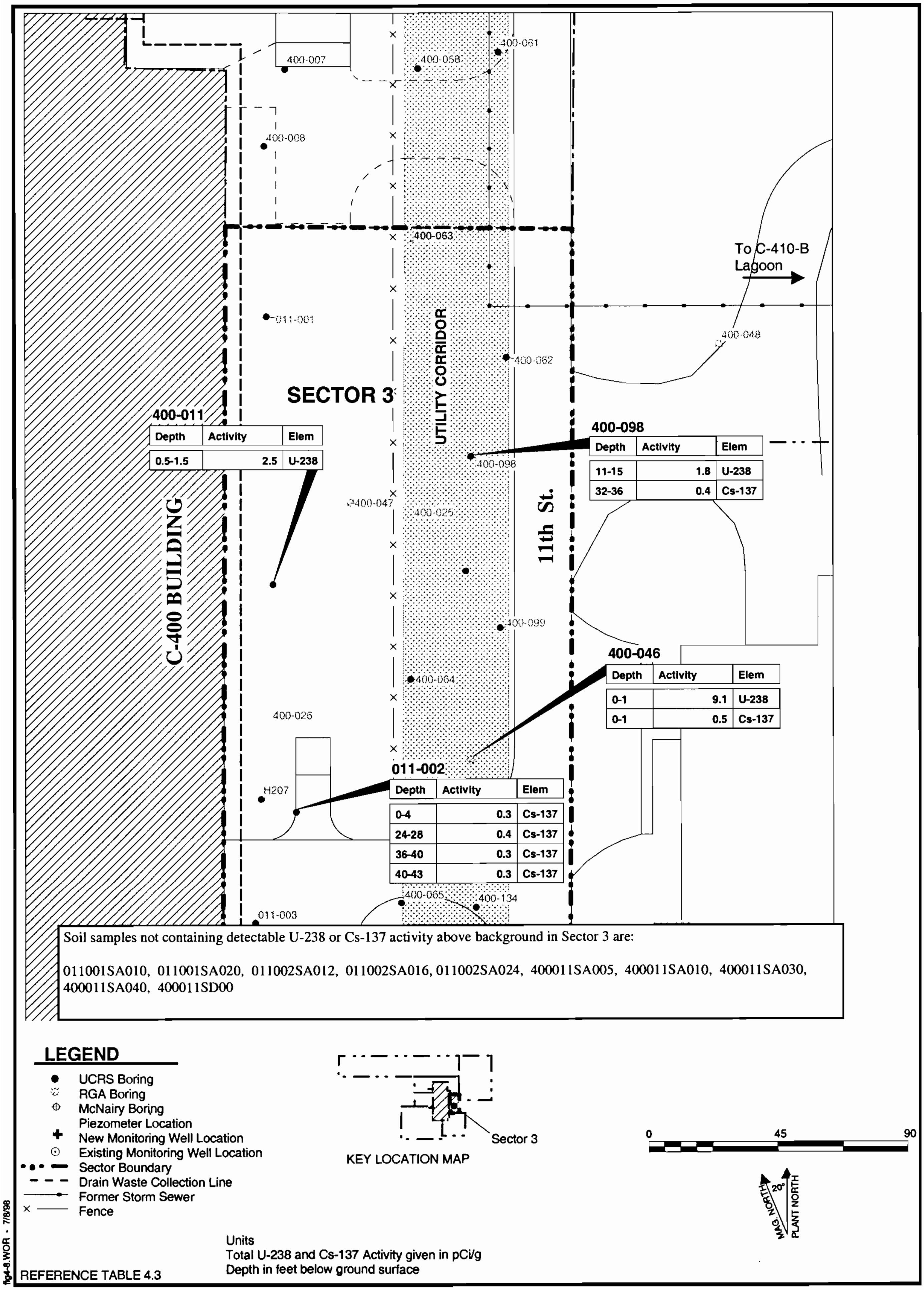


Soil samples not containing detectable PCB compounds in Sector 3 are:

011001SA010, 011001SA020, 011001SA030, 400011SA005, 400011SA010, 400011SA020, 400011SA030, 400011SA040, 400011SD005, 400062SA015, 400063SA015, 400099SA015

Units
Total PCB Concentration given in ug/kg
Depth in feet below ground surface

Fig. 4.7. Map showing distribution and total concentration of PCBs detected in sector 3 UCRS soil.



400-011

Depth	Activity	Elem
0.5-1.5	2.5	U-238

400-098

Depth	Activity	Elem
11-15	1.8	U-238
32-36	0.4	Cs-137

400-046

Depth	Activity	Elem
0-1	9.1	U-238
0-1	0.5	Cs-137

011-002

Depth	Activity	Elem
0-4	0.3	Cs-137
24-28	0.4	Cs-137
36-40	0.3	Cs-137
40-43	0.3	Cs-137

Soil samples not containing detectable U-238 or Cs-137 activity above background in Sector 3 are:

011001SA010, 011001SA020, 011002SA012, 011002SA016, 011002SA024, 400011SA005, 400011SA010, 400011SA030, 400011SA040, 400011SD00

Units
Total U-238 and Cs-137 Activity given in pCi/g
Depth in feet below ground surface

REFERENCE TABLE 4.3

Fig. 4.8. Map showing distribution and total activity of U-238 and Cs-137 detected in sector 3 UCRS soil.

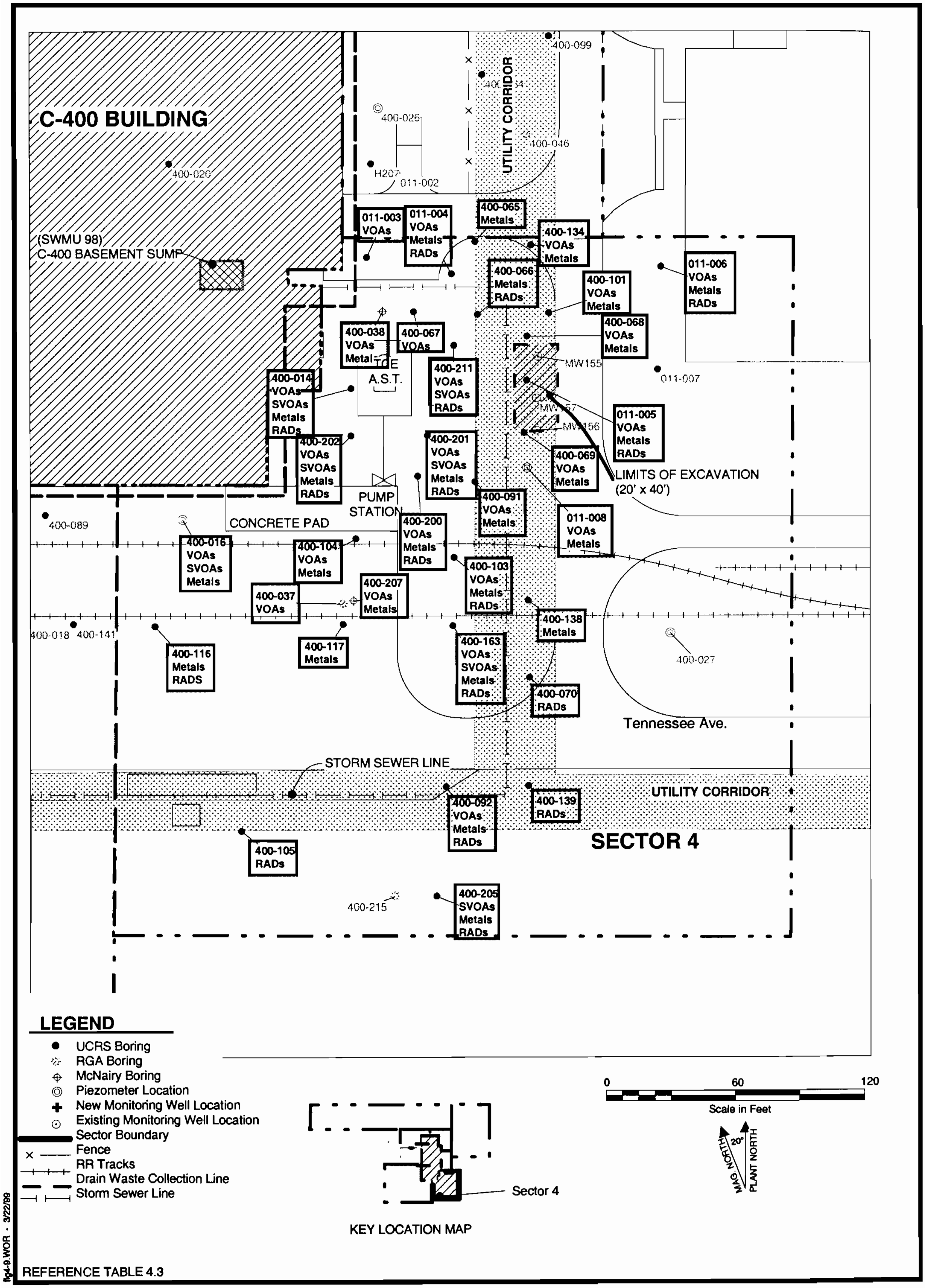


Fig. 4.9. Sector 4 site map showing contaminant groups detected in UCRS soil above SQL at each sample location.

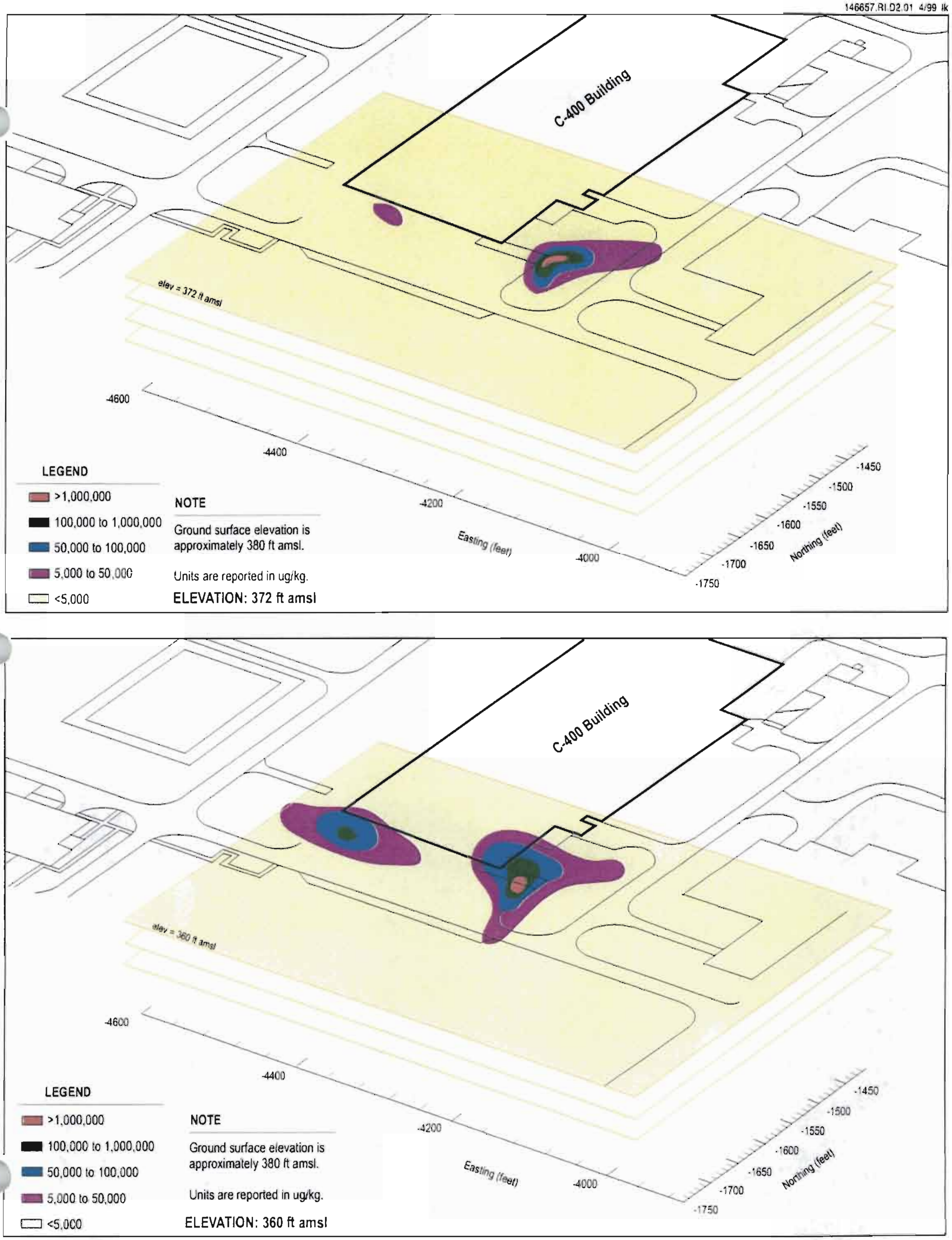


Fig. 4.10.b. 372 ft amsl and 360 ft amsl elevation slice through TCE distribution at sector 4 and 5 UCRS soil.

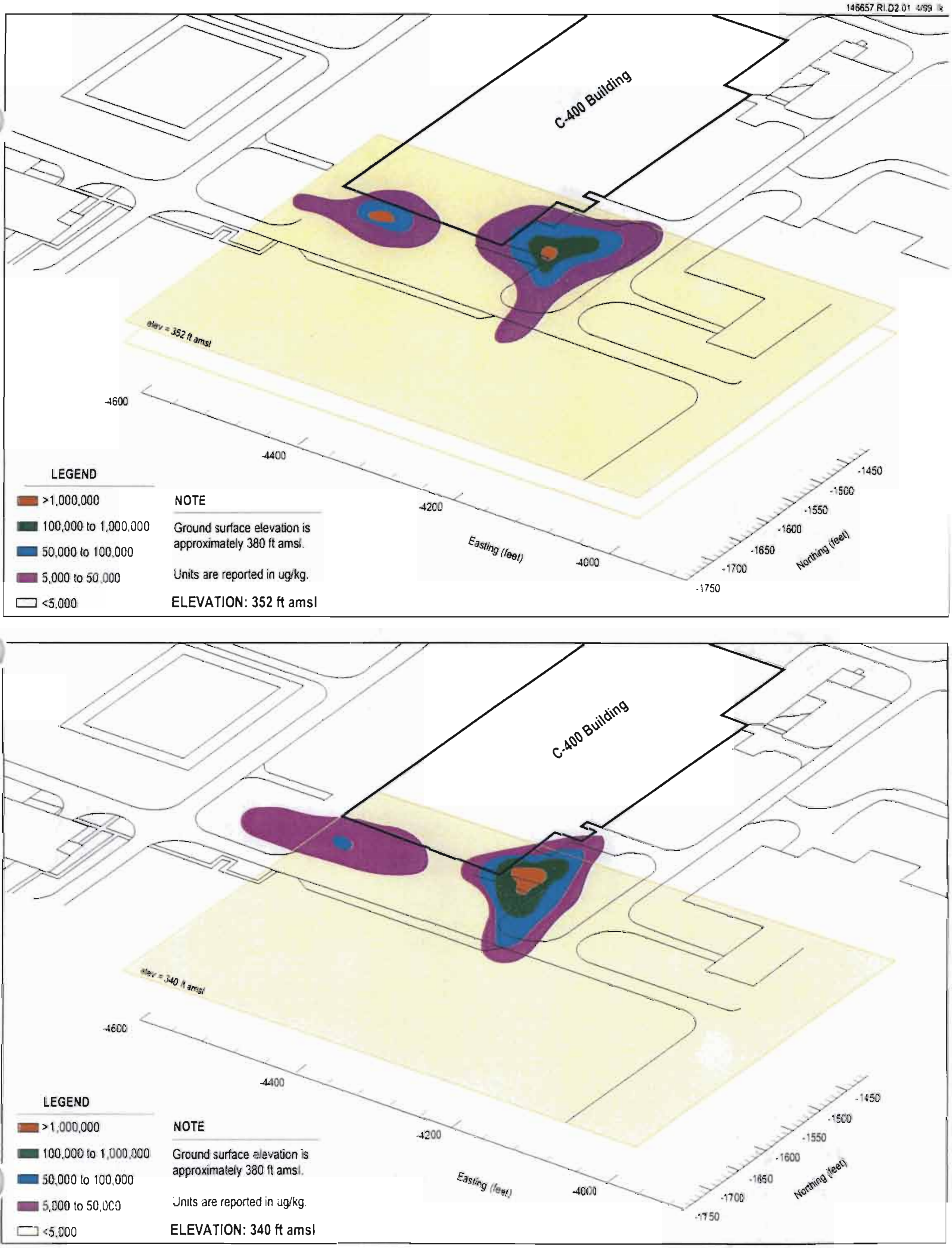


Fig. 4.10.c. 352 ft amsl and 340 ft amsl elevation slice through TCE distribution at sector 4 and 5 UCRS soil.

Fig. 4.10.a. Index map of elevation slices through TCE distribution and total concentration of sector 4 and 5 UCRS soil.

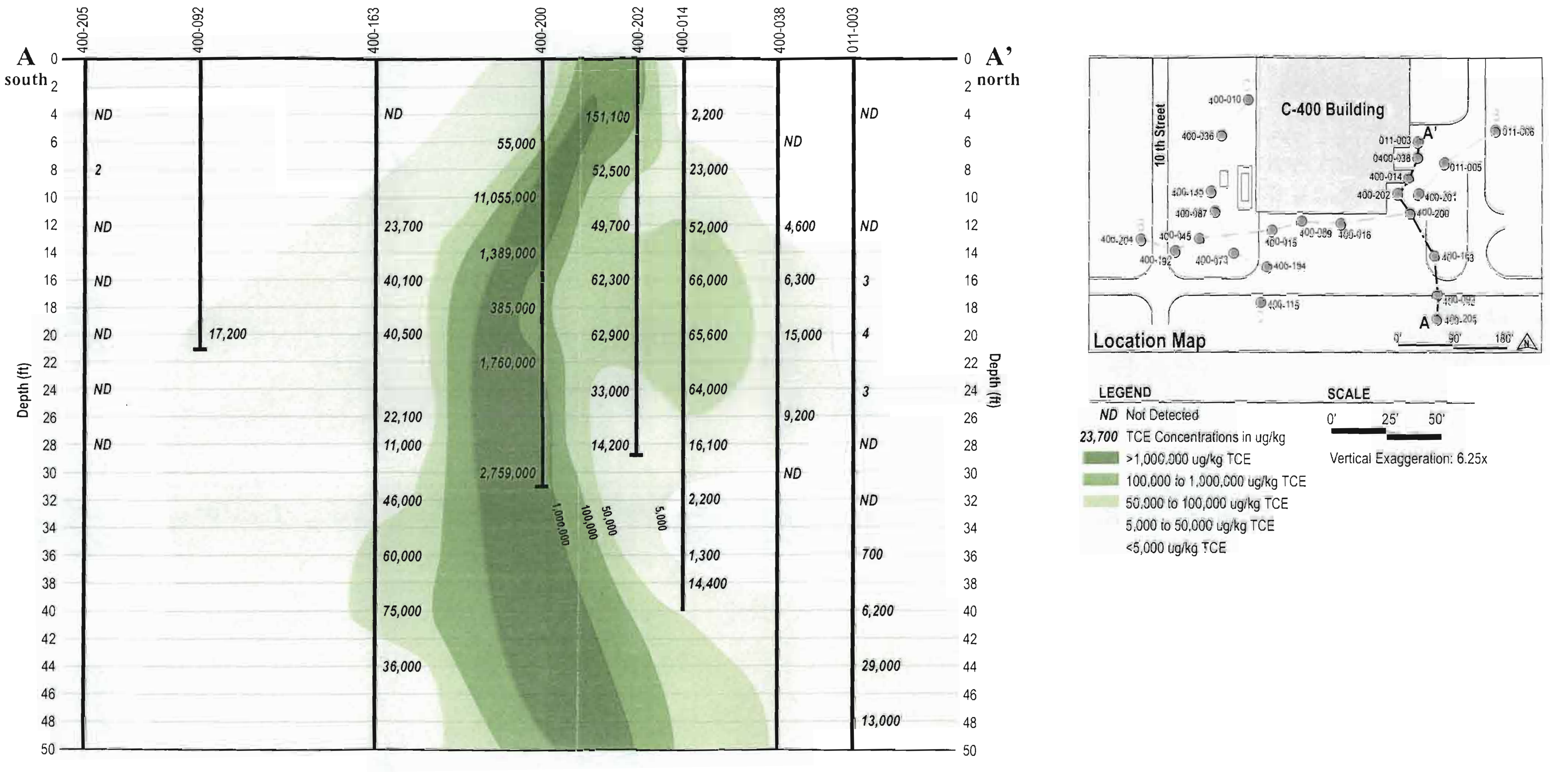


Fig. 4.11.a. North-south cross-section A-A' showing distribution of TCE in the LCRS soils at sector 4.

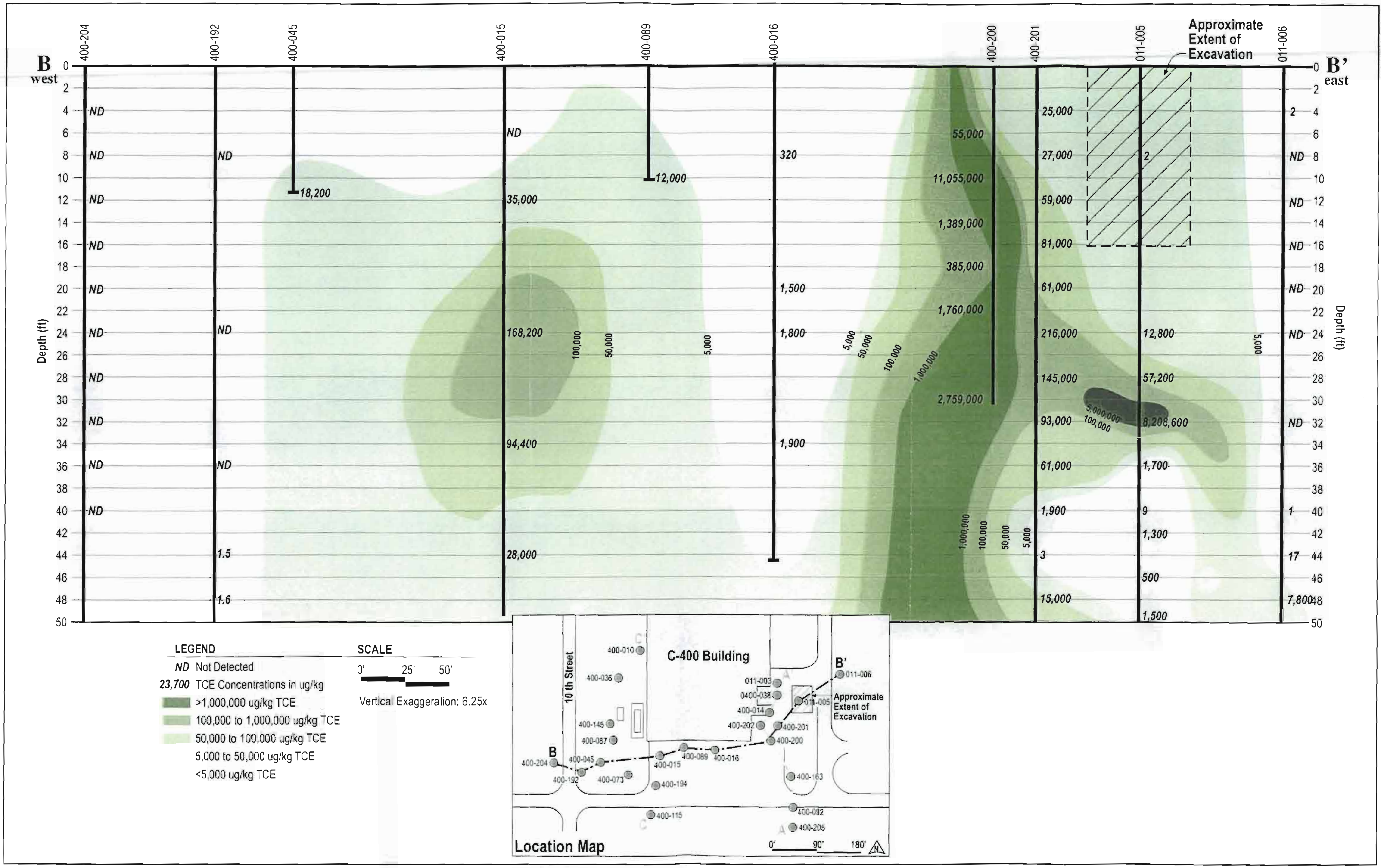


Fig. 4.11.b. East-west cross-section B-B' showing the distribution of TCE in the UCRS soils at sector 4 and sector 5.

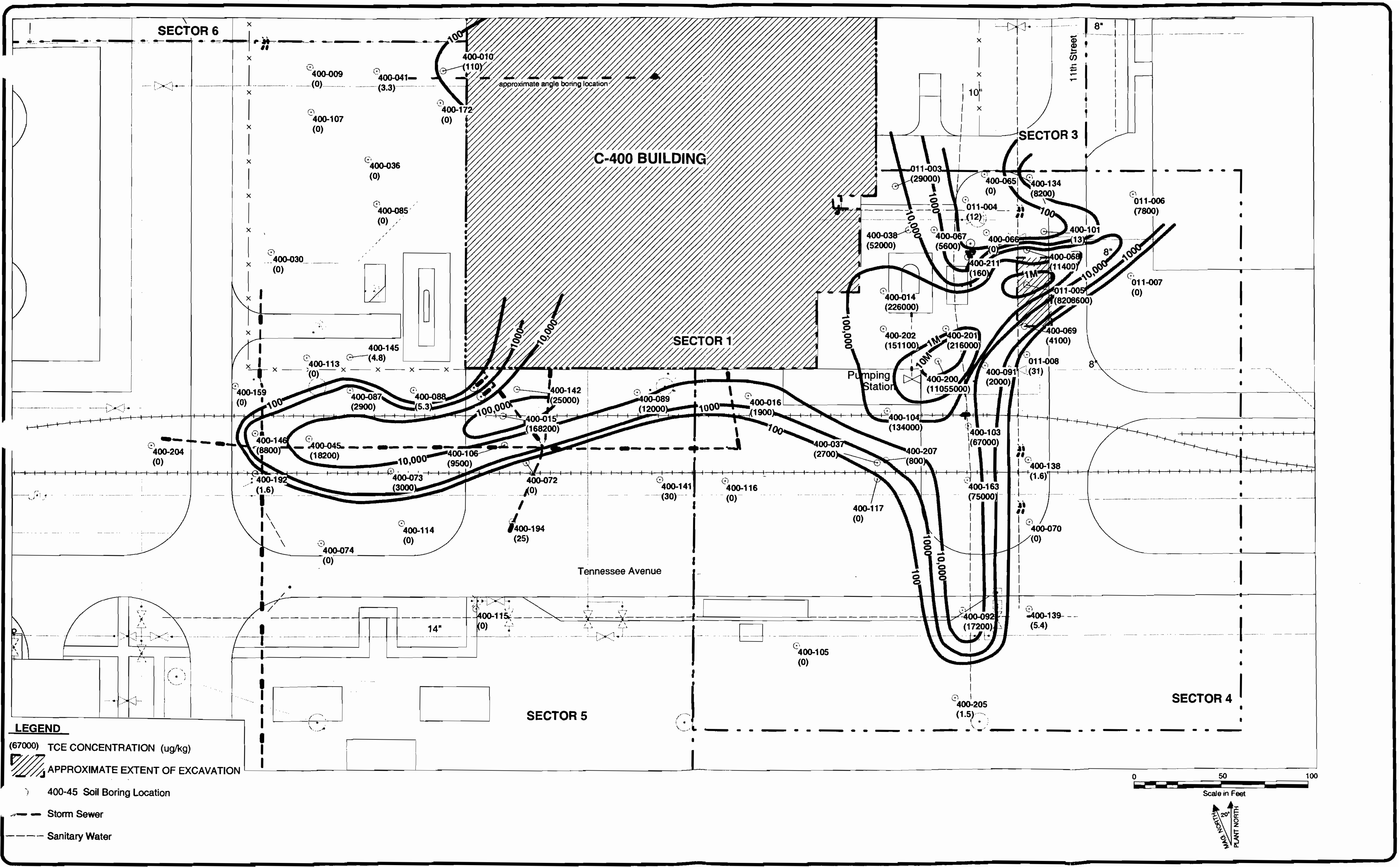
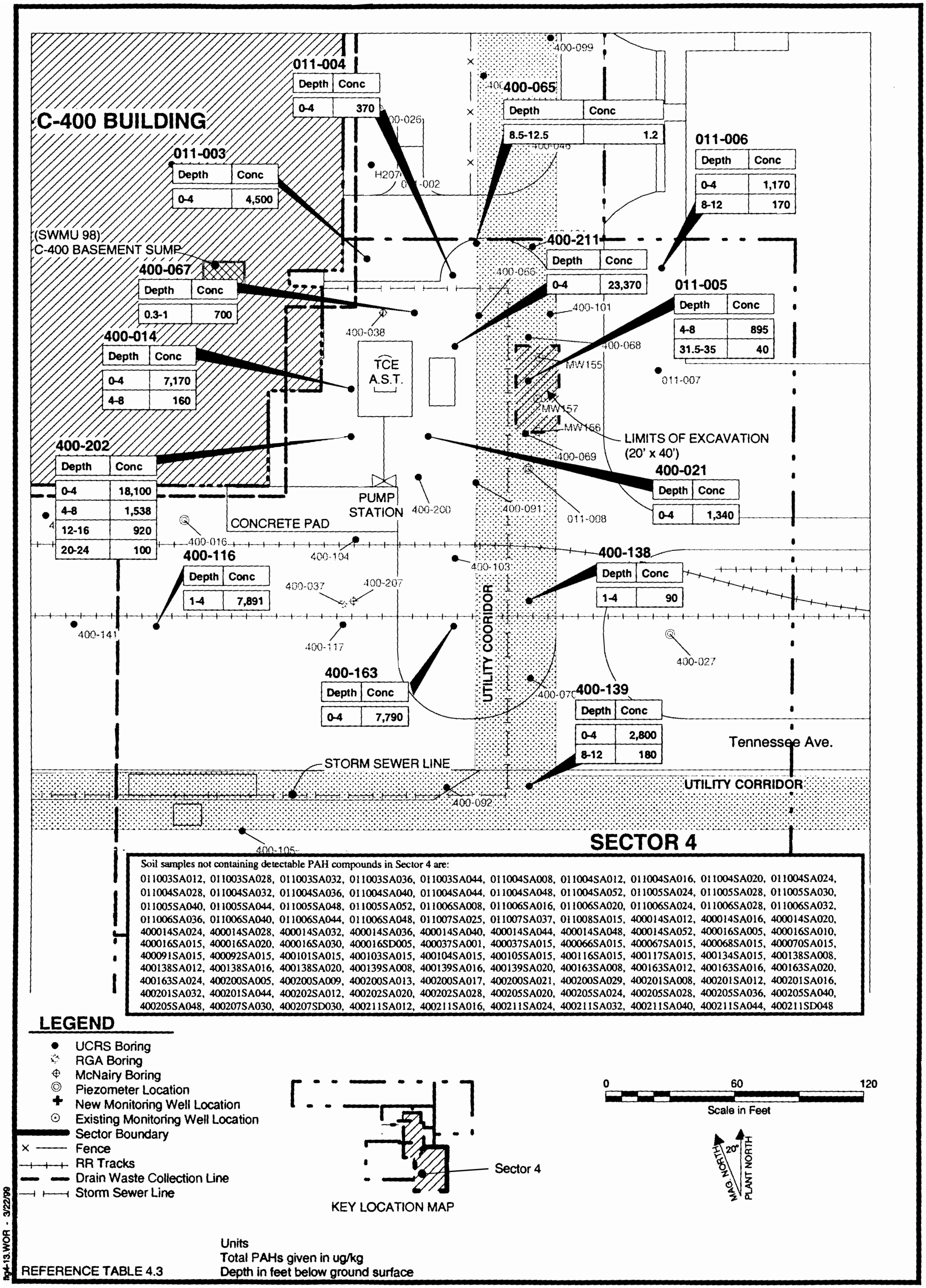


Fig. 4.12. Contour map of maximum TCE concentration detected in UCRS soil at each sampling location in sectors 4 and 5.



Soil samples not containing detectable PAH compounds in Sector 4 are:

011003SA012, 011003SA028, 011003SA032, 011003SA036, 011003SA044, 011004SA008, 011004SA012, 011004SA016, 011004SA020, 011004SA024, 011004SA028, 011004SA032, 011004SA036, 011004SA040, 011004SA044, 011004SA048, 011004SA052, 011005SA024, 011005SA028, 011005SA030, 011005SA040, 011005SA044, 011005SA048, 011005SA052, 011006SA008, 011006SA016, 011006SA020, 011006SA024, 011006SA028, 011006SA032, 011006SA036, 011006SA040, 011006SA044, 011006SA048, 011007SA025, 011007SA037, 011008SA015, 400014SA012, 400014SA016, 400014SA020, 400014SA024, 400014SA028, 400014SA032, 400014SA036, 400014SA040, 400014SA044, 400014SA048, 400014SA052, 400016SA005, 400016SA010, 400016SA015, 400016SA020, 400016SA030, 400016SD005, 400037SA001, 400037SA015, 400066SA015, 400067SA015, 400068SA015, 400070SA015, 400091SA015, 400092SA015, 400101SA015, 400103SA015, 400104SA015, 400105SA015, 400116SA015, 400117SA015, 400134SA015, 400138SA008, 400138SA012, 400138SA016, 400138SA020, 400139SA008, 400139SA016, 400139SA020, 400163SA008, 400163SA012, 400163SA016, 400163SA020, 400163SA024, 400200SA005, 400200SA009, 400200SA013, 400200SA017, 400200SA021, 400200SA029, 400201SA008, 400201SA012, 400201SA016, 400201SA032, 400201SA044, 400202SA012, 400202SA020, 400202SA028, 400205SA020, 400205SA024, 400205SA028, 400205SA036, 400205SA040, 400205SA048, 400207SA030, 400207SD030, 400211SA012, 400211SA016, 400211SA024, 400211SA032, 400211SA040, 400211SA044, 400211SD048

Fig. 4.13. Map showing distrubution and total concentration of PAHs detected in sector 4 UCRS soil.

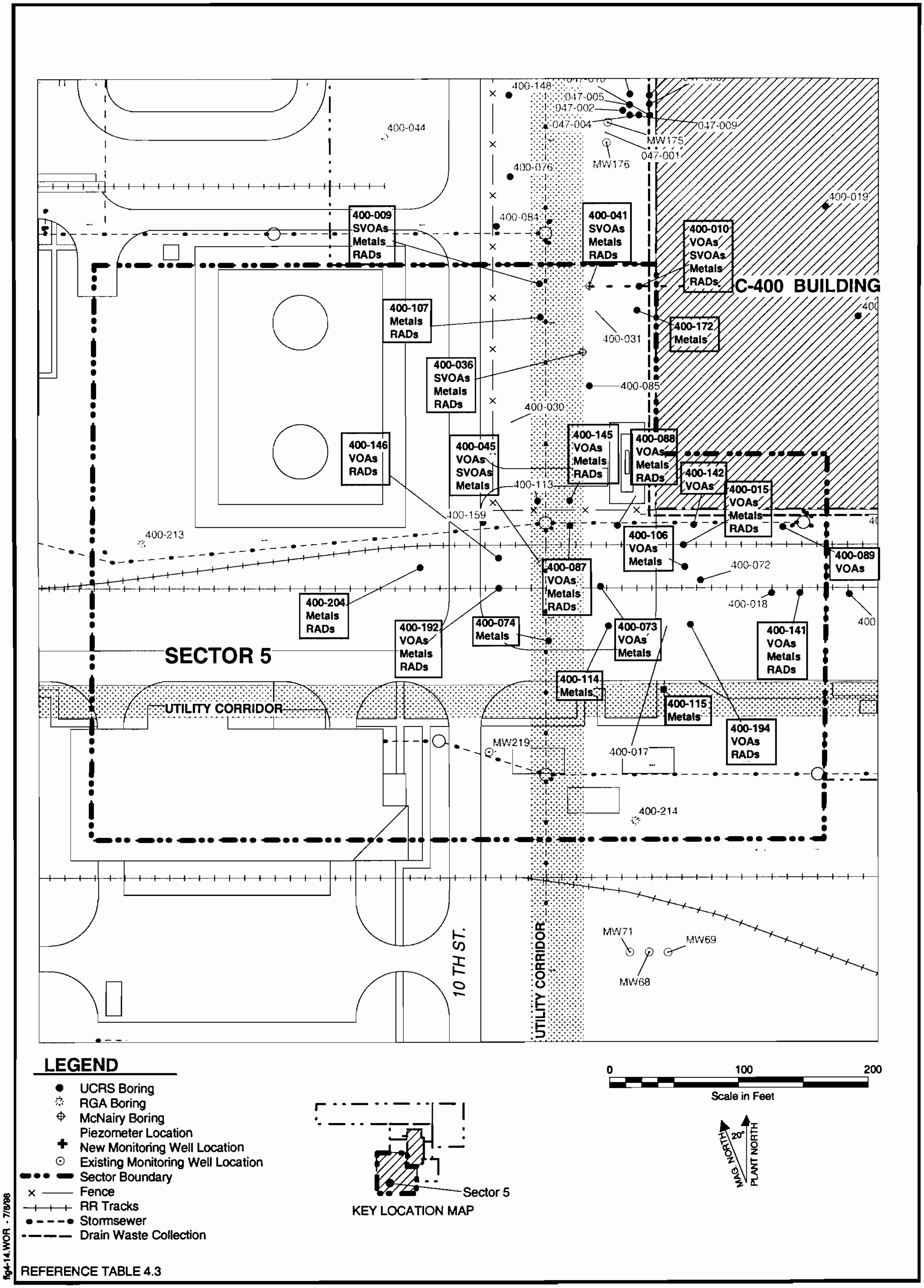
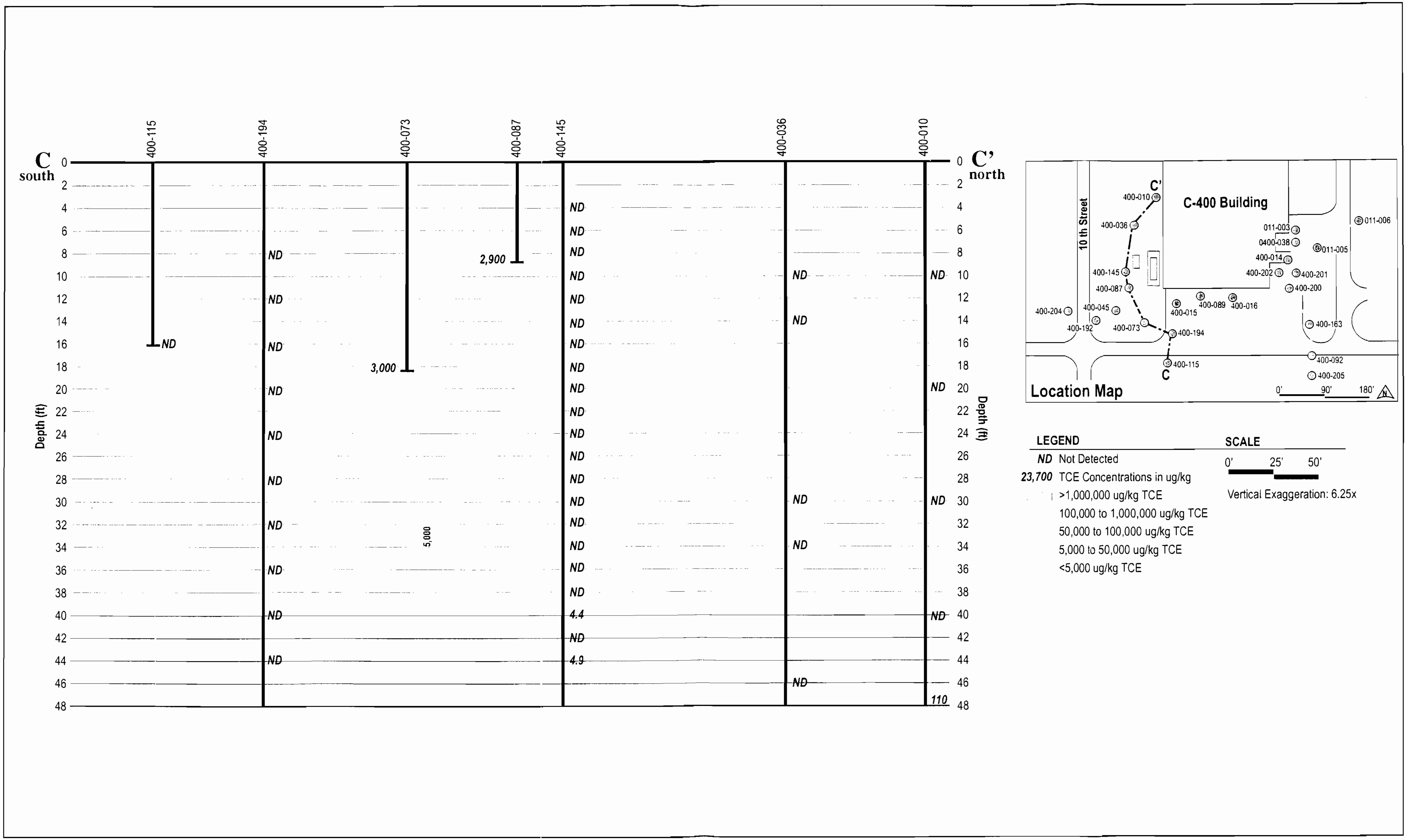
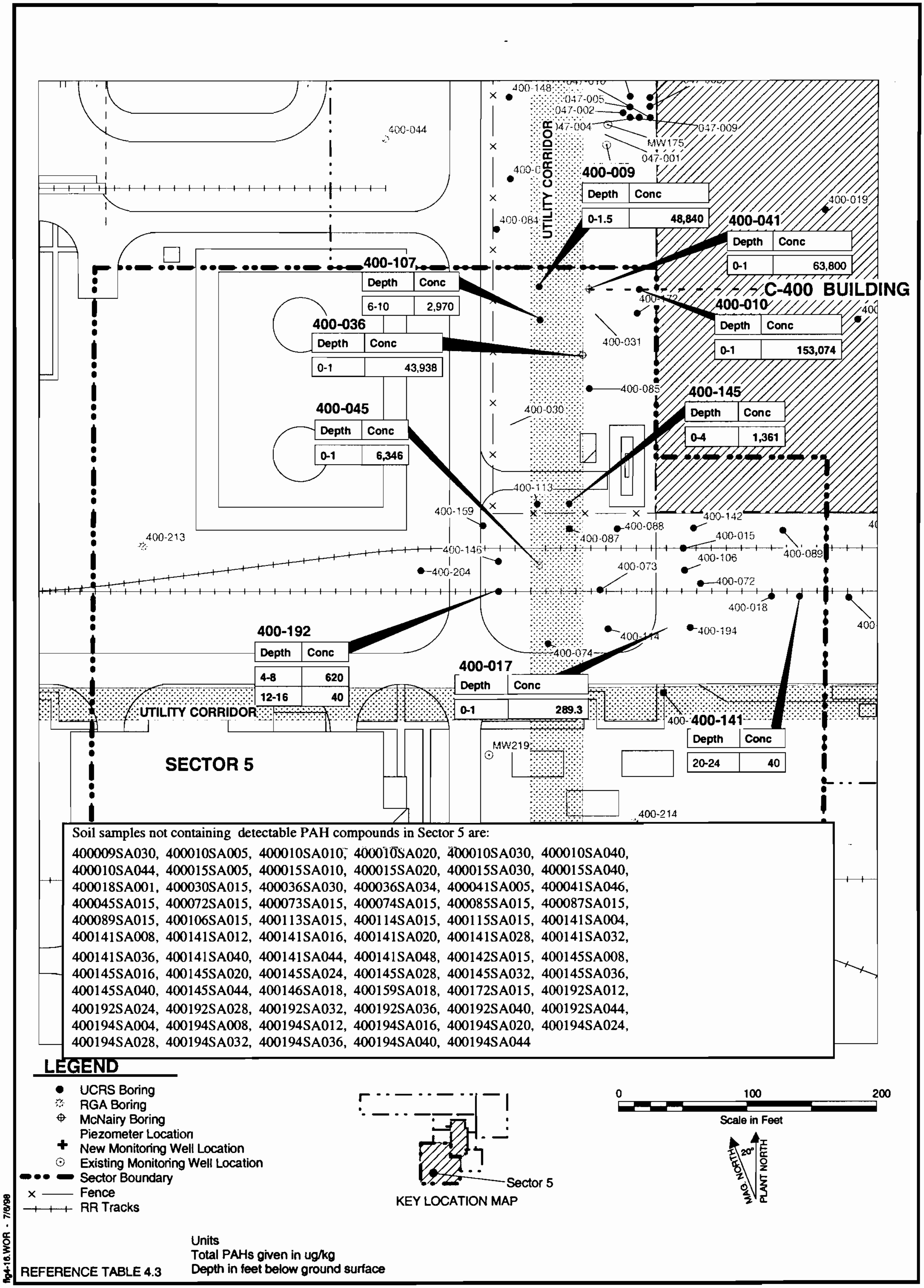


Fig. 4.14. Sector 5 site map showing contaminant groups detected in UCRS soil above SQL at each sample location.



14657 R/D2.01 4/99 lk

Fig. 4.15. North-south cross-section C-C' showing the distribution of TCE in the UCRS soils at sector 5.



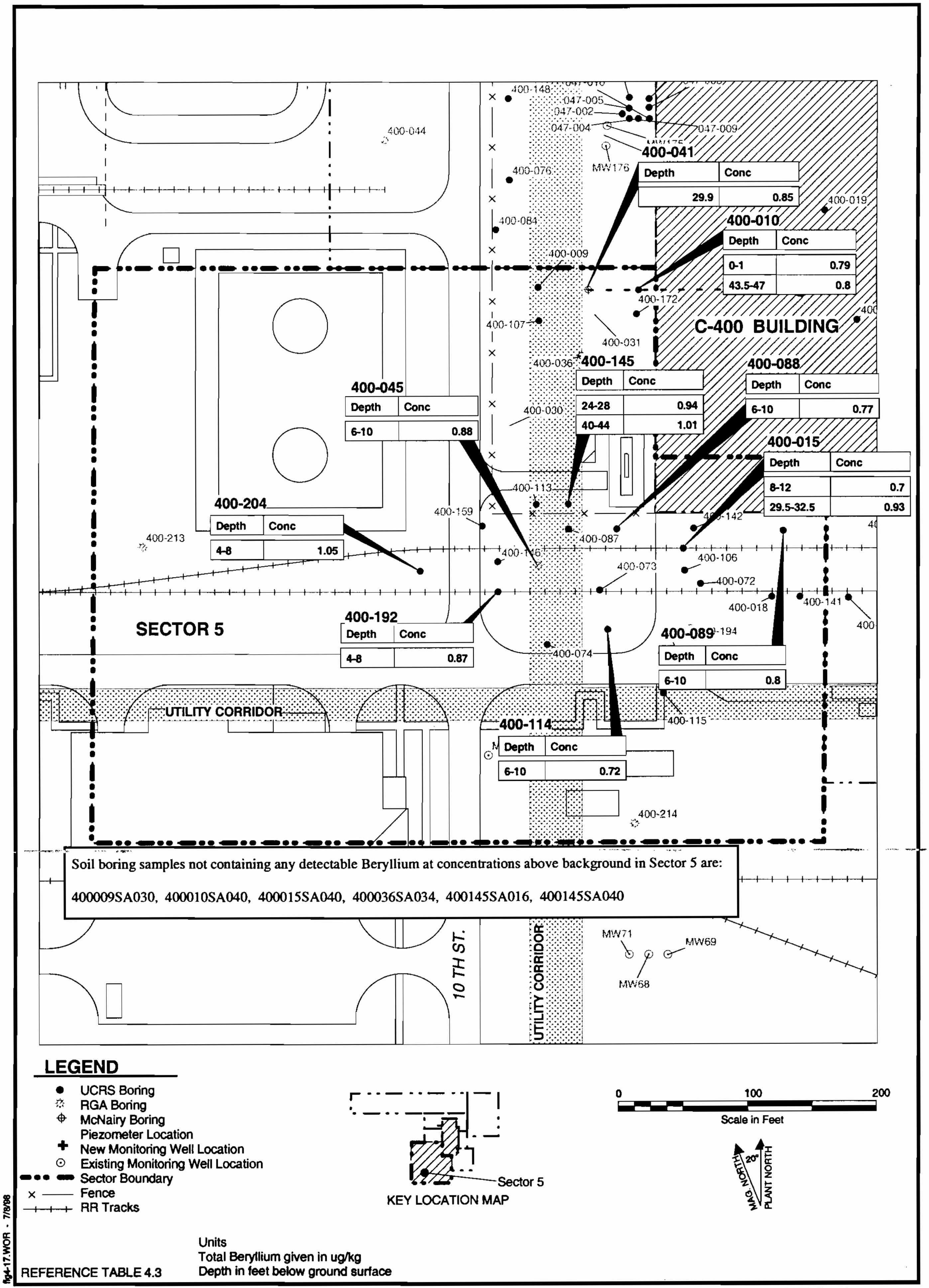
Soil samples not containing detectable PAH compounds in Sector 5 are:

400009SA030, 400010SA005, 400010SA010, 400010SA020, 400010SA030, 400010SA040, 400010SA044, 400015SA005, 400015SA010, 400015SA020, 400015SA030, 400015SA040, 400018SA001, 400030SA015, 400036SA030, 400036SA034, 400041SA005, 400041SA046, 400045SA015, 400072SA015, 400073SA015, 400074SA015, 400085SA015, 400087SA015, 400089SA015, 400106SA015, 400113SA015, 400114SA015, 400115SA015, 400141SA004, 400141SA008, 400141SA012, 400141SA016, 400141SA020, 400141SA028, 400141SA032, 400141SA036, 400141SA040, 400141SA044, 400141SA048, 400142SA015, 400145SA008, 400145SA016, 400145SA020, 400145SA024, 400145SA028, 400145SA032, 400145SA036, 400145SA040, 400145SA044, 400146SA018, 400159SA018, 400172SA015, 400192SA012, 400192SA024, 400192SA028, 400192SA032, 400192SA036, 400192SA040, 400192SA044, 400194SA004, 400194SA008, 400194SA012, 400194SA016, 400194SA020, 400194SA024, 400194SA028, 400194SA032, 400194SA036, 400194SA040, 400194SA044

REFERENCE TABLE 4.3

Units
Total PAHs given in ug/kg
Depth in feet below ground surface

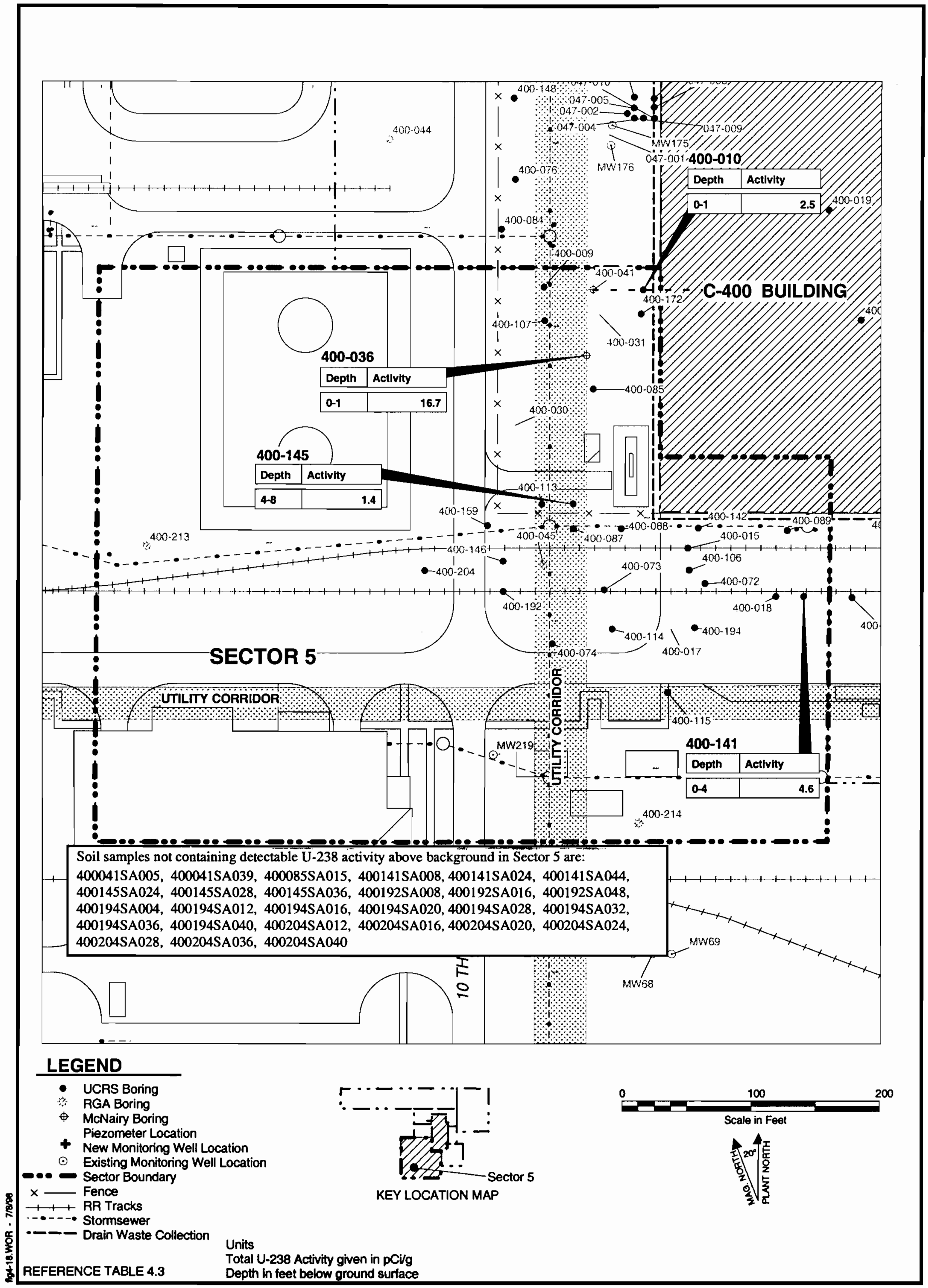
Fig. 4-16. Map showing distribution and total concentration of PAHs detected in sector 5 UCRS soil.



Soil boring samples not containing any detectable Beryllium at concentrations above background in Sector 5 are:

400009SA030, 400010SA040, 400015SA040, 400036SA034, 400145SA016, 400145SA040

Fig. 4.17. Map showing distribution and total concentration of Beryllium detected in sector 5 UCRS soil.



400-010

Depth	Activity
0-1	2.5

400-036

Depth	Activity
0-1	16.7

400-145

Depth	Activity
4-8	1.4

400-141

Depth	Activity
0-4	4.6

Soil samples not containing detectable U-238 activity above background in Sector 5 are:
400041SA005, 400041SA039, 400085SA015, 400141SA008, 400141SA024, 400141SA044, 400145SA024, 400145SA028, 400145SA036, 400192SA008, 400192SA016, 400192SA048, 400194SA004, 400194SA012, 400194SA016, 400194SA020, 400194SA028, 400194SA032, 400194SA036, 400194SA040, 400204SA012, 400204SA016, 400204SA020, 400204SA024, 400204SA028, 400204SA036, 400204SA040

Fig. 4.18. Map showing distribution and activity of U-238 detected in sector 5 UCRS soil.

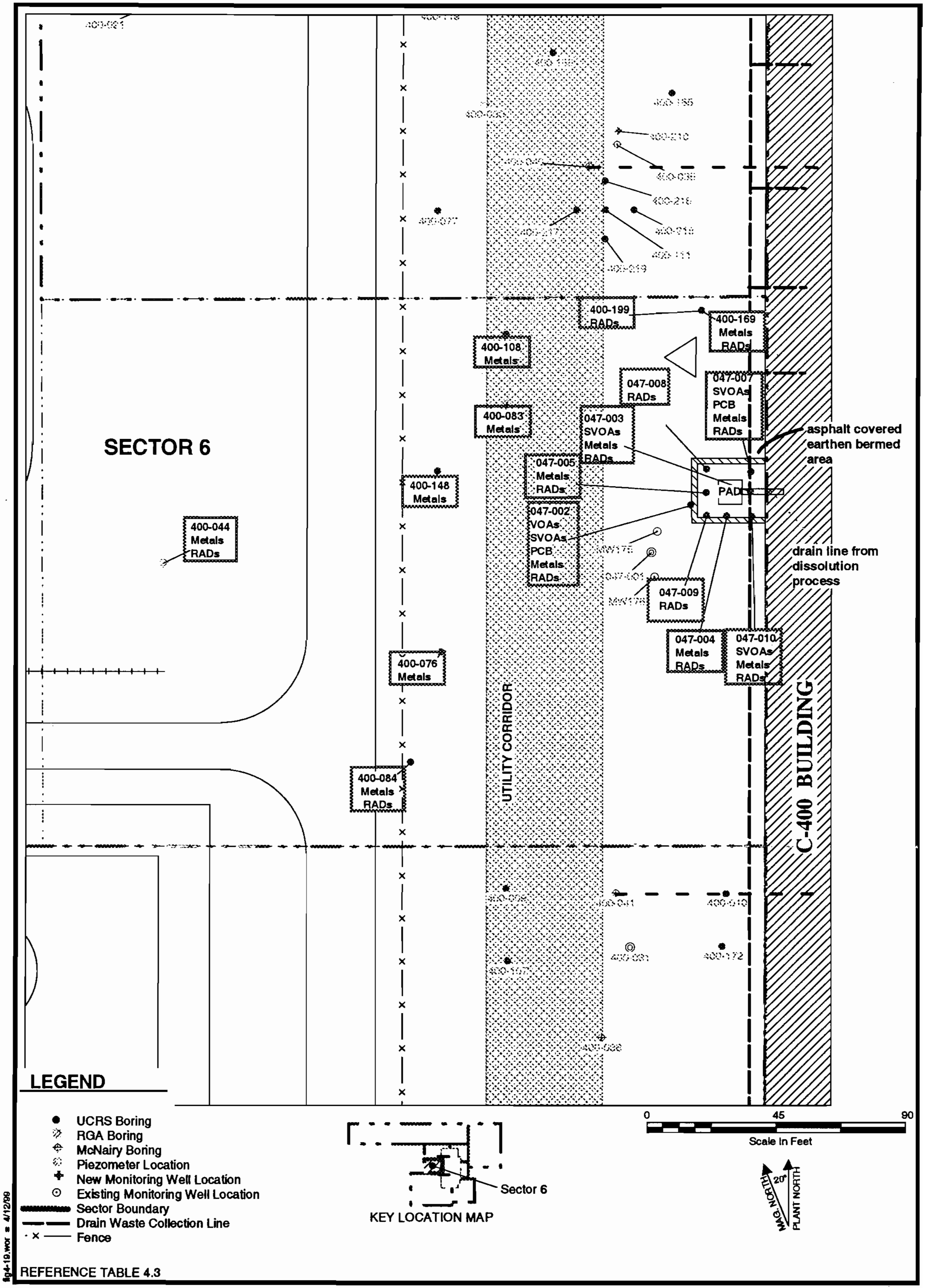
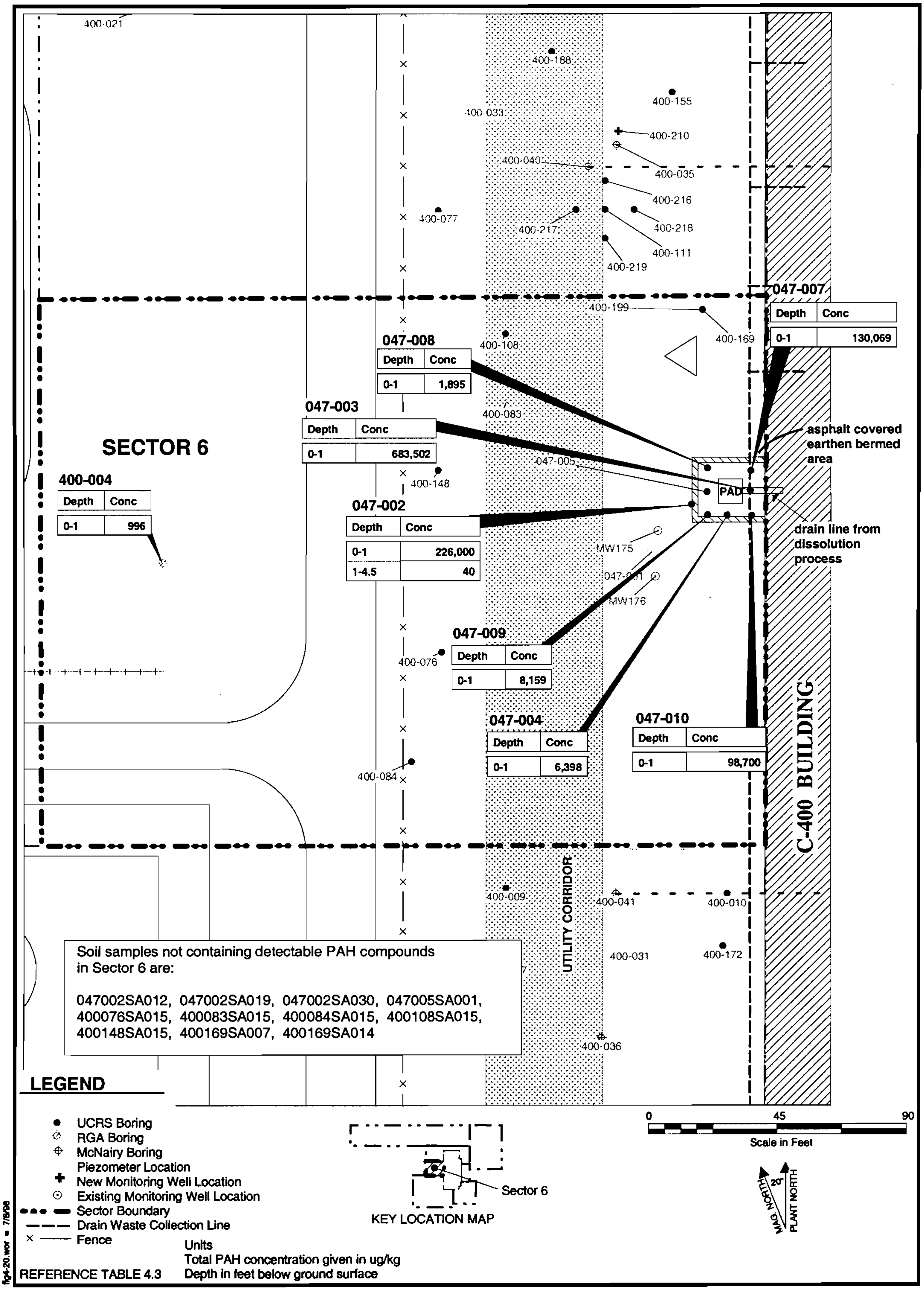


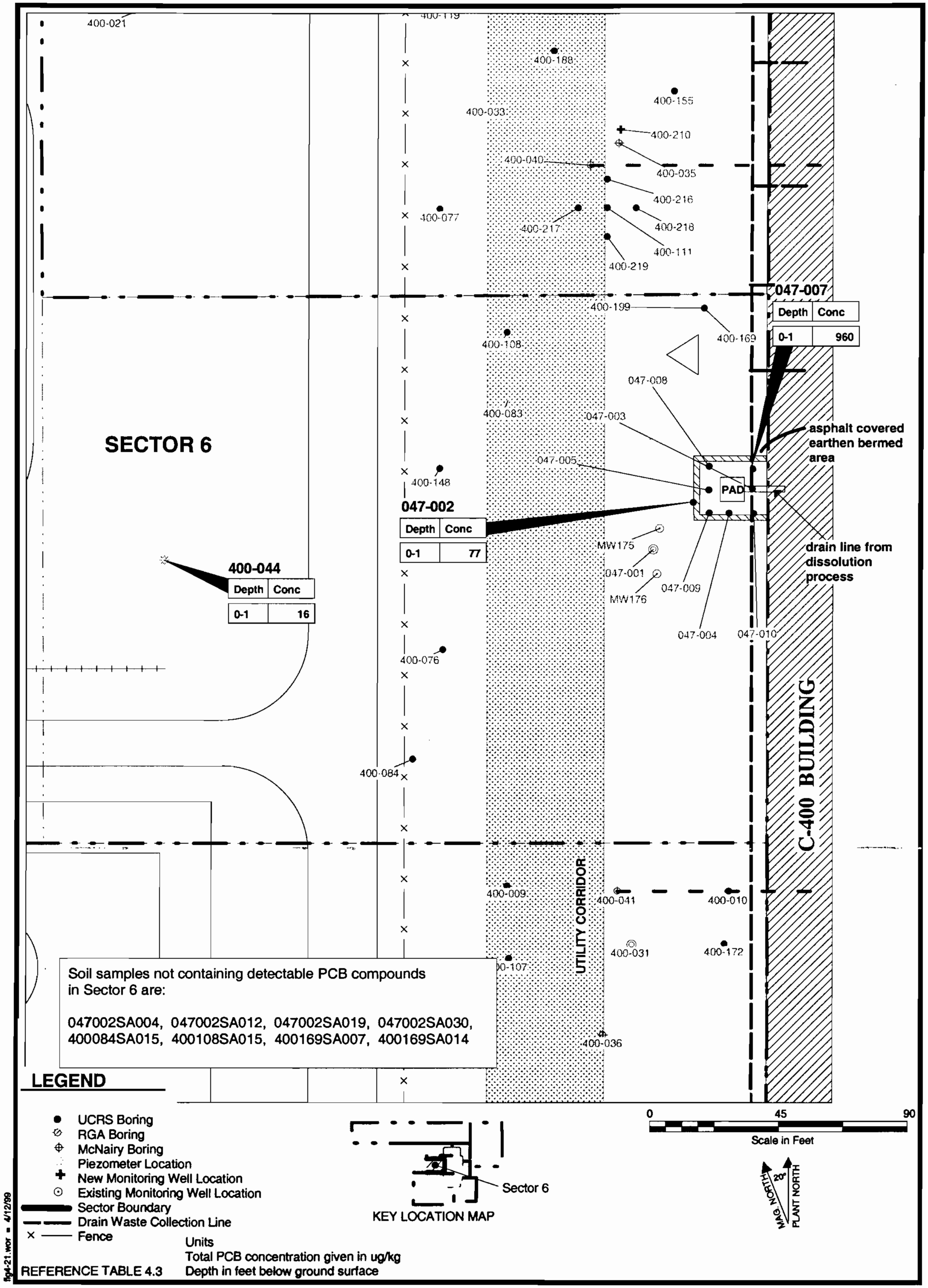
Fig. 4.19. Sector 6 site map showing contaminant groups detected in UCRS soil above SQL at each sample location.



Soil samples not containing detectable PAH compounds in Sector 6 are:

047002SA012, 047002SA019, 047002SA030, 047005SA001, 400076SA015, 400083SA015, 400084SA015, 400108SA015, 400148SA015, 400169SA007, 400169SA014

Fig. 4.20. Map showing distribution and total concentration of PAHs detected in sector 6 UCRS soil.

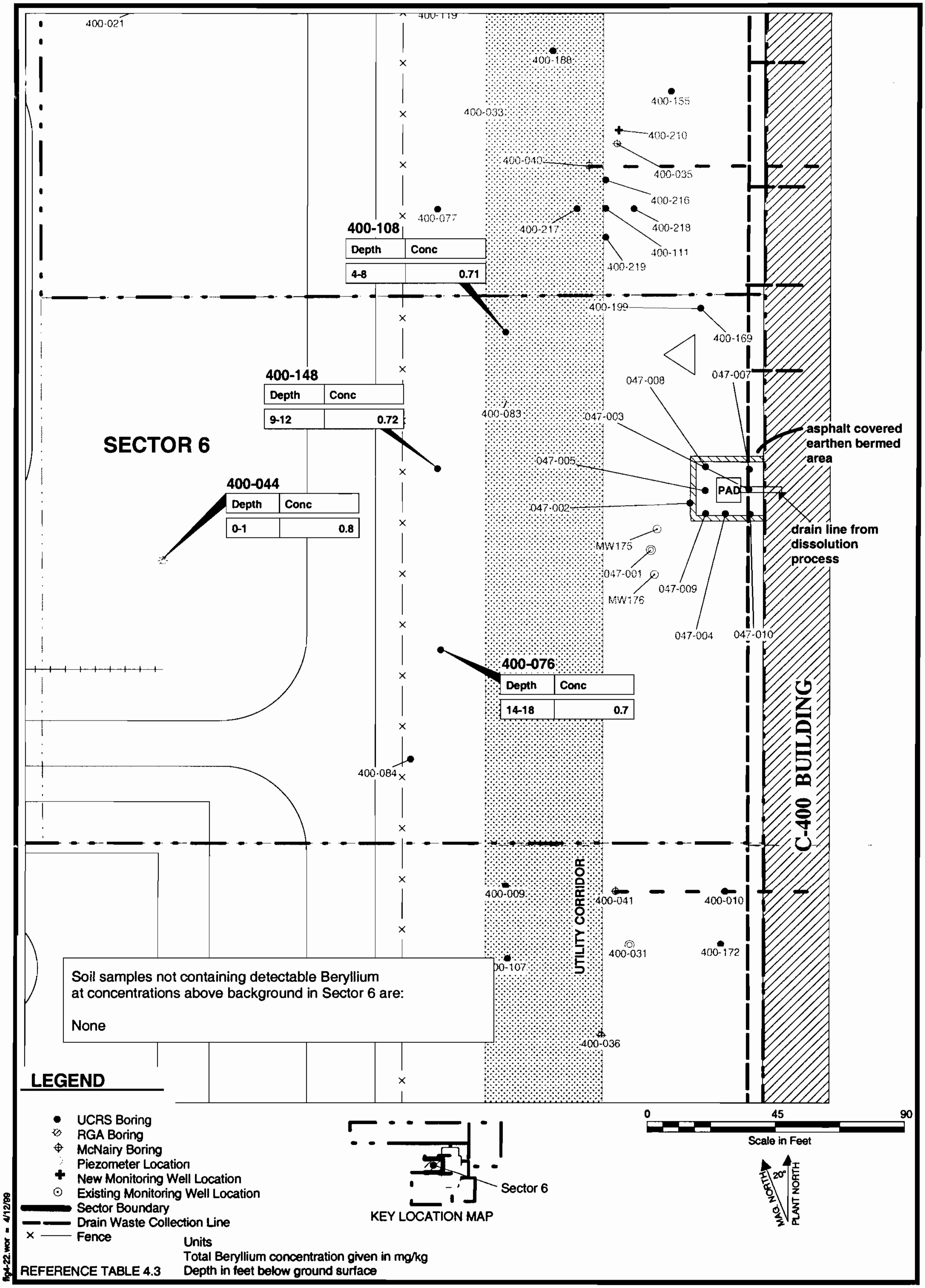


Soil samples not containing detectable PCB compounds in Sector 6 are:

047002SA004, 047002SA012, 047002SA019, 047002SA030, 400084SA015, 400108SA015, 400169SA007, 400169SA014

Units
Total PCB concentration given in ug/kg
Depth in feet below ground surface

Fig. 4.21. Map showing distribution and total Concentration of PCBs detected in sector 6 UCRS soil.

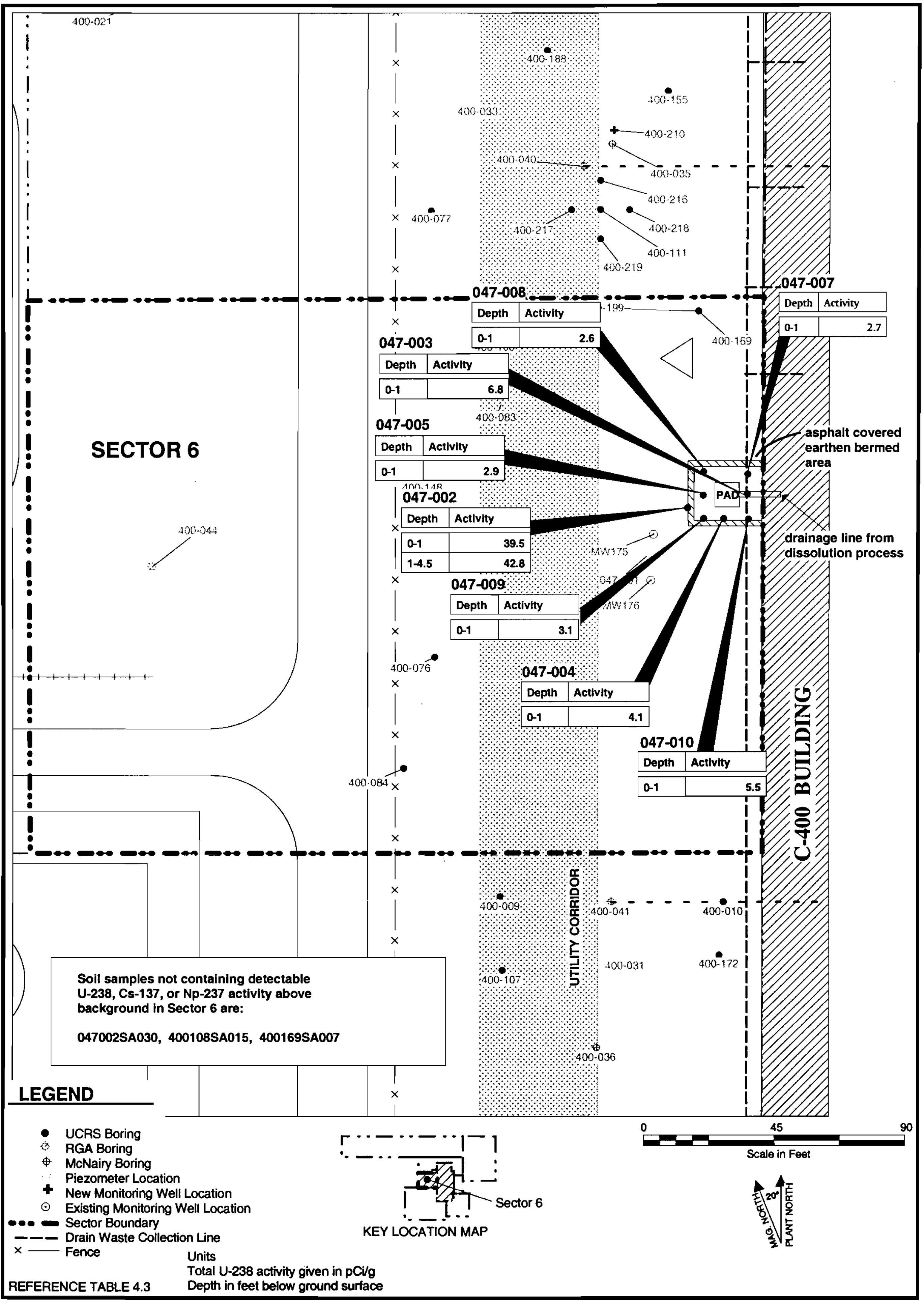


Soil samples not containing detectable Beryllium at concentrations above background in Sector 6 are:

None

Units
Total Beryllium concentration given in mg/kg
Depth in feet below ground surface

Fig. 4.22. Map showing distribution and total concentration of Beryllium detected in sector 6 UCRS soil.



Soil samples not containing detectable U-238, Cs-137, or Np-237 activity above background in Sector 6 are:

047002SA030, 400108SA015, 400169SA007

Units
Total U-238 activity given in pCi/g
Depth in feet below ground surface

Fig. 4.23. Map showing distribution and activity of U-238 in sector 6 UCRS soil.

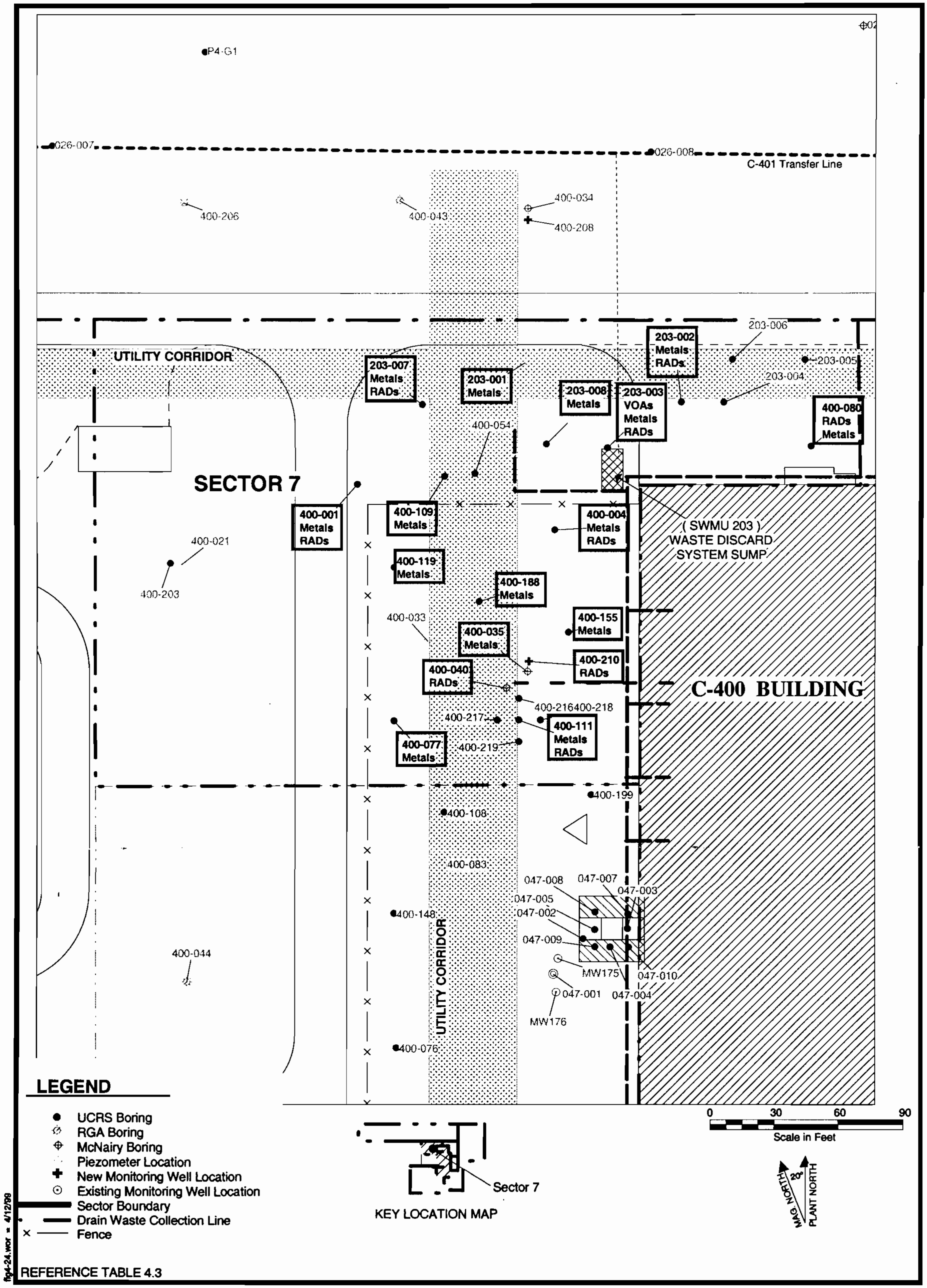
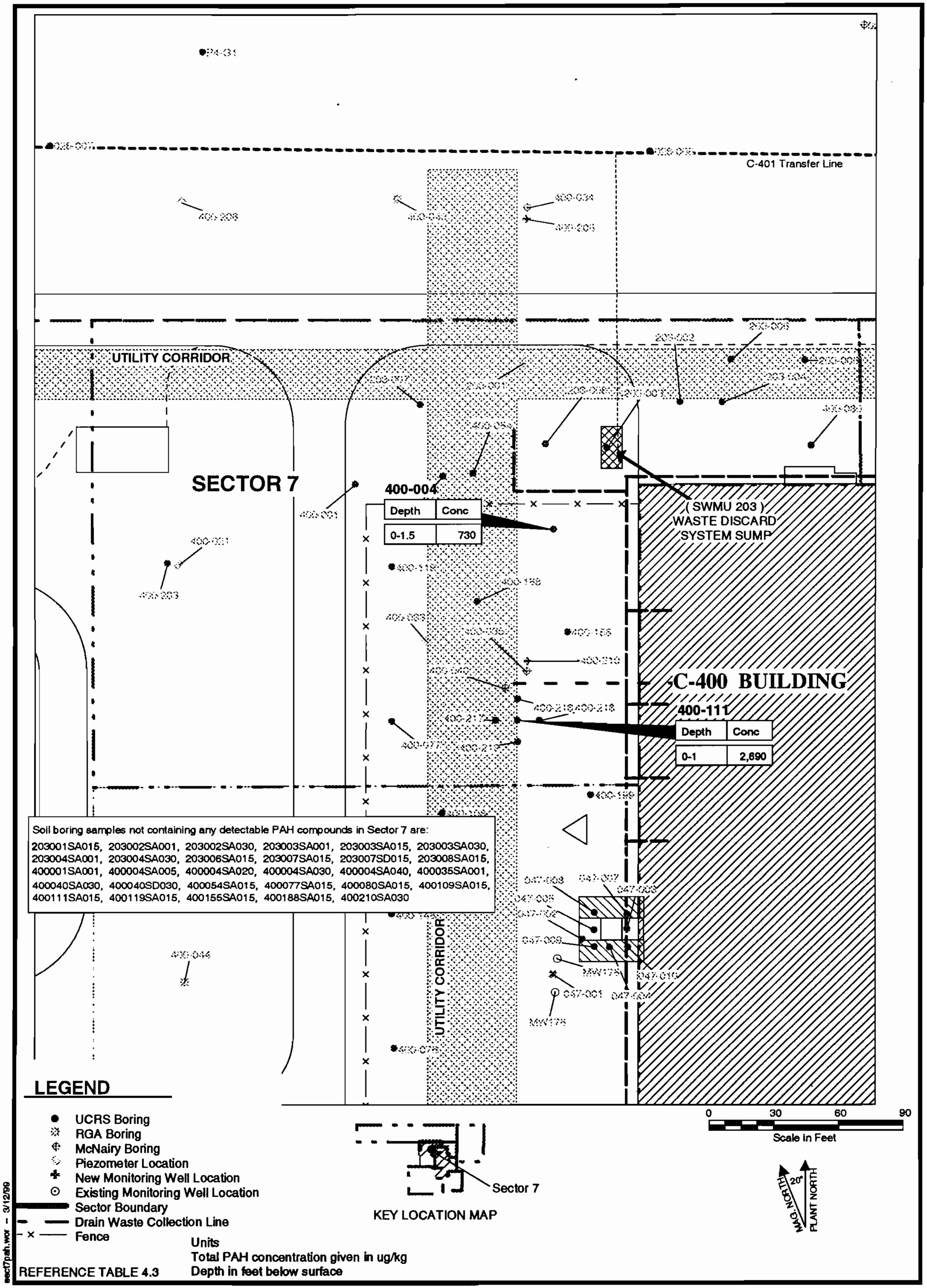
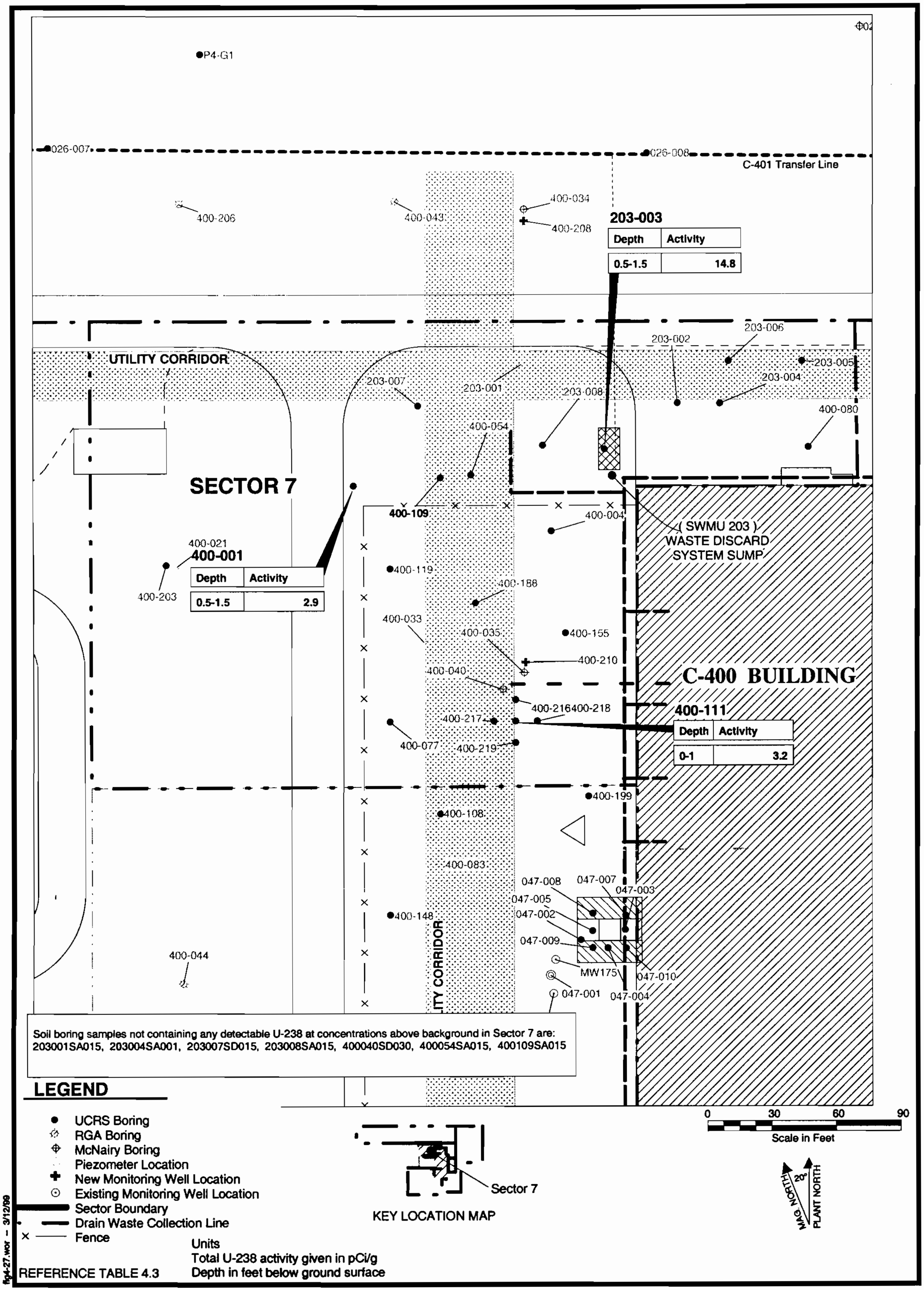


Fig. 4.24. Sector 7 site map showing contaminant groups detected in UCRS soil above SQL at each sample location.



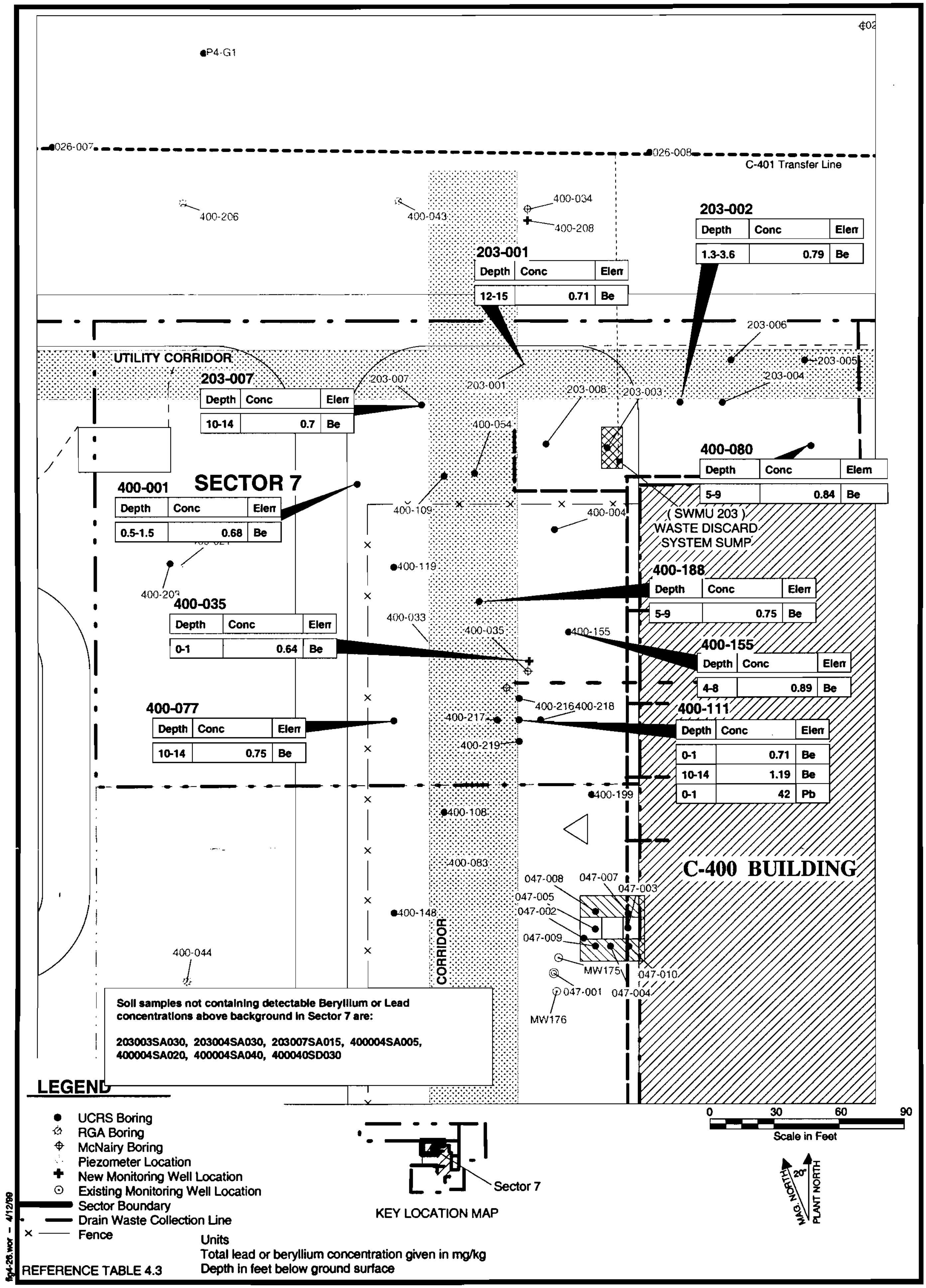
Soil boring samples not containing any detectable PAH compounds in Sector 7 are:
203001SA015, 203002SA001, 203002SA030, 203003SA001, 203003SA015, 203003SA030, 203004SA001, 203004SA030, 203006SA015, 203007SA015, 203007SD015, 203008SA015, 400001SA001, 400004SA005, 400004SA020, 400004SA030, 400004SA040, 400035SA001, 400040SA030, 400040SD030, 400054SA015, 400077SA015, 400080SA015, 400109SA015, 400111SA015, 400119SA015, 400155SA015, 400188SA015, 400210SA030

Fig. 4.25. Map showing distribution and total concentration of PAHs detected in sector 7 UCRS soil.



Soil boring samples not containing any detectable U-238 at concentrations above background in Sector 7 are: 203001SA015, 203004SA001, 203007SD015, 203008SA015, 400040SD030, 400054SA015, 400109SA015

Fig. 4.27. Map showing distribution and activity of U-238 detected in sector 7 UCRS soil.

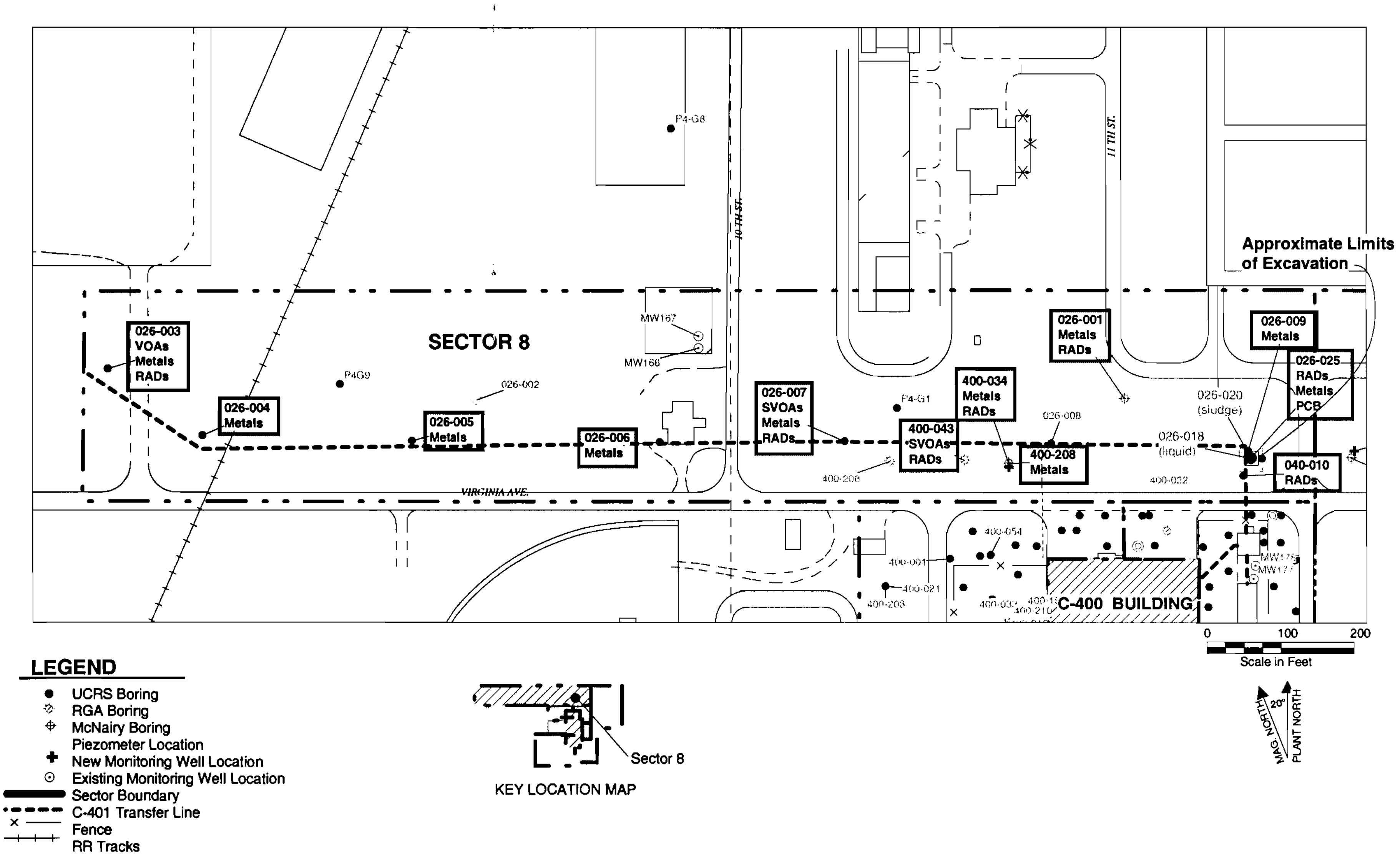


Soil samples not containing detectable Beryllium or Lead concentrations above background in Sector 7 are:

203003SA030, 203004SA030, 203007SA015, 400004SA005, 400004SA020, 400004SA040, 400040SD030

Units
Total lead or beryllium concentration given in mg/kg
Depth in feet below ground surface

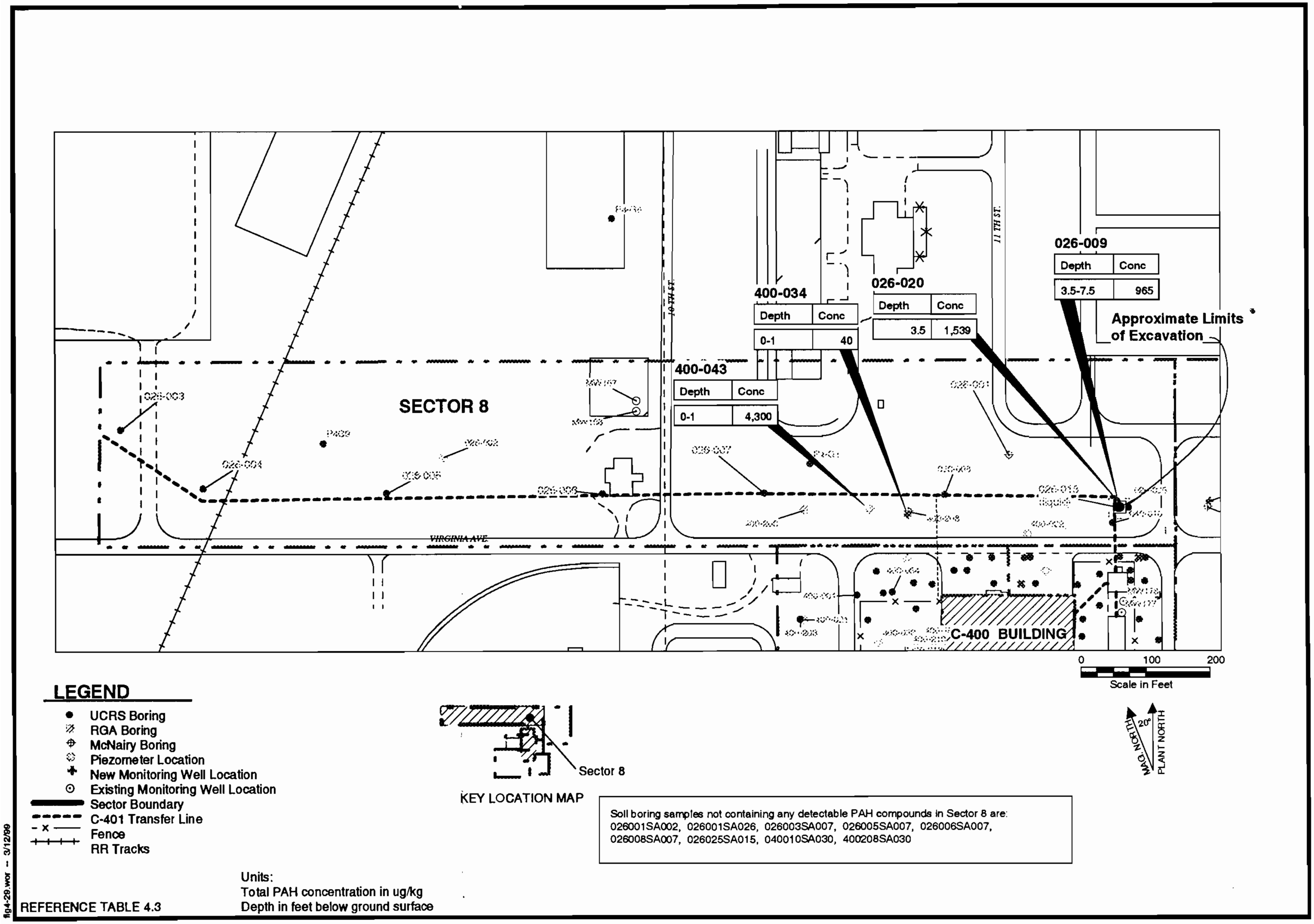
Fig. 4.26. Map showing distribution and total concentration of Lead and Beryllium detected in sector 7 UCRS soil.



REFERENCE TABLE 4.3

fig4-28.wor – 4/12/99

Fig. 4.28. Sector 8 site map showing contaminant groups detected in UCRS soil above SQL at each sample location.



Soil boring samples not containing any detectable PAH compounds in Sector 8 are: 026001SA002, 026001SA026, 026003SA007, 026005SA007, 026006SA007, 026008SA007, 026025SA015, 040010SA030, 400208SA030

Units:
Total PAH concentration in ug/kg
Depth in feet below ground surface

REFERENCE TABLE 4.3

fig4-29.wor -- 3/12/99

Fig. 4.29. Map showing distribution and total concentration of PAHs detected in sector 8 UCRS soil.

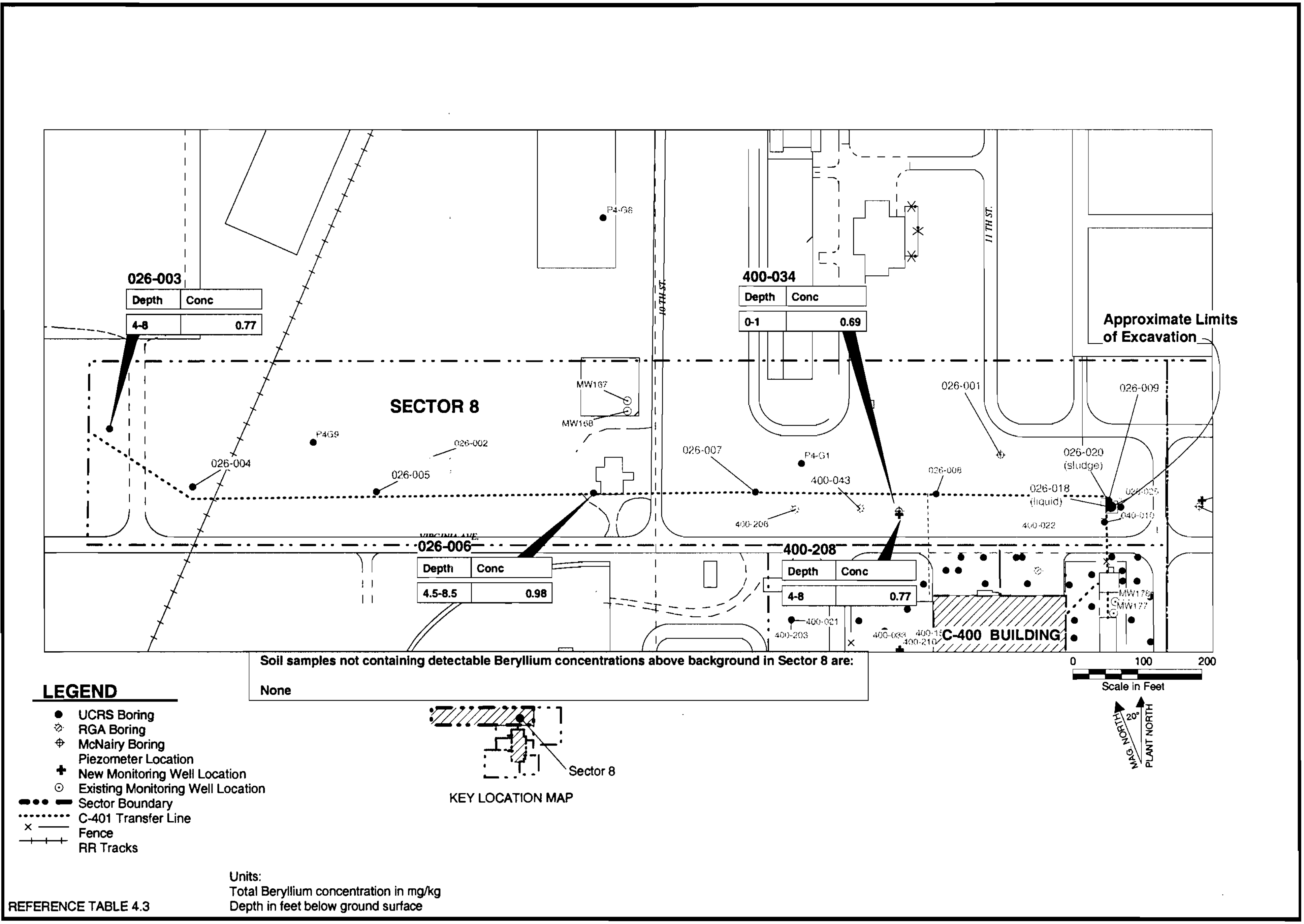
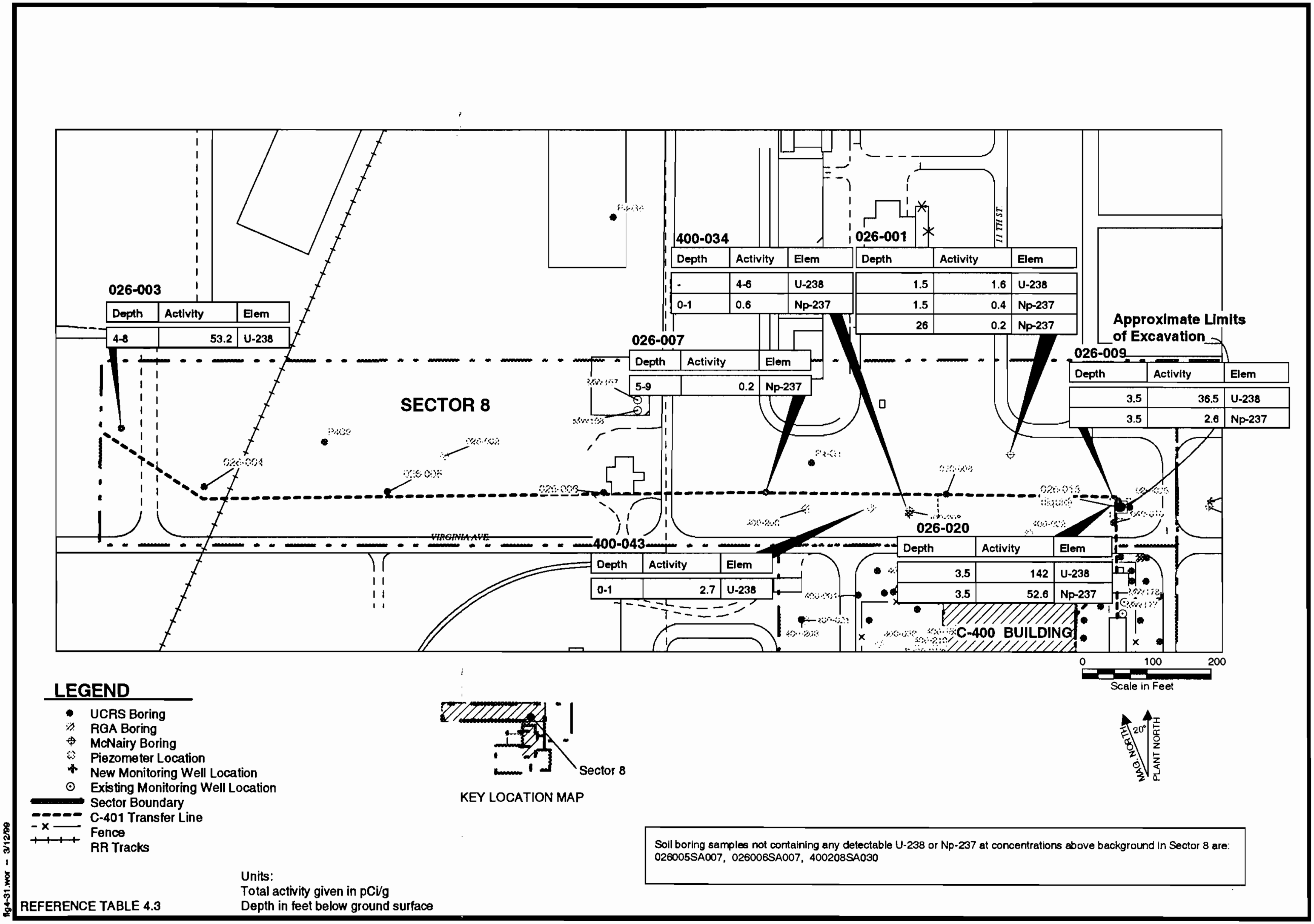


Fig. 4.30. Map showing distribution and total concentration of beryllium in sector 8 UCRS soil.



Soil boring samples not containing any detectable U-238 or Np-237 at concentrations above background in Sector 8 are: 026005SA007, 026006SA007, 400208SA030

Units:
Total activity given in pCi/g
Depth in feet below ground surface

Fig. 4.31. Map showing distribution and total activity of U-238 and Np-237 detected in sector 8 UCRS soil.

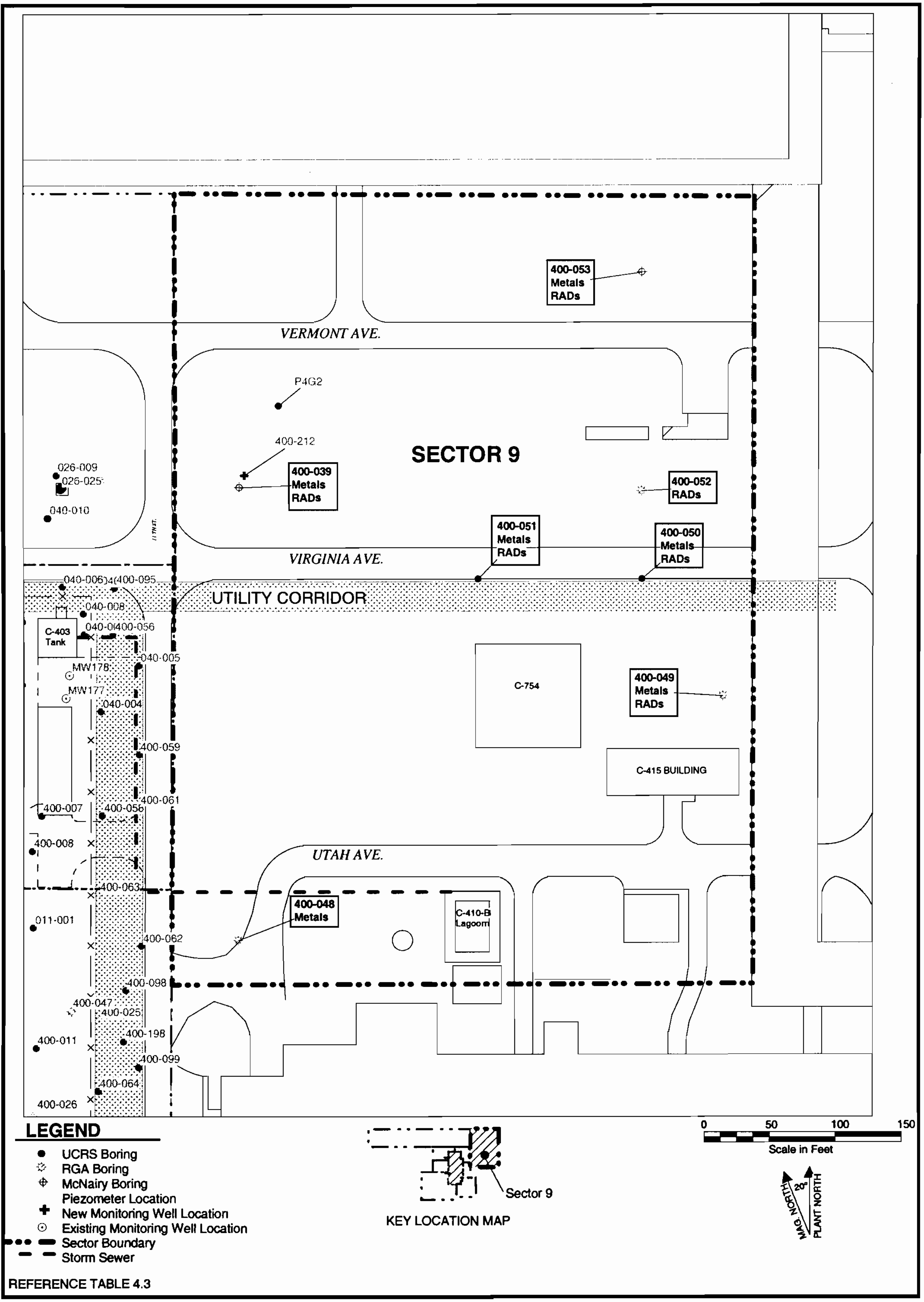


Fig. 4.32. Sector 9 site map showing contaminant groups detected in UCRS soil above SQL at each sampling location.

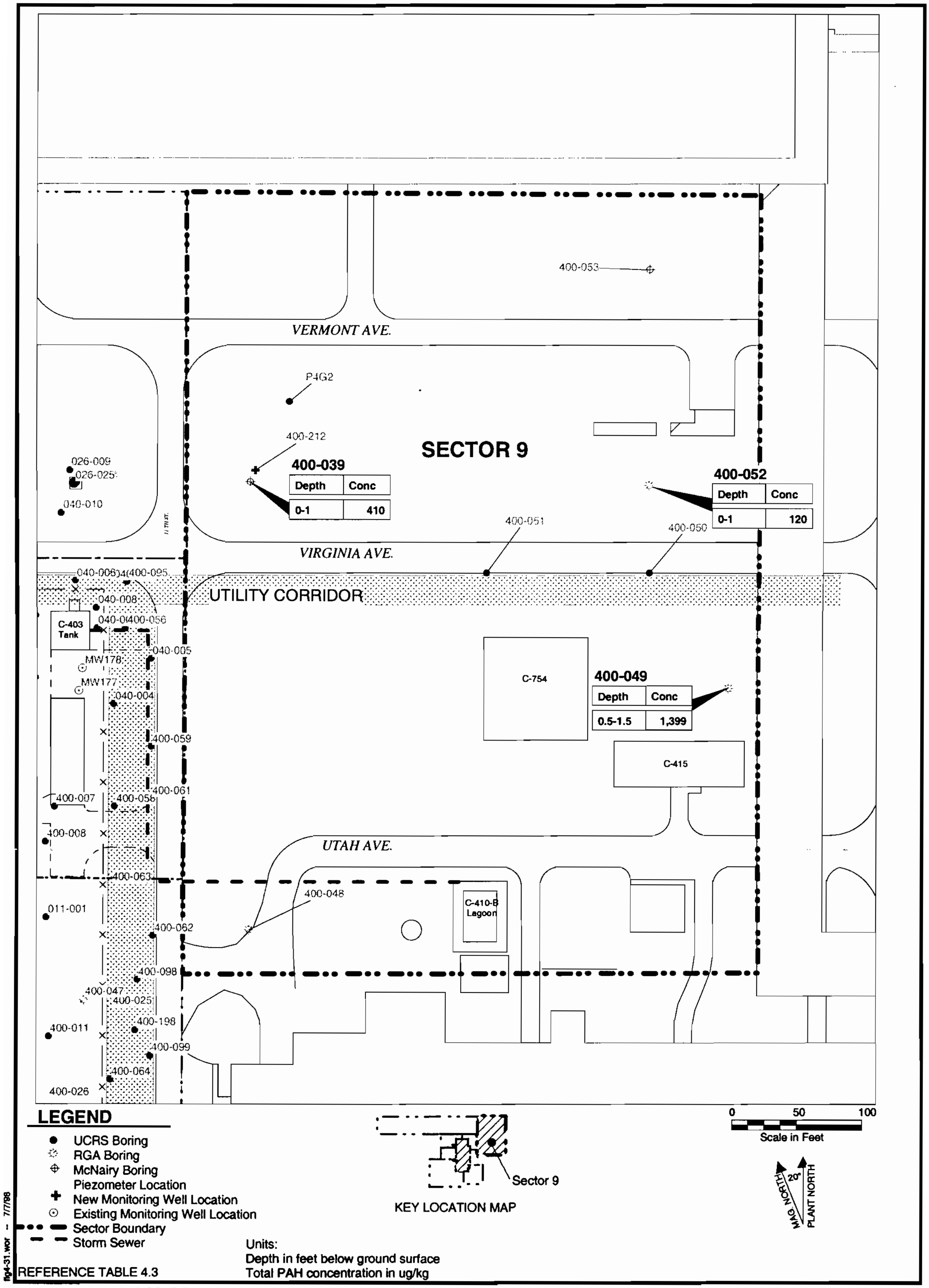
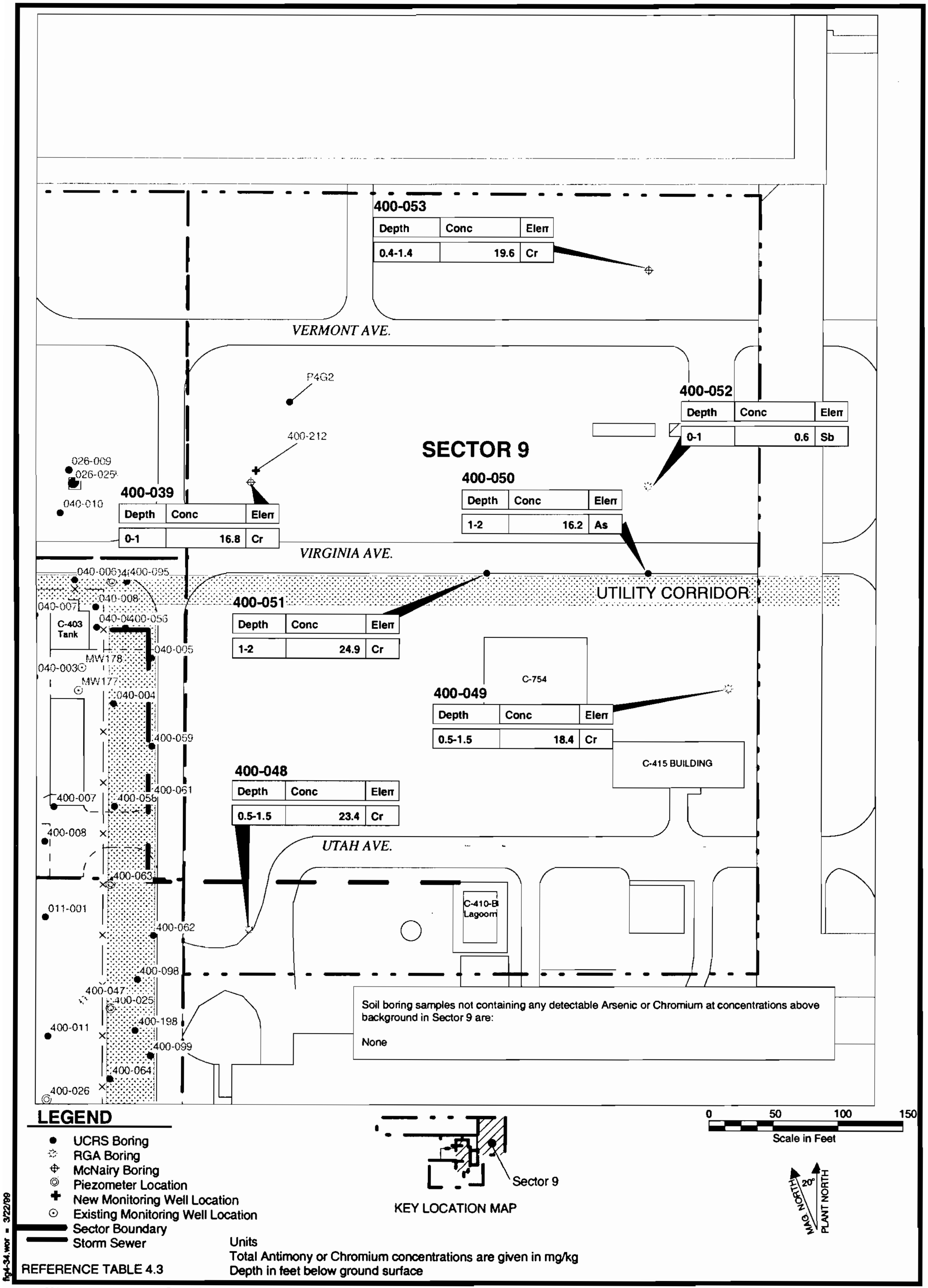


Fig. 4.33. Map showing distribution and total concentration of PAH's in sector 9 UCRS soil.



Soil boring samples not containing any detectable Arsenic or Chromium at concentrations above background in Sector 9 are:

None

Units
Total Antimony or Chromium concentrations are given in mg/kg
Depth in feet below ground surface

Fig. 4.34. Map showing distribution and total concentration of Antimony and Chromium detected in sector 9 UCRS soil.

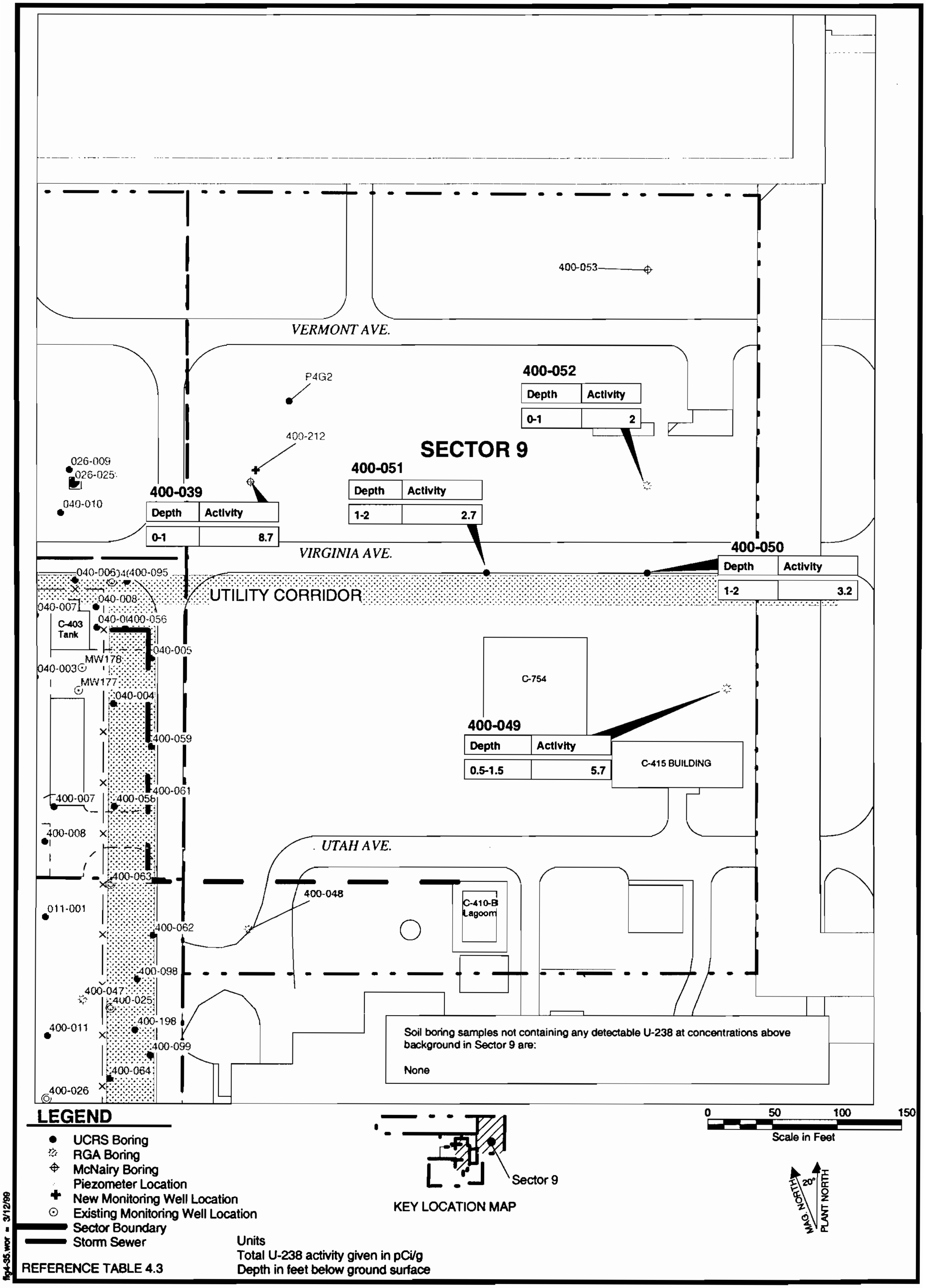


Fig. 4.35. Map showing distribution and total activity of U-238 detected in sector 9 UCRS soil.

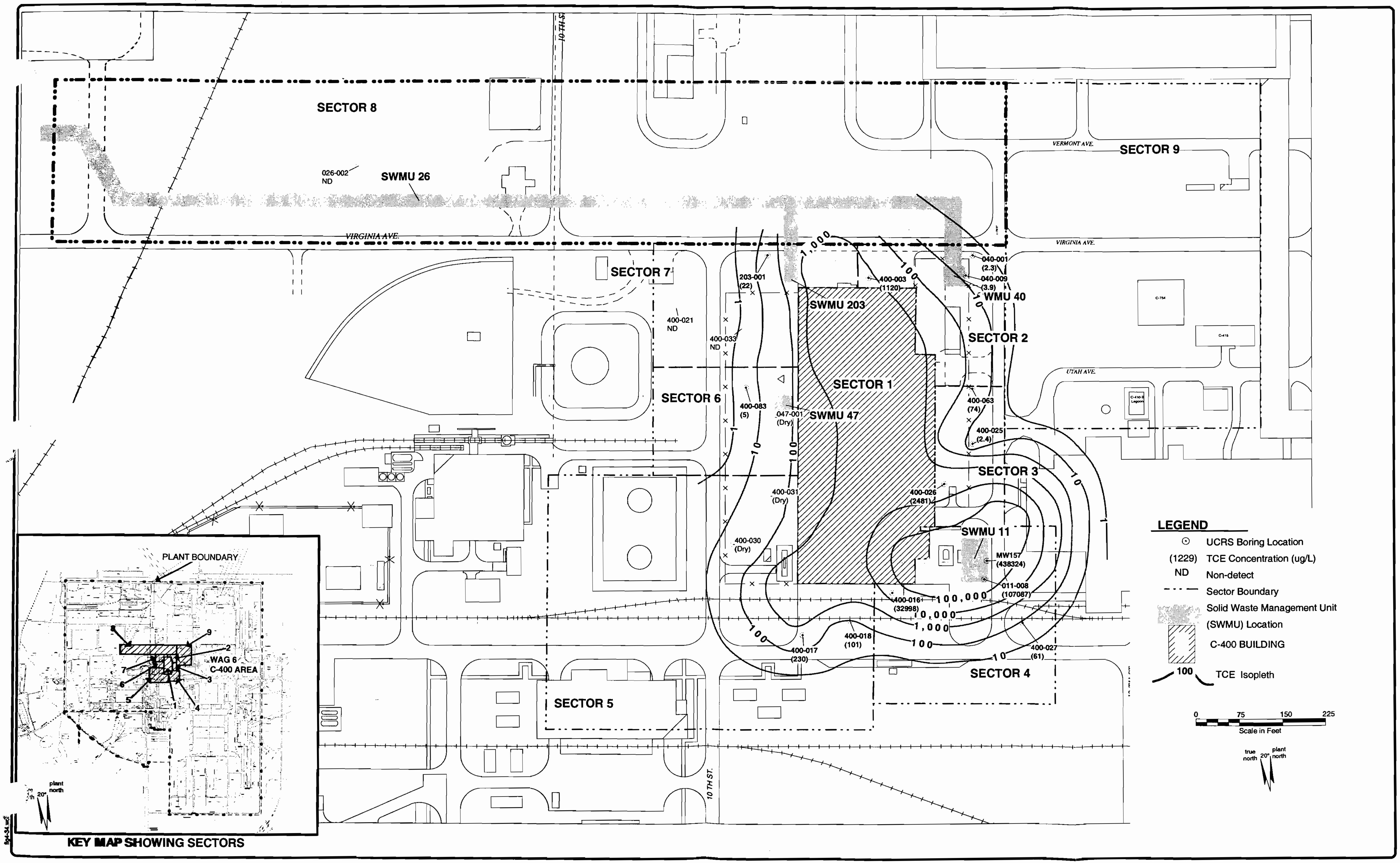


Fig. 4.36. Maximum concentration of TCE detected in UCRS groundwater.

The **Enclosure** is not available due to ***SIZE***.

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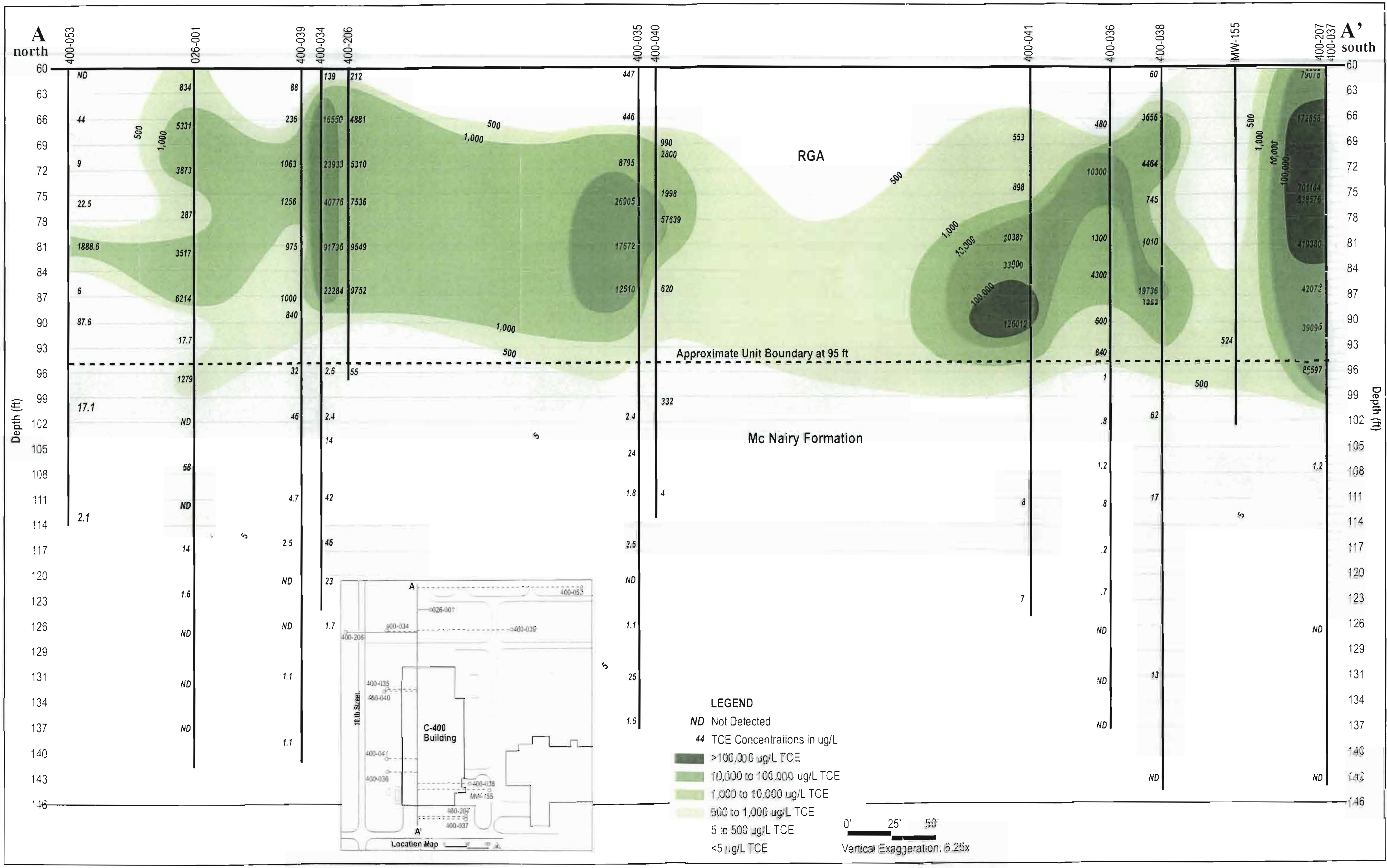

Fig. 4.39. North-south cross-section showing distribution and total concentration of TCE in the RGA and McNairy groundwater.

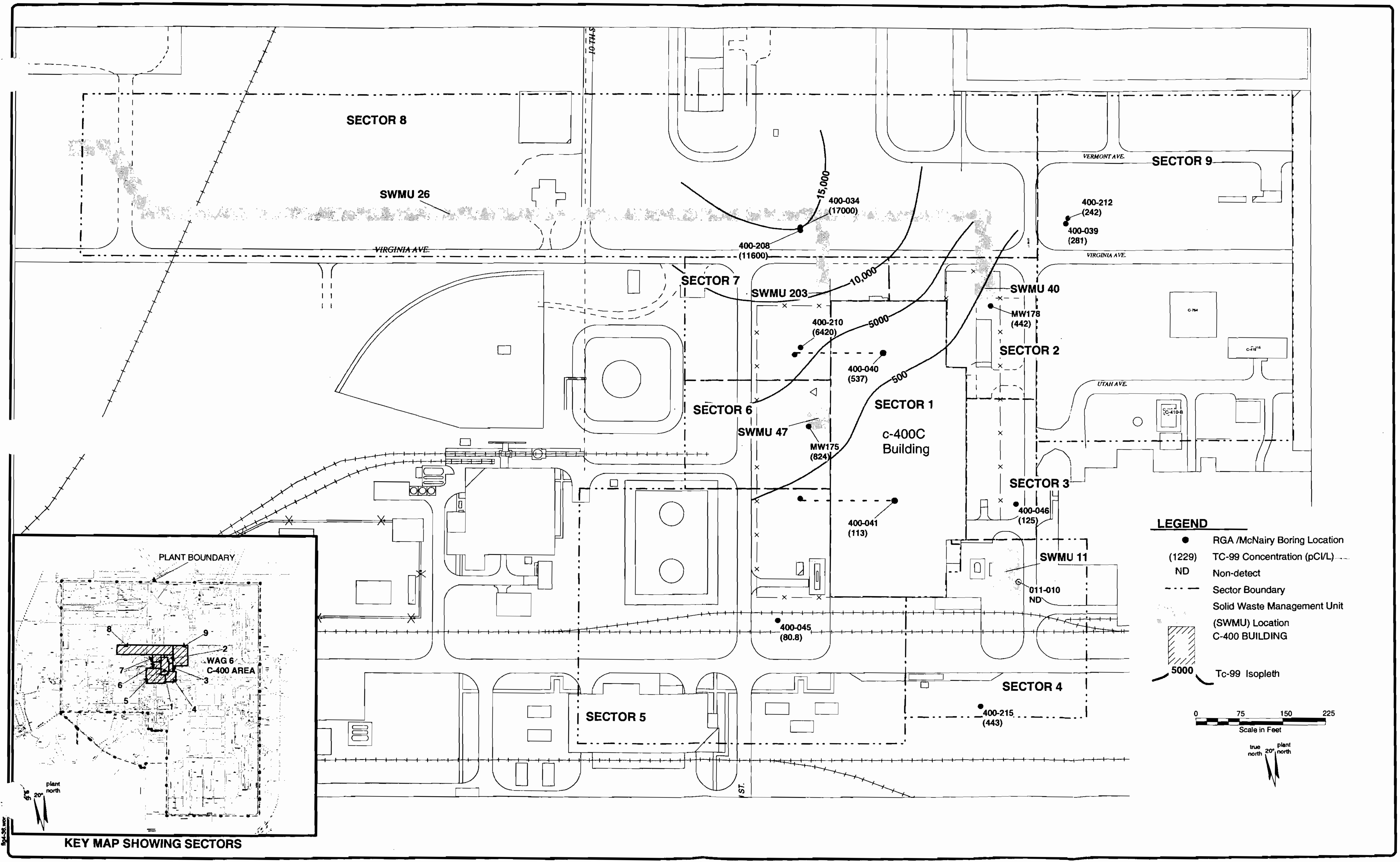

Fig. 4.38. Maximum concentration of Tc-99 detected in RGA groundwater.

Table 4.1. Background values
Metals

Analytical Compound	SOIL Background Data *(a)* (mg/kg) Near Surface	 Subsurface	WATER Background Data *(b)* (mg/L) Groundwater
Aluminum	13000	12000	22
Antimony	0.21	0.21	0.11
Arsenic	12	7.9	0.011
Barium	200	170	0.29
Beryllium	0.67	0.69	0.0093
Cadmium	0.21	0.21	0.021
Calcium	200000	6100	44
Chromium	16	43	0.13
Cobalt	14	13	0.096
Copper	19	25	0.022
Iron	28000	28000	5.1
Lead	36	23	0.1
Magnesium	7700	2100	17
Manganese	1500	820	0.16
Mercury	0.2	0.13	0.00038
Nickel	21	22	0.062
Potassium	1300	950	6.2
Selenium	0.8	0.7	0.0093
Silver	2.3	2.7	0.0041
Sodium	320	340	60
Thallium	0.21	0.34	0.11
Vanadium	38	37	0.14
Zinc	65	60	0.027

(a) **Background Levels of Selected Radionuclides and Metals in Soils and Geologic Media at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE, 1997)**

(b) **Baseline Risk Assessment and Technical Investigation Report for the Northwest Dissolved Phase Plume, Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE, 1994)**

Table 4.1. Background values
Radioactive isotopes

	SOIL		WATER
	Background Data *(a)* (pCi/g)		Background Data *(b)* (pCi/L)
Analytical Compound	Near Surface	Subsurface	Groundwater
Americium-241	N/A *(c)*	N/A	N/A
Cesium-137	0.49	0.28	0
Lead-210	N/A	N/A	N/A
Neptunium-237	0.1	0	0
Plutonium-238	0.073	0	0
Plutonium-239	0.025	0	0
Potassium-40	16	16	0
Radium-226	1.5	1.5	0
Technetium-99	2.5	2.8	0
Thorium-228	1.6	1.6	0
Thorium-230	1.5	1.4	1.4
Thorium-232	1.5	1.5	0
Uranium-234	2.5	2.4	1.2
Uranium-235	0.14	0.14	0.15
Uranium-238	1.2	1.2	1.1

(a) Background Levels of Selected Radionuclides and Metals in Soils and Geologic Media at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE, 1997)

(b) Baseline Risk Assessment and Technical Investigation Report for the Northwest Dissolved Phase Plume, Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE, 1994)

(c) Not Available

Table 4.2. Preliminary Remediation Goals

Soils

Analytical Compound	Residential Soil	Soil Units
Metals		
Aluminum	7.3E+02	mg/kg
Antimony	6.4E-02	mg/kg
Arsenic	9.2E-03	mg/kg
Barium	3.7E+01	mg/kg
Beryllium	1.0E-04	mg/kg
Cadmium	3.8E-01	mg/kg
Calcium	0.00E+00	mg/kg
Chromium	7.9E-01	mg/kg
Cobalt	2.1E+02	mg/kg
Copper	7.4E+01	mg/kg
Fluoride	2.3E+02	mg/kg
Iron	3.1E+02	mg/kg
Lead	1.0E-04	mg/kg
Magnesium	0.00E+00	mg/kg
Manganese	1.4E+01	mg/kg
Mercury	1.6E-01	mg/kg
Nickel	3.4E+01	mg/kg
Potassium	0.00E+00	mg/kg
Selenium	1.2E+01	mg/kg
Silver	6.1E+00	mg/kg
Sodium	0.00E+00	mg/kg
Thallium	0.00E+00	mg/kg
Uranium	1.1E+01	mg/kg
Vanadium	5.6E-01	mg/kg
Zinc	4.0E+02	mg/kg
Organic Compounds		
1-Tetraoxo-sufate		
1,1,1-Trichloroethane	8.4E+04	ug/kg
1,1,2-Trichloroethane	7.8E+01	ug/kg
1,1-Dichloroethene	1.8E+00	ug/kg
2,4-Dinitrotoluene	2.1E+01	ug/kg
2,6-Dinitrotoluene	2.1E+01	ug/kg
2-Hexanone	0.00E+00	ug/kg
2-Methylnaphthalene	0.00E+00	ug/kg
Acenaphthene	6.5E+04	ug/kg
Acenaphthylene	0.00E+00	ug/kg
Acetone	1.1E+05	ug/kg
Anthracene	6.6E+05	ug/kg
Benz(a)anthracene	8.5E+00	ug/kg
Benzene	1.3E+02	ug/kg
Benzo(a)pyrene	8.5E-01	ug/kg
Benzo(b)fluoranthene	8.5E+00	ug/kg
Benzo(ghi)perylene	0.00E+00	ug/kg
Benzo(k)fluoranthene	8.5E+01	ug/kg
Bis(2-ethylhexyl)phthalate	2.8E+02	ug/kg
Butyl benzyl phthalate	3.7E+05	ug/kg
Carbon disulfide	6.9E+04	ug/kg
Carbon tetrachloride	3.2E+01	ug/kg
Chloroform	6.8E+01	ug/kg
Chrysene	8.5E+02	ug/kg
cis-1,2-Dichloroethene	1.3E+04	ug/kg
Dibenz(a,h)anthracene	8.5E-01	ug/kg
Dibenzofuran	6.4E+03	ug/kg
Diethyl phthalate	2.0E+06	ug/kg
Di-n-butyl phthalate	2.6E+05	ug/kg
Di-n-octylphthalate	4.9E+04	ug/kg
Fluoranthene	4.3E+04	ug/kg
Fluorene	6.4E+04	ug/kg
Indeno(1,2,3-cd)pyrene	8.5E+00	ug/kg

Organic Compounds (cont.)		
Iodomethane	0.00E+00	ug/kg
Methylene chloride	6.9E+02	ug/kg
Naphthalene	8.1E+04	ug/kg
N-Nitroso-di-n-propylamine	7.3E-01	ug/kg
N-Nitrosodiphenylamine	1.0E+03	ug/kg
PCB-1254	1.1E+01	ug/kg
PCB-1260	1.1E+01	ug/kg
PCB-1262	1.1E+01	ug/kg
Phenanthrene	0.00E+00	ug/kg
Polychlorinated biphenyl	1.1E+01	ug/kg
Pyrene	3.2E+04	ug/kg
Tetrachloroethene	1.4E+02	ug/kg
Toluene	1.1E+05	ug/kg
trans-1,2-Dichloroethene	2.7E+04	ug/kg
Trichloroethene	1.1E+02	ug/kg
Trichlorofluoromethane	4.8E+04	ug/kg
Vinyl Acetate	5.4E+04	ug/kg
Vinyl Chloride	1.2E-02	ug/kg
Radioactive isotopes		
Alpha activity	0.00E+00	pCi/g
Americium-241	1.5E+00	pCi/g
Beta activity	0.00E+00	pCi/g
Cesium-137	1.6E-02	pCi/g
Neptunium-237	6.8E-02	pCi/g
Plutonium-239/240	2.0E+00	pCi/g
Technetium-99	4.4E+02	pCi/g
Thorium-230	1.6E+01	pCi/g
Uranium-234	1.4E+01	pCi/g
Uranium-235	1.2E-01	pCi/g
Uranium-238	4.7E-01	pCi/g

Groundwater

Analytical Compound	Residential Groundwater	Groundwater Units
Metals		
Aluminum	1.5E+00	mg/L
Antimony	5.6E-04	mg/L
Arsenic	3.5E-06	mg/L
Barium	1.0E-01	mg/L
Beryllium	1.0E-06	mg/L
Bromide	0.00E+00	mg/L
Cadmium	6.6E-04	mg/L
Calcium	0.00E+00	mg/L
Chloride	0.00E+00	mg/L
Chromium	7.1E-03	mg/L
Cobalt	9.1E-02	mg/L
Copper	6.0E-02	mg/L
Fluoride	9.1E-02	mg/L
Iron	4.5E-01	mg/L
Lead	1.5E-07	mg/L
Magnesium	0.00E+00	mg/L
Manganese	6.7E-02	mg/L
Mercury	4.4E-04	mg/L
Nickel	3.0E-02	mg/L
Nitrate	2.4E+00	mg/L
Nitrate as Nitrogen	2.4E+00	mg/L
Orthophosphate	0.00E+00	mg/L
Potassium	0.00E+00	mg/L
Selenium	7.5E-03	mg/L
Silver	7.5E-03	mg/L
Sodium	0.00E+00	mg/L
Thallium	0.00E+00	mg/L
Uranium	4.5E-03	mg/L
Vanadium	9.3E-03	mg/L
Zinc	4.5E-01	mg/L

Organic Compounds		
1-Tetraoxo-sufate	0.00E+00	ug/L
1,1,1-Trichloroethane	4.4E+01	ug/L
1,1,2-Trichloroethane	1.8E-02	ug/L
1,1-Dichloroethene	9.3E-04	ug/L
1,2-Dichloroethane	1.1E-02	ug/L
2,4-Dinitrotoluene	7.7E-03	ug/L
2,6-Dinitrotoluene	7.7E-03	ug/L
2-Hexanone	0.00E+00	ug/L
2-Methylnaphthalene	0.00E+00	ug/L
Acenaphthene	1.1E+01	ug/L
Acenaphthylene	0.00E+00	ug/L
Acetone	1.5E+02	ug/L
Anthracene	5.7E+01	ug/L
Benz(a)anthracene	1.3E-03	ug/L
Benzene	3.5E-02	ug/L
Benzo(a)pyrene	9.5E-05	ug/L
Benzo(b)fluoranthene	9.3E-04	ug/L
Benzo(ghi)perylene	0.00E+00	ug/L
Benzo(k)fluoranthene	1.7E-02	ug/L
Benzoic Acid	6.0E+03	ug/L
Bis(2-ethylhexyl)phthalate	3.1E-01	ug/L
Bromodichloromethane	8.4E-02	ug/L
Butyl benzyl phthalate	2.6E+02	ug/L
Carbon disulfide	3.5E+01	ug/L
Carbon tetrachloride	1.5E-02	ug/L
Chloroform	1.5E-02	ug/L
Chrysene	1.3E-01	ug/L
cis-1,2-Dichloroethene	1.5E+01	ug/L
Dibenz(a,h)anthracene	4.6E-05	ug/L
Dibenzofuran	1.6E+00	ug/L
Dibromochloromethane	6.2E-02	ug/L
Diethyl phthalate	1.2E+03	ug/L
Di-n-butyl phthalate	1.3E+02	ug/L
Di-n-octylphthalate	6.9E-01	ug/L
Fluoranthene	2.3E+01	ug/L
Fluorene	7.4E+00	ug/L
Indeno(1,2,3-cd)pyrene	6.3E-04	ug/L
Iodomethane	0.00E+00	ug/L
Methylene chloride	3.6E-01	ug/L
Naphthalene	8.7E-02	ug/L
N-Nitroso-di-n-propylamine	7.4E-04	ug/L
N-Nitrosodiphenylamine	9.5E-01	ug/L
PCB-1254	8.0E-03	ug/L
PCB-1260	4.4E-03	ug/L
PCB-1262	0.00E+00	ug/L
Phenanthrene	0.00E+00	ug/L
Phenol	9.0E+02	ug/L
Polychlorinated biphenyl	8.0E-03	ug/L
Pyrene	1.8E+01	ug/L
Tetrachloroethene	5.7E-02	ug/L
Toluene	2.4E+01	ug/L
trans-1,2-Dichloroethene	3.0E+01	ug/L
Trichloroethene	1.4E-01	ug/L
Trichlorofluoromethane	4.2E+01	ug/L
Vinyl Acetate	1.3E+01	ug/L
Vinyl Chloride	1.7E-03	ug/L
		ug/L
Radioactive isotopes		
Actinium-228	2.4E+01	pCi/L
Alpha activity	0.00E+00	pCi/L
Americium-241	1.2E-01	pCi/L
Beta activity	0.00E+00	pCi/L
Bismuth-212	6.2E+01	pCi/L
Bismuth-214	2.0E+02	pCi/L
Cesium-137	1.2E+00	pCi/L
Lead-210	3.8E-02	pCi/L
Lead-212	2.1E+00	pCi/L
Lead-214	1.3E+01	pCi/L
Neptunium-237	1.3E-01	pCi/L
Plutonium-239/240	1.2E-01	pCi/L

Radioactive Isotopes (cont.)		
Potassium-40	3.1E+00	pCi/L
Technetium-99	2.8E+01	pCi/L
Thallium-208	2.2E+03	pCi/L
Thorium-228	1.7E-01	pCi/L
Thorium-230	1.0E+00	pCi/L
Thorium-232	1.2E+00	pCi/L
Thorium-234	2.0E+00	pCi/L
Uranium-233/234	8.7E-01	pCi/L
Uranium-234	8.7E-01	pCi/L
Uranium-235	8.2E-01	pCi/L
Uranium-238	6.2E-01	pCi/L

Table 4.3. Analytical group with key constituents summarized in sector maps

Analytical Group	Analytical Compounds/Metals/Radioactive isotopes
VOA	1,1-Dichloroethene Carbon Tetrachloride Chloroform cis-1,2-Dichloroethene N-nitroso-di-n-propylamine Tetrachloroethene trans-1,2-Dichloroethene Trichloroethene Vinyl Chloride
SVOA	PAHs (Total)
PPCB	PCBs (Total)
Metals	Aluminum Antimony Arsenic Beryllium Chromium Iron Lead Manganese Vanadium
Radioactive isotopes	Americium-241 Cesium-137 Lead-210 Neptunium-237 Technetium-99 Thorium-228 Thorium-230 Uranium-238

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Table 4.4. VOA compounds detected in Sector 1
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Soil	400019SA003	0	4	Toluene	1.2	J	?	
	400019SA008	4	8	Toluene	1.4	J	?	
		4	8	Trichloroethene	1.6	J	?	
	400019SA010	8	12	Chloroform	1.4	J	?	
		8	12	Toluene	1.7	J	?	
		8	12	Trichloroethene	11		?	
	400019SA020	16	20	Trichloroethene	6.3		?	
	400019SA025	20	24	Trichloroethene	2.2	J	?	
	400019SA030	24	28	Toluene	1.4	J	?	
		24	28	Trichloroethene	13		?	
	400019SA040	32	36	Toluene	1.8	J	?	
		32	36	Trichloroethene	7.1		?	
	400020SA012	8	12	Trichloroethene	17		?	
	400020SA020	16	20	Trichloroethene	700		?	
	400020SA024	20	24	Trichloroethene	5.6		?	
	400020SA032	28	32	Trichloroethene	70		?	
	400020SA036	32	36	Trichloroethene	34		?	
	400020SA040	36	40	Trichloroethene	28		?	
	400020SA044	40	44	Trichloroethene	1200		?	
	400020SA048	44	48	Trichloroethene	2900		?	
	400020SD020	16	20	Trichloroethene	1000		?	

Table 4.4. VOA compounds detected in Sector 1
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					

Note: Soil boring samples not containing any detectable VOA compounds in Sector 1 are:
400019SA035, 400019SA045, 400019SA050, 400020SA003, 400020SA008

Table 4.5. Metals detected in Sector 1
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	400019SA003	0	4	Sodium	567		?		340
		0	4	Thallium	0.7	B	?		0.34
	400019SA008	4	8	Antimony	4.5	B	?		0.21
		4	8	Iron	29000		?		28000
		4	8	Sodium	832		?		340
	400020SA012	8	12	Cadmium	0.3		?		0.21
		8	12	Sodium	618		?		340
	400020SA020	16	20	Antimony	1.1	B	?		0.21
		16	20	Sodium	582		?		340
	400020SD020	16	20	Sodium	530		?		340

Note: Soil boring samples not containing any detectable metals at concentrations above background in Sector 1 are:

None

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Table 4.6. Radioactive isotopes detected in Sector 1
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/g	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/g
		Top	Bottom						
Soil	400019SA025	20	24	Cesium-137	0.3		?		0.28
		20	24	Neptunium-237	0.2		?		0
	400019SA035	28	32	Neptunium-237	0.3		?		0
	400020SA012	8	12	Cesium-137	0.3		?		0.28
		8	12	Neptunium-237	0.2		?		0
	400020SA024	20	24	Cesium-137	0.5		?		0.28
	400020SA044	40	44	Cesium-137	0.3		?		0.28
	400020SD020	16	20	Neptunium-237	0.3		?		0

Note: Soil boring samples not containing any detectable radioactive isotopes at concentrations above background in Sector 1 are:

400019SA003, 400019SA008, 400019SA010, 400019SA020, 400019SA030, 400019SA040, 400019SA045, 400019SA050, 400020SA008, 400020SA020, 400020SA032, 400020SA036, 400020SA040, 400020SA048

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Table 4.7. Frequency of detection of organic compounds, metals, and radioactive isotopes in Sector 1 UCRS soil

Analytical Group	Analytical Compound	No. of Detects	No. of Analyses	Maximum Result	Minimum Result	Average Result	Units
VOA	Trichloroethene	15	21	2900.00	1.60	216.39	ug/kg
	Toluene	5	21	1.80	1.20	1.50	ug/kg
	Chloroform	1	21	1.40	1.40	1.40	ug/kg
Metals	Sodium	5	5	832.00	530.00	625.80	mg/kg
	Antimony	2	5	4.50	1.10	2.80	mg/kg
	Cadmium	1	5	0.30	0.30	0.30	mg/kg
	Iron	1	5	29000.00	29000.00	29000.00	mg/kg
	Thallium	1	5	0.70	0.70	0.70	mg/kg
Radioactive isotopes	Cesium-137	4	20	0.50	0.30	0.35	pCi/g
	Neptunium-237	4	20	0.30	0.20	0.25	pCi/g

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Table 4.8. VOA compounds detected in Sector 2
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Soil	040003SA015	7	11	Toluene	2.3	J	?	
	040005SA015	7	11	Toluene	1.6	J	?	
		7	11	Vinyl acetate	1.3	J	?	BH-SS
	040005SD015	7	11	Toluene	1.8	J	?	
		7	11	Vinyl acetate	28	J	?	BH-SS
	400005SA030	30	33	2-Butanone	6	J	?	
		30	33	Vinyl acetate	1.3	J	?	BH-SS
	400007SA015	9	12.5	Toluene	1.5	J	=	
	400008SA040	35	42	Toluene	1.4	J	=	
	400008SD040	35	42	Toluene	1.5	J	=	
	400081SA015	6	10	Trichloroethene	2.2	J	?	

Note: Soil boring samples not containing any detectable VOA compounds in Sector 2 are:

040002SA015, 040004SA015, 040006SA015, 040007SA030, 040008SA030, 400003SA005, 400003SA010, 400003SA020, 400003SA030, 400003SA040, 400005SA005, 400005SA010, 400005SA020, 400005SA040, 400008SA005, 400008SA010, 400008SA020, 400008SA030, 400056SA015, 400058SA015, 400059SA015, 400061SA015, 400094SA015, 400095SA015, 400153SA015

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Table 4.9. SVOA and PCB compounds detected in Sector 2
UCRS soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
			Top	Bottom					
Soil	SVOA	040003SA015	7	11	N-Nitroso-di-n-propylamin	484	JB	?	
		040006SA015	8.5	12.5	2,6-Dinitrotoluene	432	J	?	
		400003SA001	1	1.5	2,6-Dinitrotoluene	347	J	?	
		400005SA001	0.8	2.5	2,6-Dinitrotoluene	374	J	?	
			0.8	2.5	Acenaphthene	1220		?	
			0.8	2.5	Anthracene	1893		?	
			0.8	2.5	Benz(a)anthracene	4133		?	
			0.8	2.5	Benzo(a)pyrene	3362		?	
			0.8	2.5	Benzo(b)fluoranthene	3424		?	
			0.8	2.5	Benzo(ghi)perylene	1867		?	
			0.8	2.5	Benzo(k)fluoranthene	1982		?	
			0.8	2.5	Chrysene	3968		?	
			0.8	2.5	Dibenz(a,h)anthracene	412	J	?	
			0.8	2.5	Dibenzofuran	576	J	?	
			0.8	2.5	Fluoranthene	8285		?	
			0.8	2.5	Fluorene	925		?	
			0.8	2.5	Indeno(1,2,3-cd)pyrene	1891		?	
			0.8	2.5	Naphthalene	503	J	?	
			0.8	2.5	Phenanthrene	7473		?	
			0.8	2.5	Pyrene	7853		?	
		400005SA040	39	42	2,6-Dinitrotoluene	345	J	?	

Table 4.9. SVOA and PCB compounds detected in Sector 2
UCRS soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
Soil	SVOA	400008SA001	0.2	1	Acenaphthene	40	J	?	
			0.2	1	Anthracene	80	J	?	
			0.2	1	Benz(a)anthracene	350	J	?	
			0.2	1	Benzo(a)pyrene	300	J	?	
			0.2	1	Benzo(b)fluoranthene	430	J	?	
			0.2	1	Benzo(ghi)perylene	170	J	?	
			0.2	1	Benzo(k)fluoranthene	280	J	?	
			0.2	1	Chrysene	400	J	?	
			0.2	1	Fluoranthene	860		?	
			0.2	1	Indeno(1,2,3-cd)pyrene	180	J	?	
			0.2	1	Phenanthrene	470	J	?	
			0.2	1	Pyrene	680	J	?	
		400008SA005	3.5	7	Fluoranthene	80	J	?	
			3.5	7	N-Nitroso-di-n-propylamin	634	J	?	
			3.5	7	Phenanthrene	50	J	?	
			3.5	7	Pyrene	60	J	?	
		400008SA010	10.5	14	2,6-Dinitrotoluene	416	J	?	
		400008SD040	35	42	N-Nitroso-di-n-propylamin	385	J	?	
	PPCB	400003SA001	1	1.5	PCB-1254	5.2	J	?	
		400008SA001	0.2	1	PCB-1260	43		?	

Table 4.9. SVOA and PCB compounds detected in Sector 2
UCRS soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
			Top	Bottom					

Note: Soil boring samples not containing any detectable SVOA compounds in Sector 2 are:

040002SA015, 040004SA015, 040005SA015, 040005SD015, 040007SA030, 040008SA030, 400002SA001, 400003SA005, 400003SA010, 400003SA020, 400003SA030, 400003SA040, 400005SA005, 400005SA010, 400005SA020, 400005SA030, 400007SA001, 400007SA015, 400008SA020, 400008SA030, 400008SA040, 400042SA001, 400056SA015, 400058SA015, 400059SA015, 400061SA015, 400081SA015, 400094SA015, 400095SA015, 400153SA015

Soil boring samples not containing any detectable PCB compounds in Sector 2 are:

040003SA015, 040005SA015, 040005SD015, 040006SA015, 040007SA030, 040008SA030, 400002SA001, 400003SA005, 400003SA010, 400007SA001, 400007SA015, 400008SA005, 400008SA010, 400008SA020, 400008SA030, 400008SA040, 400008SD040, 400056SA015, 400081SA015, 400095SA015

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Table 4.10. Metals detected in Sector 2
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	040002SA015	11	15	Sodium	382		?		340
		11	15	Thallium	0.7	B	?		0.34
	040003SA015	7	11	Magnesium	2150		?		2100
		7	11	Nickel	24.9		?		22
		7	11	Sodium	409		?		340
	040005SA015	7	11	Sodium	389		?		340
	040005SD015	7	11	Aluminum	12400		?		12000
		7	11	Antimony	0.7	B	?		0.21
		7	11	Sodium	408		?		340
	040006SA015	8.5	12.5	Sodium	359		?		340
	040008SA030	28.5	32	Aluminum	12600		=		12000
		28.5	32	Antimony	1.2	B	=		0.21
		28.5	32	Thallium	0.6	B	=		0.34
	400002SA001	0.8	2.7	Antimony	1.2	B	?		0.21
		0.8	2.7	Cadmium	0.26	B	?		0.21
		0.8	2.7	Cobalt	15.4		?		14
		0.8	2.7	Nickel	21.9		?		21
		0.8	2.7	Sodium	1670		?		320
	400003SA001	1	1.5	Antimony	3.4	B	?		0.21
		1	1.5	Cadmium	0.33	B	?		0.21
		1	1.5	Calcium	318000		?		200000

Table 4.10. Metals detected in Sector 2
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Bottom	Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
Soil	400003SA001	1	1.5	Magnesium	8040		?		7700
		1	1.5	Sodium	352		?		320
		1	1.5	Thallium	2.3		?		0.21
	400003SA010	6	12	Barium	181		?		170
		6	12	Magnesium	2270		?		2100
		6	12	Sodium	398		?		340
	400003SA020	20	24	Sodium	379		?		340
	400005SA005	3.5	7	Aluminum	13700		?		12000
		3.5	7	Antimony	0.9	B	?		0.21
	400005SA010	10.5	14	Aluminum	12900		?		12000
		10.5	14	Sodium	451		?		340
	400005SA040	39	42	Vanadium	47		?		37
	400007SA001	1.3	2.3	Aluminum	13800		=		13000
		1.3	2.3	Antimony	1.6	B	=		0.21
		1.3	2.3	Chromium	22.9		=		16
		1.3	2.3	Thallium	0.9	B	=		0.21
	400008SA001	0.2	1	Chromium	19.3		?		16
		0.2	1	Zinc	70.2		?		65
	400008SA005	3.5	7	Aluminum	13800		?		12000
		3.5	7	Arsenic	9.2		?		7.9
		3.5	7	Beryllium	0.7		?		0.69

Table 4.10. Metals detected in Sector 2
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	400008SA005	3.5	7	Sodium	386		?		340
	400008SA020	21	24.5	Antimony	0.8	B	?		0.21
		21	24.5	Beryllium	0.79		?		0.69
		21	24.5	Chromium	54.3		?		43
		21	24.5	Vanadium	53.3		?		37
	400008SA030	31.5	35	Thallium	0.8	B	=		0.34
	400008SA040	35	42	Antimony	5.5	B	=		0.21
		35	42	Beryllium	0.9		=		0.69
		35	42	Thallium	0.6	B	=		0.34
		35	42	Vanadium	38.6		=		37
	400008SD040	35	42	Aluminum	12900		=		12000
		35	42	Beryllium	0.7		=		0.69
		35	42	Thallium	0.8	B	=		0.34
	400042SA001	1.2	1.7	Antimony	1.2	B	?		0.21
		1.2	1.7	Cadmium	0.49	B	?		0.21
		1.2	1.7	Calcium	340000		?		200000
		1.2	1.7	Sodium	665		?		320
	400056SA015	12	16	Aluminum	17100		=		12000
		12	16	Antimony	1.9	B	=		0.21
		12	16	Arsenic	8.83		=		7.9
		12	16	Magnesium	2350		=		2100

Table 4.10. Metals detected in Sector 2
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	400056SA015	12	16	Potassium	1080		=		950
		12	16	Sodium	619		=		340
	400058SA015	10	14	Aluminum	13500		?		12000
		10	14	Sodium	451		?		340
	400059SA015	10	14	Aluminum	12600		?		12000
		10	14	Antimony	4.7		?		0.21
		10	14	Beryllium	0.79		?		0.69
		10	14	Silver	4.28		?		2.7
		10	14	Sodium	341		?		340
		10	14	Thallium	0.8	B	?		0.34
		10	14	Vanadium	37.7		?		37
	400061SA015	10	14	Aluminum	14900		?		12000
	400081SA015	6	10	Aluminum	15300		?		12000
		6	10	Barium	179		?		170
		6	10	Beryllium	0.81		?		0.69
		6	10	Cobalt	16.8		?		13
		6	10	Magnesium	2490		?		2100
		6	10	Manganese	842		?		820
		6	10	Sodium	410		?		340

Table 4.10. Metals detected in Sector 2
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						

Note: Soil boring samples not containing any detectable metals at concentrations above background in Sector 2 are:

040004SA015, 040007SA030, 400003SA005, 400003SA030, 400003SA040, 400005SA001, 400005SA020, 400005SA030, 400007SA015, 400008SA010, 400094SA015, 400095SA015, 400153SA015

Table 4.11. Radioactive isotopes detected in Sector 2
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/g	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/g
		Top	Bottom						
Soil	040005SA015	7	11	Neptunium-237	0.3		?		0
	040007SA030	30.5	33.5	Americium-241	0.2		?		0
	040008SA030	28.5	32	Uranium-234	13		=		2.4
		28.5	32	Uranium-235	0.6		=		0.14
		28.5	32	Uranium-238	13.4		=		1.2
	400007SA001	1.3	2.3	Uranium-238	2.5		=		1.2
	400007SA015	9	12.5	Thorium-230	1.5		=		1.4
	400008SA001	0.2	1	Technetium-99	3.6		?		2.5
		0.2	1	Thorium-230	1.8		?		1.5
		0.2	1	Uranium-234	3.4		?		2.5
		0.2	1	Uranium-235	0.2		?		0.14
		0.2	1	Uranium-238	4.6		?		1.2
	400008SD040	35	42	Americium-241	0.8		=		0
		35	42	Thorium-230	1.6		=		1.4
	400056SA015	12	16	Technetium-99	4		=		2.8
		12	16	Thorium-230	1.9		=		1.4
		12	16	Uranium-234	3.5		=		2.4
		12	16	Uranium-235	0.2		=		0.14
		12	16	Uranium-238	3.8		=		1.2
	400061SA015	10	14	Uranium-234	20.1		?		2.4
		10	14	Uranium-235	0.7		?		0.14

Table 4.11. Radioactive isotopes detected in Sector 2
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/g	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/g
		Top	Bottom						
Soil	400061SA015	10	14	Uranium-238	20.2		?		1.2

Note: Soil boring samples not containing any detectable radioactive isotopes at concentrations above background in Sector 2 are: 040005SD015, 400008SA030, 400008SA040

Table 4.12. Frequency of detection of organic compounds, metals, and radioactive isotopes in Sector 2 UCRS soil

Analytical Group	Analytical Compound	No. of Detects	No. of Analyses	Maximum Result	Minimum Result	Average Result	Units
VOA	Toluene	6	20	2.30	1.40	1.68	ug/kg
	Vinyl acetate	3	20	28.00	1.30	10.20	ug/kg
	2-Butanone	1	20	6.00	6.00	6.00	ug/kg
	Trichloroethene	1	34	2.20	2.20	2.20	ug/kg
SVOA	2,6-Dinitrotoluene	5	39	432.00	345.00	382.80	ug/kg
	Fluoranthene	3	39	8285.00	80.00	3075.00	ug/kg
	N-Nitroso-di-n-propylamine	3	39	634.00	385.00	501.00	ug/kg
	Phenanthrene	3	39	7473.00	50.00	2664.33	ug/kg
	Pyrene	3	39	7853.00	60.00	2864.33	ug/kg
	Acenaphthene	2	39	1220.00	40.00	630.00	ug/kg
	Anthracene	2	39	1893.00	80.00	986.50	ug/kg
	Benz(a)anthracene	2	39	4133.00	350.00	2241.50	ug/kg
	Benzo(a)pyrene	2	39	3362.00	300.00	1831.00	ug/kg
	Benzo(b)fluoranthene	2	39	3424.00	430.00	1927.00	ug/kg
	Benzo(ghi)perylene	2	39	1867.00	170.00	1018.50	ug/kg
	Benzo(k)fluoranthene	2	39	1982.00	280.00	1131.00	ug/kg
	Chrysene	2	39	3968.00	400.00	2184.00	ug/kg
	Indeno(1,2,3-cd)pyrene	2	39	1891.00	180.00	1035.50	ug/kg
	Dibenz(a,h)anthracene	1	39	412.00	412.00	412.00	ug/kg
	Dibenzofuran	1	39	576.00	576.00	576.00	ug/kg
	Fluorene	1	39	925.00	925.00	925.00	ug/kg
	Naphthalene	1	39	503.00	503.00	503.00	ug/kg
PCB	PCB-1254	1	22	5.20	5.20	5.20	ug/kg
	PCB-1260	1	22	43.00	43.00	43.00	ug/kg
Metals	Sodium	16	39	1670.00	341.00	504.31	mg/kg
	Aluminum	12	39	17100.00	12400.00	13791.67	mg/kg
	Antimony	11	39	5.50	0.70	2.10	mg/kg
	Thallium	8	39	2.30	0.60	0.94	mg/kg
	Beryllium	6	39	0.90	0.70	0.78	mg/kg
	Magnesium	5	39	8040.00	2150.00	3460.00	mg/kg
	Vanadium	4	39	53.30	37.70	44.15	mg/kg
	Cadmium	3	39	0.49	0.26	0.36	mg/kg

Table 4.12. Frequency of detection of organic compounds, metals, and radioactive isotopes in Sector 2 UCRS soil

Analytical Group	Analytical Compound	No. of Detects	No. of Analyses	Maximum Result	Minimum Result	Average Result	Units
Metals	Chromium	3	39	54.30	19.30	32.17	mg/kg
	Arsenic	2	39	9.20	8.83	9.02	mg/kg
	Barium	2	39	181.00	179.00	180.00	mg/kg
	Calcium	2	39	340000.00	318000.00	329000.00	mg/kg
	Cobalt	2	39	16.80	15.40	16.10	mg/kg
	Nickel	2	39	24.90	21.90	23.40	mg/kg
	Manganese	1	39	842.00	842.00	842.00	mg/kg
	Potassium	1	39	1080.00	1080.00	1080.00	mg/kg
	Silver	1	39	4.28	4.28	4.28	mg/kg
	Zinc	1	39	70.20	70.20	70.20	mg/kg
Radioactive isotopes	Uranium-238	5	12	20.20	2.50	8.90	pCi/g
	Thorium-230	4	12	1.90	1.50	1.70	pCi/g
	Uranium-234	4	12	20.10	3.40	10.00	pCi/g
	Uranium-235	4	12	0.70	0.20	0.43	pCi/g
	Americium-241	2	12	0.80	0.20	0.50	pCi/g
	Technetium-99	2	12	4.00	3.60	3.80	pCi/g
	Neptunium-237	1	12	0.30	0.30	0.30	pCi/g

Table 4.13. VOA compounds detected in Sector 3
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
Soil	011001SA010	8	12	Toluene	2	J	?	
		8	12	Trichloroethene	5.3	J	?	
	011001SA020	19.5	23	Toluene	1.8	J	?	
		19.5	23	Trichloroethene	3.2	J	?	
	011001SA030	30	33.5	Trichloroethene	2.4	J	?	
	011001SA048	47.5	50.5	Trichloroethene	14000		?	
	011002SA024	20	24	Trichloroethene	1.9	J	?	BH-ER
	011002SA028	24	28	Trichloroethene	1.8	J	?	BH-ER
	400011SA005	5	8	cis-1,2-Dichloroethene	46		?	
		5	8	Trichloroethene	2900		?	
	400011SA010	10	13.5	cis-1,2-Dichloroethene	9.7		?	
		10	13.5	Trichloroethene	2700		?	
	400011SA020	20	23.5	Trichloroethene	5000		?	
	400011SA030	29.5	32	Trichloroethene	1800		?	
	400011SA040	38	41	Trichloroethene	4100		?	
	400011SD005	5	8	cis-1,2-Dichloroethene	15		?	
		5	8	Trichloroethene	2100		?	
	400062SA015	11	15	Toluene	260		=	
		11	15	Trichloroethene	36	J	=	
	400063SA015	11	15	Toluene	270		=	
	400098SA036	32	36	Trichloroethene	2	J	?	
	400098SA040	36	40	Trichloroethene	3.1	J	?	

Table 4.13. VOA compounds detected in Sector 3
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					

Note: Soil boring samples not containing any detectable VOA compounds in Sector 3 are:

011002SA004, 011002SA008, 011002SA012, 011002SA016, 011002SA020, 011002SA032, 011002SA040, 011002SA044, 011002SA048, 400064SA015, 400098SA008, 400098SA012, 400098SA015, 400098SA020, 400098SA024, 400098SA028, 400098SA032, 400098SA044, 400099SA015, 400198SA015

Table 4.14. SVOA and PCB compounds detected in Sector 3 UCRS soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
			Top	Bottom					
Soil	SVOA	011001SA048	47.5	50.5	N-Nitroso-di-n-propylamin	331	J	?	
		011002SA004	0	4	Benz(a)anthracene	300	J	?	
			0	4	Benzo(a)pyrene	300	J	?	
			0	4	Benzo(b)fluoranthene	200	J	?	
			0	4	Benzo(k)fluoranthene	300	J	?	
			0	4	Chrysene	300	J	?	
			0	4	Fluoranthene	600	J	?	
			0	4	Phenanthrene	300	J	?	
			0	4	Pyrene	500	J	?	
		011002SA020	16	20	Fluoranthene	60	J	?	
			16	20	Pyrene	50	J	?	
		400011SA001	0.5	1.5	Acenaphthene	100	J	?	
			0.5	1.5	Anthracene	463	J	?	
			0.5	1.5	Benz(a)anthracene	968		?	
			0.5	1.5	Benzo(a)pyrene	887		?	
			0.5	1.5	Benzo(b)fluoranthene	924		?	
			0.5	1.5	Benzo(ghi)perylene	130	J	?	
			0.5	1.5	Benzo(k)fluoranthene	947		?	
			0.5	1.5	Chrysene	962		?	
			0.5	1.5	Dibenzofuran	50	J	?	
			0.5	1.5	Fluoranthene	1642		?	

Table 4.14. SVOA and PCB compounds detected in Sector 3
UCRS soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
			Top	Bottom					
Soil	SVOA	400011SA001	0.5	1.5	Fluorene	70	J	?	
			0.5	1.5	Indeno(1,2,3-cd)pyrene	160	J	?	
			0.5	1.5	Naphthalene	40	J	?	
			0.5	1.5	Phenanthrene	1269		?	
			0.5	1.5	Pyrene	1566		?	
		400046SA001	0	1	Acenaphthene	130	J	?	
			0	1	Anthracene	220	J	?	
			0	1	Benz(a)anthracene	960	J	?	
			0	1	Benzo(a)pyrene	1000	J	?	
			0	1	Benzo(b)fluoranthene	1400	J	?	
			0	1	Benzo(ghi)perylene	370	J	?	
			0	1	Benzo(k)fluoranthene	870	J	?	
			0	1	Chrysene	1000	J	?	
			0	1	Dibenz(a,h)anthracene	160	J	?	
			0	1	Fluoranthene	2100		?	
			0	1	Fluorene	90	J	?	
			0	1	Indeno(1,2,3-cd)pyrene	420	J	?	
			0	1	Phenanthrene	1200	J	?	
			0	1	Pyrene	1800		?	
		400047SA001	0	1	Benzo(k)fluoranthene	254	J	?	
			0	1	Fluoranthene	224	J	?	

Table 4.14. SVOA and PCB compounds detected in Sector 3 UCRS soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
			Top	Bottom					
Soil	SVOA	400047SA001	0	1	Pyrene	227	J	?	
		400064SA015	9	12	Fluoranthene	40	J	?	
		400098SA008	4	8	Anthracene	40	J	?	
			4	8	Benz(a)anthracene	250	J	?	
			4	8	Benzo(a)pyrene	210	J	?	
			4	8	Benzo(b)fluoranthene	230	J	?	
			4	8	Benzo(ghi)perylene	120	J	?	
			4	8	Benzo(k)fluoranthene	180	J	?	
			4	8	Chrysene	270	J	?	
			4	8	Fluoranthene	260	J	?	
			4	8	Indeno(1,2,3-cd)pyrene	110	J	?	
			4	8	Pyrene	230	J	?	
		400098SA015	11	15	Fluoranthene	70	J	=	
			11	15	Pyrene	50	J	=	
	PPCB	400011SA001	0.5	1.5	PCB-1260	47		?	
		400046SA001	0	1	PCB-1260	3300		?	
		400064SA015	9	12	PCB-1260	21		?	
		400098SA015	11	15	PCB-1260	120		=	

Table 4.14. SVOA and PCB compounds detected in Sector 3
UCRS soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
			Top	Bottom					

Note: Soil boring samples not containing any detectable SVOA compounds in Sector 3 are:

011001SA010, 011001SA020, 011001SA030, 011002SA008, 011002SA012, 011002SA016, 011002SA024, 011002SA028, 011002SA032, 011002SA040, 011002SA044, 011002SA048, 400011SA005, 400011SA010, 400011SA020, 400011SA030, 400011SA040, 400011SD005, 400062SA015, 400063SA015, 400098SA012, 400098SA020, 400099SA015, 400198SA015

Soil boring samples not containing any detectable PCB compounds in Sector 3 are:

011001SA010, 011001SA020, 011001SA030, 400011SA005, 400011SA010, 400011SA020, 400011SA030, 400011SA040, 400011SD005, 400062SA015, 400063SA015, 400099SA015

Table 4.15. Metals detected in Sector 3
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	011001SA010	8	12	Aluminum	12700		?		12000
		8	12	Magnesium	2310		?		2100
		8	12	Sodium	432		?		340
	011001SA020	19.5	23	Sodium	610		?		340
	011001SA030	30	33.5	Sodium	518		?		340
	011002SA004	0	4	Aluminum	20300		?		12000
		0	4	Antimony	0.8	B	?		0.21
		0	4	Arsenic	9.12		?		7.9
		0	4	Magnesium	3060		?		2100
		0	4	Potassium	1070		?		950
		0	4	Sodium	864		?		340
	011002SA008	4	8	Aluminum	17300		?		12000
		4	8	Arsenic	8.96		?		7.9
		4	8	Cobalt	15.8		?		13
		4	8	Magnesium	2260		?		2100
		4	8	Manganese	996		?		820
		4	8	Sodium	787		?		340
	011002SA012	8	12	Aluminum	14400		?		12000
		8	12	Magnesium	2410		?		2100
		8	12	Sodium	793		?		340
	011002SA016	12	16	Aluminum	12600		?		12000

Table 4.15. Metals detected in Sector 3
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	011002SA016	12	16	Cobalt	18.6		?		13
		12	16	Manganese	996		?		820
		12	16	Sodium	635		?		340
	011002SA020	16	20	Aluminum	18100		?		12000
		16	20	Sodium	620		?		340
	011002SA024	20	24	Aluminum	12400		?		12000
		20	24	Sodium	547		?		340
		20	24	Thallium	0.8	B	?		0.34
	011002SA028	24	28	Aluminum	15700		?		12000
		24	28	Sodium	582		?		340
	011002SA032	28	32	Aluminum	13900		?		12000
		28	32	Beryllium	1		?		0.69
		28	32	Sodium	751		?		340
	011002SA040	36	40	Sodium	465		?		340
	011002SA048	43	46.5	Aluminum	13400		?		12000
		43	46.5	Sodium	563		?		340
	400011SA001	0.5	1.5	Aluminum	15400		?		13000
		0.5	1.5	Antimony	0.6	B	?		0.21
		0.5	1.5	Cadmium	0.39	B	?		0.21
		0.5	1.5	Chromium	20.4		?		16
		0.5	1.5	Sodium	357		?		320

Table 4.15. Metals detected in Sector 3
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	400011SA005	5	8	Aluminum	19000		?		12000
		5	8	Arsenic	18.1		?		7.9
		5	8	Magnesium	2220		?		2100
		5	8	Sodium	528		?		340
	400011SA010	10	13.5	Aluminum	12500		?		12000
		10	13.5	Magnesium	2700		?		2100
		10	13.5	Sodium	540		?		340
	400011SA030	29.5	32	Beryllium	0.9		=		0.69
		29.5	32	Vanadium	37.7		=		37
	400011SA040	38	41	Antimony	3	B	=		0.21
	400011SD005	5	8	Aluminum	17500		?		12000
		5	8	Magnesium	2390		?		2100
		5	8	Sodium	559		?		340
	400046SA001	0	1	Cadmium	0.38	B	?		0.21
		0	1	Chromium	18.2		?		16
		0	1	Copper	34.6		?		19
		0	1	Nickel	22.8		?		21
		0	1	Sodium	620		?		320
	400047SA001	0	1	Sodium	573		?		320
		0	1	Thallium	1.2	B	?		0.21
	400062SA015	11	15	Aluminum	12900		=		12000

Table 4.15. Metals detected in Sector 3
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	400062SA015	11	15	Sodium	394		=		340
	400063SA015	11	15	Aluminum	16600		=		12000
	400064SA015	9	12	Calcium	9260		?		6100
		9	12	Magnesium	2290		?		2100
		9	12	Sodium	375		?		340
	400098SA008	4	8	Cadmium	0.4	B	?		0.21
		4	8	Sodium	633		?		340
	400098SA012	8	12	Antimony	0.8	B	?		0.21
		8	12	Sodium	739		?		340
	400098SA015	11	15	Aluminum	14000		=		12000
		11	15	Sodium	419		=		340
	400098SA020	16	20	Calcium	14300		?		6100
		16	20	Sodium	569		?		340
	400099SA015	9	13	Sodium	364		?		340

Note: Soil boring samples not containing any detectable metals at concentrations above background in Sector 3 are: 011001SA048, 011002SA004, 400011SA020

Table 4.16. Radioactive isotopes detected in Sector 3
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/g	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/g
		Top	Bottom						
Soil	011001SA030	30	33.5	Neptunium-237	0.2		?		0
	011001SA048	47.5	50.5	Neptunium-237	0.2		?		0
	011002SA004	0	4	Cesium-137	0.3		?		0.28
		0	4	Neptunium-237	0.3		?		0
	011002SA008	4	8	Neptunium-237	0.4		?		0
	011002SA020	16	20	Neptunium-237	0.3		?		0
	011002SA028	24	28	Cesium-137	0.4		?		0.28
		24	28	Neptunium-237	0.3		?		0
	011002SA032	28	32	Neptunium-237	0.3		?		0
	011002SA040	36	40	Cesium-137	0.3		?		0.28
	011002SA044	40	43	Cesium-137	0.3		?		0.28
	011002SA048	43	46.5	Neptunium-237	0.4		?		0
	400011SA001	0.5	1.5	Uranium-238	2.5		?		1.2
	400011SA020	20	23.5	Thorium-230	1.6		?		1.4
	400046SA001	0	1	Cesium-137	0.5		?		0.49
		0	1	Neptunium-237	0.4		?		0.1
		0	1	Technetium-99	3.5		?		2.5
		0	1	Thorium-230	4.2		?		1.5
		0	1	Uranium-234	7.1		?		2.5
		0	1	Uranium-235	0.4		?		0.14
		0	1	Uranium-238	9.1		?		1.2

Table 4.16. Radioactive isotopes detected in Sector 3
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/g	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/g
		Top	Bottom						
Soil	400098SA015	11	15	Uranium-238	1.8		=		1.2
	400098SA036	32	36	Cesium-137	0.4		?		0.28
	400098SA044	40	44	Uranium-235	0.2		?		0.14
	400099SA015	9	13	Americium-241	0.2		?		0

Note: Soil boring samples not containing any detectable radioactive isotopes at concentrations above background in Sector 3 are:

011001SA010, 011001SA020, 011002SA012, 011002SA016, 011002SA024, 400011SA005, 400011SA010, 400011SA030, 400011SA040, 400011SD005, 400062SA015, 400063SA015, 400064SA015, 400098SA008, 400098SA012, 400098SA020, 400098SA024, 400098SA028, 400098SA032, 400098SA040

Table 4.17. Frequency of detection of organic compounds, metals, and radioactive isotopes in Sector 3 UCRS soil

Analytical Group	Analytical Compound	No. of Detects	No. of Analyses	Maximum Result	Minimum Result	Average Result	Units
VOA	Trichloroethene	15	36	14000.00	1.80	1103.45	ug/kg
	Toluene	4	35	270.00	1.80	133.45	ug/kg
	cis-1,2-Dichloroethene	3	36	46.00	9.70	23.57	ug/kg
SVOA	Fluoranthene	8	33	2100.00	40.00	510.19	ug/kg
	Pyrene	7	33	1800.00	50.00	531.57	ug/kg
	Benzo(k)fluoranthene	5	33	947.00	180.00	433.40	ug/kg
	Benz(a)anthracene	4	33	968.00	250.00	509.13	ug/kg
	Benzo(a)pyrene	4	33	1000.00	210.00	518.50	ug/kg
	Benzo(b)fluoranthene	4	33	1400.00	200.00	598.50	ug/kg
	Chrysene	4	33	1000.00	270.00	518.88	ug/kg
	Anthracene	3	33	463.00	40.00	187.17	ug/kg
	Benzo(ghi)perylene	3	33	370.00	120.00	206.67	ug/kg
	Indeno(1,2,3-cd)pyrene	3	33	420.00	110.00	230.00	ug/kg
	Phenanthrene	3	33	1269.00	300.00	803.17	ug/kg
	Acenaphthene	2	33	130.00	100.00	115.00	ug/kg
	Fluorene	2	33	90.00	70.00	80.00	ug/kg
	Dibenz(a,h)anthracene	1	33	160.00	160.00	160.00	ug/kg
	Dibenzofuran	1	33	50.00	50.00	50.00	ug/kg
	Naphthalene	1	33	40.00	40.00	40.00	ug/kg
	N-Nitroso-di-n-propylamine	1	33	331.00	331.00	331.00	ug/kg
PCB	PCB-1260	4	16	3300.00	21.00	872.00	ug/kg
Metals	Sodium	26	32	864.00	357.00	570.65	mg/kg
	Aluminum	17	32	20300.00	12400.00	15217.65	mg/kg
	Magnesium	8	32	3060.00	2220.00	2455.00	mg/kg
	Antimony	4	32	3.00	0.60	1.30	mg/kg
	Arsenic	3	32	18.10	8.96	12.06	mg/kg
	Cadmium	3	32	0.40	0.38	0.39	mg/kg
	Beryllium	2	32	1.00	0.90	0.95	mg/kg
	Calcium	2	32	14300.00	9260.00	11780.00	mg/kg
	Chromium	2	32	20.40	18.20	19.30	mg/kg
	Cobalt	2	32	18.60	15.80	17.20	mg/kg
	Manganese	2	32	996.00	996.00	996.00	mg/kg

Table 4.17. Frequency of detection of organic compounds, metals, and radioactive isotopes in Sector 3 UCRS soil

Analytical Group	Analytical Compound	No. of Detects	No. of Analyses	Maximum Result	Minimum Result	Average Result	Units
Metals	**Thallium**	2	32	1.20	0.80	1.00	mg/kg
	Copper	1	32	34.60	34.60	34.60	mg/kg
	Nickel	1	32	22.80	22.80	22.80	mg/kg
	Potassium	1	32	1070.00	1070.00	1070.00	mg/kg
	Vanadium	1	32	37.70	37.70	37.70	mg/kg
Radioactive isotopes	**Neptunium-237**	9	37	0.40	0.20	0.31	pCi/g
	Cesium-137	6	37	0.50	0.30	0.37	pCi/g
	Uranium-238	3	37	9.10	1.80	4.47	pCi/g
	Thorium-230	2	37	4.20	1.60	2.90	pCi/g
	Uranium-235	2	37	0.40	0.20	0.30	pCi/g
	Americium-241	1	37	0.20	0.20	0.20	pCi/g
	Technetium-99	1	37	3.50	3.50	3.50	pCi/g
	Uranium-234	1	37	7.10	7.10	7.10	pCi/g

Table 4.18. VOA compounds detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Soil	011003SA016	13.5	17	cis-1,2-Dichloroethene	2.6	J	?	
		13.5	17	Trichloroethene	2.6	J	?	
	011003SA020	17	20	cis-1,2-Dichloroethene	2.5	J	?	
		17	20	Trichloroethene	4.1	J	?	
	011003SA024	20	24	Trichloroethene	3.3	J	?	
	011003SA036	32	36	Trichloroethene	700	J	?	BH-RB
	011003SA040	36	40	cis-1,2-Dichloroethene	4.9	J	?	
		36	40	Trichloroethene	6200		?	BH-RB
	011003SA044	40	44	cis-1,2-Dichloroethene	4.5	J	?	
		40	44	Trichloroethene	29000		?	BH-RB
	011003SA048	44	48	cis-1,2-Dichloroethene	11		?	
		44	48	Trichloroethene	13000		?	BH-RB
	011004SA008	4	8	cis-1,2-Dichloroethene	1.4	J	?	
		4	8	Trichloroethene	2.6	J	?	
	011004SA012	8	12	cis-1,2-Dichloroethene	3.7	J	?	
		8	12	Trichloroethene	12		?	
	011004SA016	12	16	cis-1,2-Dichloroethene	1.6	J	?	
		12	16	Trichloroethene	3.8	J	?	
	011004SA020	16	20	Trichloroethene	2.7	J	?	
	011004SA024	20	23.5	Trichloroethene	8.5		?	

Table 4.18. VOA compounds detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Soil	011004SA028	23.5	27	Trichloroethene	1.6	J	?	
	011004SA044	37.5	41	Trichloroethene	1.8	J	?	
	011004SA048	41	44.5	Trichloroethene	3.2	J	?	
	011005SA008	4	8	Trichloroethene	2	J	?	
	011005SA024	20	24	cis-1,2-Dichloroethene	15		?	
		20	24	Trichloroethene	12800		?	
		20	24	Vinyl chloride	5.1	J	?	
	011005SA028	24	28	cis-1,2-Dichloroethene	57		?	
		24	28	Tetrachloroethene	4.7	J	?	
		24	28	Trichloroethene	57200		?	
		24	28	Vinyl chloride	14		?	
	011005SA030	28	31.5	cis-1,2-Dichloroethene	13		?	
		28	31.5	Tetrachloroethene	4	J	?	
		28	31.5	Trichloroethene	8208600		?	
		28	31.5	Vinyl chloride	5.6	J	?	
	011005SA036	31.5	35	Trichloroethene	1700		?	
	011005SA040	35	38.5	Trichloroethene	9.1		?	
	011005SA044	38.5	41.5	Trichloroethene	1300		?	
	011005SA048	41.5	45	Trichloroethene	500	J	?	
	011005SA052	45	48.5	Trichloroethene	1500		?	

Table 4.18. VOA compounds detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
Soil	011006SA004	0	4	Trichloroethene	2	J	?	
	011006SA028	24	28	2-Propanol	60		?	
	011006SA036	32	36	2-Propanol	60		?	
	011006SA040	36	40	Trichloroethene	1.237	J	?	BH-ER
	011006SA044	40	44	Trichloroethene	17		?	BH-ER
	011006SA048	44	48	Trichloroethene	7800		?	
	011008SA015	13	17	cis-1,2-Dichloroethene	36		?	
		13	17	Trichloroethene	31		?	
	400014SA004	0	4	cis-1,2-Dichloroethene	24		?	
		0	4	Trichloroethene	2200		?	
	400014SA008	4	8	cis-1,2-Dichloroethene	37		?	
		4	8	Trichloroethene	23000		?	
	400014SA012	8	12	cis-1,2-Dichloroethene	130		?	
		8	12	trans-1,2-Dichloroethene	2200		?	
		8	12	Trichloroethene	52000		?	
	400014SA016	12	16	cis-1,2-Dichloroethene	99		?	
		12	16	Trichloroethene	66000		?	
	400014SA020	16	20	cis-1,2-Dichloroethene	10		?	
		16	20	Trichloroethene	65600		?	
	400014SA024	20	24	Trichloroethene	64000		?	

Table 4.18. VOA compounds detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Soil	400014SA028	24	27.5	cis-1,2-Dichloroethene	14		?	
		24	27.5	Trichloroethene	16100		?	
	400014SA032	27.5	31	cis-1,2-Dichloroethene	2.7	J	?	
		27.5	31	Trichloroethene	2200		?	
	400014SA036	31	34.5	cis-1,2-Dichloroethene	1.8	J	?	
		31	34.5	Trichloroethene	1300		?	
	400014SA040	34.5	38	cis-1,2-Dichloroethene	2.5	J	?	
		34.5	38	Trichloroethene	14900		?	
	400014SA044	38	41.5	Trichloroethene	129000		?	
	400014SA048	41.5	45	Trichloroethene	42000		?	BH-RB
	400014SA052	45	49	Chloromethane	270	J	?	
		45	49	Iodomethane	430	J	?	
		45	49	Trichloroethene	226000		?	BH-RB
	400016SA005	5	8	Trichloroethene	320		EJ	
	400016SA015	16	20	Trichloroethene	1500		?	
	400016SA020	20	24	cis-1,2-Dichloroethene	3.2	J	?	
		20	24	Trichloroethene	1800		?	
	400016SA030	30	34	cis-1,2-Dichloroethene	3.8	J	=	
		30	34	Trichloroethene	1900		?	
	400016SD005	5	8	Trichloroethene	280		EJ	

Table 4.18. VOA compounds detected in Sector 4 UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Soil	400037SA015	6	10	cis-1,2-Dichloroethene	11		?	
		6	10	Trichloroethene	2700		?	
	400038SA010	10	10.5	Trichloroethene	4600		?	
	400038SA015	15	15	Trichloroethene	6300		?	
	400038SA020	20	20	Trichloroethene	6300		?	
	400038SA025	25	25	cis-1,2-Dichloroethene	1300	J	?	BL-T
		25	25	Trichloroethene	15000		?	BL-T
	400038SA030	30	30	Trichloroethene	9200	J	?	BL-T
	400038SA040	49	49	cis-1,2-Dichloroethene	560	J	?	BL-T
		49	49	Trichloroethene	43000		?	BL-T
	400038SA045	46	48.5	cis-1,2-Dichloroethene	680	J	?	BL-T
		46	48.5	Trichloroethene	52000		?	BL-T
	400038SA050	49	49	Trichloroethene	44000		?	BL-T
	400066SA015	13	17	Toluene	1.6	J	=	
	400067SA015	8	12	1,1-Dichloroethene	1.5	J	?	BL-T
		8	12	cis-1,2-Dichloroethene	410		?	BL-T
		8	12	trans-1,2-Dichloroethene	2100		?	
		8	12	Trichloroethene	5600		?	
	400068SA015	13	17	cis-1,2-Dichloroethene	2.5	J	=	
		13	17	Toluene	2	J	=	

Table 4.18. VOA compounds detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Soil	400068SA015	13	17	Trichloroethene	11400		?	
	400069SA015	13	17	cis-1,2-Dichloroethene	44		=	
		13	17	Tetrachloroethene	1.3	J	=	
		13	17	Toluene	2.5	J	=	
		13	17	Trichloroethene	4100		?	
	400091SA015	8	12	1,1-Dichloroethene	4	J	?	
		8	12	cis-1,2-Dichloroethene	1200		?	
		8	12	trans-1,2-Dichloroethene	3900		?	
		8	12	Trichloroethene	2000		?	
		8	12	Vinyl chloride	3.4	J	?	
	400092SA015	16	20	cis-1,2-Dichloroethene	5.5	J	?	
		16	20	Trichloroethene	17200		?	
	400101SA015	7	11	Trichloroethene	13		=	
	400103SA015	9	13	1,1-Dichloroethene	4.9	J	?	
		9	13	cis-1,2-Dichloroethene	940		?	
		9	13	trans-1,2-Dichloroethene	12500		?	
		9	13	Trichloroethene	67000	J	?	
		9	13	Vinyl chloride	110		?	
	400104SA015	15	19	1,1,2-Trichloroethane	2.8	J	=	
		15	19	1,1-Dichloroethene	17		=	

Table 4.18. VOA compounds detected in Sector 4 UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Soil	400104SA015	15	19	cis-1,2-Dichloroethene	200		=	
		15	19	Tetrachloroethene	1.9	J	=	
		15	19	Toluene	1.6	J	=	
		15	19	trans-1,2-Dichloroethene	7300		?	
		15	19	Trichloroethene	134000		?	
		15	19	Vinyl chloride	130		=	
	400134SA015	12	16	cis-1,2-Dichloroethene	4.3	J	?	
		12	16	Trichloroethene	8200		?	
		12	16	Vinyl acetate	1.7	J	?	BH-SS
	400138SA016	12	16	Trichloroethene	1.6	J	?	
	400139SA008	4	8	Trichloroethene	2.9	J	?	
	400139SA012	8	12	Trichloroethene	2.6	J	?	
	400139SA020	16	20	cis-1,2-Dichloroethene	1.8	J	?	
		16	20	Trichloroethene	5.4	J	?	
	400163SA008	4	8	cis-1,2-Dichloroethene	27		?	
		4	8	Vinyl chloride	4.5	J	?	
	400163SA012	8	12	cis-1,2-Dichloroethene	63		?	
		8	12	Trichloroethene	23700		?	
	400163SA016	12	16	cis-1,2-Dichloroethene	93		?	
		12	16	Trichloroethene	40100		?	

Table 4.18. VOA compounds detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Soil	400163SA020	16	20	cis-1,2-Dichloroethene	49		?	
		16	20	Trichloroethene	40500		?	
	400163SA024	21	25	cis-1,2-Dichloroethene	5.3	J	?	
		21	25	Trichloroethene	22100		?	
	400163SA028	24	28	cis-1,2-Dichloroethene	1.5	J	?	
		24	28	Trichloroethene	11000		?	
	400163SA032	28	32	cis-1,2-Dichloroethene	14		?	
		28	32	Trichloroethene	46000		?	
	400163SA036	32	36	cis-1,2-Dichloroethene	4.4	J	?	
		32	36	Trichloroethene	15000		?	
	400163SA040	36	40	cis-1,2-Dichloroethene	5.1	J	?	
		36	40	Trichloroethene	60000		?	
	400163SA044	40	44	cis-1,2-Dichloroethene	9.5		?	
		40	44	Trichloroethene	75000		?	
	400163SA048	44	48	cis-1,2-Dichloroethene	13		?	
		44	48	Trichloroethene	36000		?	
	400200SA005	1	5	1,1,1-Trichloroethane	12		=	
		1	5	1,1-Dichloroethene	22		=	
		1	5	Carbon tetrachloride	2	J	=	
		1	5	cis-1,2-Dichloroethene	1300		=	

Table 4.18. VOA compounds detected in Sector 4 UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Bottom	Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
Soil	400200SA005	1	5	Tetrachloroethene	19		DJ	
		1	5	Toluene	5.4	J	=	
		1	5	trans-1,2-Dichloroethene	8700		?	
		1	5	Trichloroethene	55000		?	
		1	5	Vinyl chloride	470		=	
	400200SA009	5	9	1,1,1-Trichloroethane	2400		=	
		5	9	1,1,2-Trichloroethane	530		=	
		5	9	1,1-Dichloroethene	950		=	
		5	9	Benzene	17		=	
		5	9	Carbon tetrachloride	710		=	
		5	9	Chloroform	18		=	
		5	9	cis-1,2-Dichloroethene	1100		=	
		5	9	Tetrachloroethene	690		=	
		5	9	Toluene	33		=	
		5	9	Trichloroethene	11055000		?	
		5	9	Trichlorofluoromethane	1.7	J	=	
		5	9	Vinyl chloride	120		=	
	400200SA013	9	13	1,1,1-Trichloroethane	19		=	
		9	13	1,1,2-Trichloroethane	20		=	
		9	13	1,1-Dichloroethene	4	J	=	

Table 4.18. VOA compounds detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Soil	400200SA013	9	13	Carbon tetrachloride	13		=	
		9	13	Chloroform	2.4	J	=	
		9	13	cis-1,2-Dichloroethene	22		=	
		9	13	Tetrachloroethene	8.6		=	
		9	13	Trichloroethene	1389000		?	
		9	13	Vinyl chloride	21		=	
	400200SA017	13	17	1,1,2-Trichloroethane	8.6		=	
		13	17	Chloroform	1.5	J	=	
		13	17	cis-1,2-Dichloroethene	6		=	
		13	17	Toluene	1.5	J	=	
		13	17	Trichloroethene	385000		?	
		13	17	Vinyl chloride	6.8	J	=	
	400200SA021	17	21	1,1,1-Trichloroethane	3.3	J	=	
		17	21	1,1,2-Trichloroethane	22		=	
		17	21	1,1-Dichloroethene	3	J	=	
		17	21	Carbon tetrachloride	23		=	
		17	21	Chloroform	5.1	J	=	
		17	21	cis-1,2-Dichloroethene	7.7		=	
		17	21	Tetrachloroethene	15		=	
		17	21	Trichloroethene	1760000		?	

Table 4.18. VOA compounds detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Soil	400200SA021	17	21	Vinyl chloride	8.9	J	=	
	400200SA029	25	29	1,1,2-Trichloroethane	390		=	
		25	29	1,1-Dichloroethene	71		=	
		25	29	1,2-Dichloroethane	8.2		=	
		25	29	Benzene	30		=	
		25	29	Bromodichloromethane	190		=	
		25	29	Carbon tetrachloride	300		=	
		25	29	Chloroform	250		=	
		25	29	cis-1,2-Dichloroethene	33		=	
		25	29	Tetrachloroethene	460		=	
		25	29	Toluene	1.5	J	=	
		25	29	trans-1,2-Dichloroethene	2.3	J	=	
		25	29	Trichloroethene	2759000		?	
		25	29	Vinyl chloride	6.6	J	=	
	400201SA004	0	4	cis-1,2-Dichloroethene	200		?	
		0	4	trans-1,2-Dichloroethene	102000		?	BH-RB
		0	4	Trichloroethene	25000		?	BH-RB
		0	4	Vinyl chloride	29000		?	BH-RB
	400201SA008	4	8	cis-1,2-Dichloroethene	1300		?	
		4	8	trans-1,2-Dichloroethene	29000		?	BH-RB

Table 4.18. VOA compounds detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
Soil	400201SA008	4	8	Trichloroethene	27000		?	BH-RB
		4	8	Vinyl chloride	3000		?	BH-RB
	400201SA012	8	12	cis-1,2-Dichloroethene	1500		?	
		8	12	trans-1,2-Dichloroethene	29000		?	BH-RB
		8	12	Trichloroethene	59000		?	BH-RB
		8	12	Vinyl chloride	37	J	?	
	400201SA016	12	16	cis-1,2-Dichloroethene	1000		?	
		12	16	trans-1,2-Dichloroethene	24000		?	BH-RB
		12	16	Trichloroethene	81000		?	BH-RB
		12	16	Vinyl chloride	13		?	
	400201SA020	16	20	cis-1,2-Dichloroethene	190		?	
		16	20	trans-1,2-Dichloroethene	16000		?	BH-RB
		16	20	Trichloroethene	61000		?	BH-RB
		16	20	Vinyl chloride	4.7	J	?	
	400201SA024	20	24	1,1,2-Trichloroethane	8.3		?	
		20	24	2-Hexanone	8.4	J	?	
		20	24	Chloroform	3	J	?	
		20	24	cis-1,2-Dichloroethene	650	J	?	
		20	24	Trichloroethene	216000		?	BH-RB
		20	24	Vinyl chloride	32		?	

Table 4.18. VOA compounds detected in Sector 4 UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Bottom	Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
Soil	400201SA028	24	28	1,1,2-Trichloroethane	3.1	J	?	
		24	28	cis-1,2-Dichloroethene	340		?	
		24	28	Trichloroethene	145000		?	BH-RB
		24	28	Vinyl chloride	14		?	
	400201SA032	28	32	1,1,2-Trichloroethane	3.2	J	?	
		28	32	Chloroform	1.2	J	?	
		28	32	cis-1,2-Dichloroethene	670		?	
		28	32	trans-1,2-Dichloroethene	6800		?	BH-RB
		28	32	Trichloroethene	93000		?	BH-RB
		28	32	Vinyl chloride	5.5	J	?	
	400201SA036	32	36	cis-1,2-Dichloroethene	110		?	
		32	36	trans-1,2-Dichloroethene	2000		?	BH-RB
		32	36	Trichloroethene	61000		?	BH-RB
		32	36	Vinyl chloride	3.5	J	?	
	400201SA040	36	40	cis-1,2-Dichloroethene	2.6	J	?	
		36	40	Trichloroethene	1900		?	BH-RB
	400201SA044	40	44	Trichloroethene	2.8	J	?	
	400201SA048	44	48	cis-1,2-Dichloroethene	13		?	
		44	48	Trichloroethene	15000		?	BH-RB
	400202SA004	0	4	1,1-Dichloroethene	1.2	J	?	

Table 4.18. VOA compounds detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Soil	400202SA004	0	4	cis-1,2-Dichloroethene	63		?	
		0	4	Tetrachloroethene	5.2	J	?	
		0	4	trans-1,2-Dichloroethene	1400		?	
		0	4	Trichloroethene	151100		?	
	400202SA008	4	8	1,1-Dichloroethene	1.3	J	?	
		4	8	cis-1,2-Dichloroethene	380		?	
		4	8	trans-1,2-Dichloroethene	34000		?	
		4	8	Trichloroethene	52500		?	
		4	8	Vinyl chloride	3.4	J	?	
	400202SA012	8	12	1,1-Dichloroethene	3	J	?	
		8	12	cis-1,2-Dichloroethene	2400		?	
		8	12	trans-1,2-Dichloroethene	15000		?	
		8	12	Trichloroethene	49700		?	
		8	12	Vinyl chloride	3.9	J	?	
	400202SA016	12	16	Chloroform	1.7	J	?	
		12	16	cis-1,2-Dichloroethene	980		?	
		12	16	trans-1,2-Dichloroethene	9900		?	
		12	16	Trichloroethene	62300		?	
		12	16	Vinyl chloride	1.9	J	?	
	400202SA020	16	20	1,1-Dichloroethene	1.4	J	?	

Table 4.18. VOA compounds detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
Soil	400202SA020	16	20	Chloroform	1.8	J	?	
		16	20	cis-1,2-Dichloroethene	190		?	
		16	20	trans-1,2-Dichloroethene	6600		?	
		16	20	Trichloroethene	62900		?	
	400202SA024	20	24	Chloroform	2	J	?	
		20	24	cis-1,2-Dichloroethene	230		?	
		20	24	trans-1,2-Dichloroethene	3900		?	
		20	24	Trichloroethene	33000		?	
	400202SA028	24	28	cis-1,2-Dichloroethene	8.6		?	
		24	28	trans-1,2-Dichloroethene	1600		?	
		24	28	Trichloroethene	14200		?	
	400205SA008	4	8	Trichloroethene	1.5	J	?	
	400207SA030	28	30	cis-1,2-Dichloroethene	1.4	J	?	
		28	30	Trichloroethene	3.2	J	?	
	400207SA045	43	44	Trichloroethene	700	J	?	
	400207SD045	43	44	Trichloroethene	800		?	
	400211SA004	0	4	cis-1,2-Dichloroethene	3.1	J	?	
		0	4	Trichloroethene	31		?	
	400211SA008	4	8	cis-1,2-Dichloroethene	2.4	J	?	
		4	8	Trichloroethene	20		?	

Table 4.18. VOA compounds detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Soil	400211SA012	8	12	Trichloroethene	1.5	J	?	
	400211SA016	12	16	cis-1,2-Dichloroethene	2.1	J	?	
		12	16	Trichloroethene	9.6		?	
	400211SA020	16	20	cis-1,2-Dichloroethene	1.5	J	?	
		16	20	Trichloroethene	9.7		?	
	400211SA024	20	24	cis-1,2-Dichloroethene	3.1	J	?	
		20	24	Trichloroethene	23		?	
	400211SA028	24	28	cis-1,2-Dichloroethene	1.7	J	?	
		24	28	Trichloroethene	16		?	
	400211SA032	28	32	Trichloroethene	4.7	J	?	
	400211SA048	44	48	Trichloroethene	160	J	?	BL-T

Note: Soil boring samples not containing any detectable VOA compounds in Sector 4 are:

011003SA004, 011003SA012, 011003SA028, 011003SA032, 011004SA004, 011004SA032, 011004SA036, 011004SA040, 011004SA052, 011006SA008, 011006SA012, 011006SA016, 011006SA020, 011006SA024, 011006SA032, 011007SA025, 011007SA037, 400016SA010, 400038SA005, 400038SA035, 400065SA015, 400070SA015, 400105SA015, 400116SA015, 400117SA015, 400138SA004, 400138SA008, 400138SA012, 400138SA020, 400139SA004, 400139SA016, 400163SA004, 400205SA004, 400205SA012, 400205SA016, 400205SA020, 400205SA024, 400205SA028, 400205SA036, 400205SA040, 400205SA044, 400205SA048, 400207SD030, 400211SA036, 400211SA040, 400211SA044, 400211SD032, 400211SD048

Table 4.19. SVOA and PCB compounds detected in Sector 4 UCRS soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
Soil	SVOA	011003SA004	0	4	Acenaphthene	90	J	?	
			0	4	Anthracene	130	J	?	
			0	4	Benz(a)anthracene	350	J	?	
			0	4	Benzo(a)pyrene	320	J	?	
			0	4	Benzo(b)fluoranthene	230	J	?	
			0	4	Benzo(ghi)perylene	250	J	?	
			0	4	Benzo(k)fluoranthene	280	J	?	
			0	4	Chrysene	350	J	?	
			0	4	Fluoranthene	860		?	
			0	4	Fluorene	60	J	?	
			0	4	Indeno(1,2,3-cd)pyrene	220	J	?	
			0	4	Phenanthrene	640		?	
			0	4	Pyrene	720		?	
		011003SA016	13.5	17	Diethyl phthalate	1500		?	
		011003SA020	17	20	Diethyl phthalate	1800		?	
		011003SA024	20	24	Diethyl phthalate	2800		?	
		011003SA040	36	40	Diethyl phthalate	1600		?	
		011003SA048	44	48	Diethyl phthalate	1700		?	
		011004SA004	0	4	Benz(a)anthracene	50	J	?	
			0	4	Benzo(a)pyrene	50	J	?	
			0	4	Benzo(k)fluoranthene	50	J	?	

Table 4.19. SVOA and PCB compounds detected in Sector 4 UCRS soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
			Top	Bottom					
Soil	SVOA	011004SA004	0	4	Chrysene	50	J	?	
			0	4	Fluoranthene	90	J	?	
			0	4	Pyrene	80	J	?	
		011005SA008	4	8	Benz(a)anthracene	80	J	?	
			4	8	Benzo(a)pyrene	90	J	?	
			4	8	Benzo(b)fluoranthene	80	J	?	
			4	8	Benzo(ghi)perylene	65	J	?	
			4	8	Benzo(k)fluoranthene	80	J	?	
			4	8	Chrysene	90	J	?	
			4	8	Fluoranthene	170	J	?	
			4	8	Phenanthrene	90	J	?	
			4	8	Pyrene	150	J	?	
		011005SA036	31.5	35	Fluoranthene	40	J	?	
		011006SA004	0	4	Benz(a)anthracene	120	J	?	
			0	4	Benzo(a)pyrene	100	J	?	
			0	4	Benzo(b)fluoranthene	90	J	?	
			0	4	Benzo(k)fluoranthene	90	J	?	
			0	4	Chrysene	120	J	?	
			0	4	Fluoranthene	250	J	?	
			0	4	Phenanthrene	190	J	?	
			0	4	Pyrene	210	J	?	

Table 4.19. SVOA and PCB compounds detected in Sector 4 UCRS soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
			Top	Bottom					
Soil	SVOA	011006SA012	8	12	Fluoranthene	70	J	?	
			8	12	Phenanthrene	40	J	?	
			8	12	Pyrene	60	J	?	
		400014SA004	0	4	Acenaphthene	100	J	?	
			0	4	Anthracene	190	J	?	
			0	4	Benz(a)anthracene	570	J	?	
			0	4	Benzo(a)pyrene	560	J	?	
			0	4	Benzo(b)fluoranthene	600	J	?	
			0	4	Benzo(ghi)perylene	370	J	?	
			0	4	Benzo(k)fluoranthene	400	J	?	
			0	4	Chrysene	700	J	?	
			0	4	Fluoranthene	1300		?	
			0	4	Fluorene	70	J	?	
			0	4	Indeno(1,2,3-cd)pyrene	350	J	?	
			0	4	Phenanthrene	860		?	
			0	4	Pyrene	1100		?	
		400014SA008	4	8	Naphthalene	160	J	?	
		400016SA001	1	4	Anthracene	70	J	=	
			1	4	Benz(a)anthracene	873		?	
			1	4	Benzo(a)pyrene	746		?	
			1	4	Benzo(b)fluoranthene	735		?	

Table 4.19. SVOA and PCB compounds detected in Sector 4 UCRS soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
			Top	Bottom					
Soil	SVOA	400016SA001	1	4	Benzo(ghi)perylene	388	J	?	
			1	4	Benzo(k)fluoranthene	469	J	?	
			1	4	Chrysene	1012		?	
			1	4	Fluoranthene	1497		?	
			1	4	Indeno(1,2,3-cd)pyrene	300	J	=	
			1	4	Phenanthrene	120	J	=	
			1	4	Pyrene	1771		?	
		400038SA001	0.3	1	Benz(a)anthracene	70	J	?	
			0.3	1	Benzo(a)pyrene	80	J	?	
			0.3	1	Benzo(b)fluoranthene	70	J	?	
			0.3	1	Benzo(k)fluoranthene	60	J	?	
			0.3	1	Chrysene	80	J	?	
			0.3	1	Fluoranthene	150	J	?	
			0.3	1	Phenanthrene	70	J	?	
			0.3	1	Pyrene	120	J	?	
		400065SA015	8.5	12.5	Fluoranthene	1.2	J	?	
		400069SA015	13	17	N-Nitroso-di-n-propylamin	447	J	?	
		400138SA004	1	4	Fluoranthene	40	J	?	
			1	4	Pyrene	50	J	?	
		400139SA004	0	4	Anthracene	40	J	?	
			0	4	Benz(a)anthracene	240	J	?	

Table 4.19. SVOA and PCB compounds detected in Sector 4
UCRS soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
Soil	SVOA	400139SA004	0	4	Benzo(a)pyrene	250	J	?	
			0	4	Benzo(b)fluoranthene	250	J	?	
			0	4	Benzo(ghi)perylene	150	J	?	
			0	4	Benzo(k)fluoranthene	250	J	?	
			0	4	Chrysene	270	J	?	
			0	4	Di-n-octylphthalate	60	J	?	
			0	4	Fluoranthene	530	J	?	
			0	4	Indeno(1,2,3-cd)pyrene	140	J	?	
			0	4	Phenanthrene	250	J	?	
			0	4	Pyrene	430	J	?	
		400139SA012	8	12	Fluoranthene	70	J	?	
			8	12	Phenanthrene	60	J	?	
			8	12	Pyrene	50	J	?	
		400163SA004	0	4	Acenaphthene	50	J	?	
			0	4	Anthracene	210	J	?	
			0	4	Benz(a)anthracene	700	J	?	
			0	4	Benzo(a)pyrene	730	J	?	
			0	4	Benzo(b)fluoranthene	800		?	
			0	4	Benzo(ghi)perylene	260	J	?	
			0	4	Benzo(k)fluoranthene	680	J	?	
			0	4	Chrysene	710	J	?	

Table 4.19. SVOA and PCB compounds detected in Sector 4 UCRS soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
			Top	Bottom					
Soil	SVOA	400163SA004	0	4	Fluoranthene	1400		?	
			0	4	Fluorene	50	J	?	
			0	4	Indeno(1,2,3-cd)pyrene	260	J	?	
			0	4	Phenanthrene	640	J	?	
			0	4	Pyrene	1300		?	
		400201SA004	0	4	Benz(a)anthracene	110	J	?	
			0	4	Benzo(a)pyrene	150	J	?	
			0	4	Benzo(b)fluoranthene	140	J	?	
			0	4	Benzo(ghi)perylene	150	J	?	
			0	4	Benzo(k)fluoranthene	130	J	?	
			0	4	Chrysene	120	J	?	
			0	4	Fluoranthene	180	J	?	
			0	4	Indeno(1,2,3-cd)pyrene	130	J	?	
			0	4	Phenanthrene	40	J	?	
			0	4	Pyrene	190	J	?	
		400201SA020	16	20	Diethyl phthalate	4900		?	
		400201SA024	20	24	Diethyl phthalate	1400		?	
		400201SA028	24	28	Diethyl phthalate	1500		?	
		400201SA036	32	36	Diethyl phthalate	4400		?	
		400201SA040	36	40	Diethyl phthalate	5700		?	
		400201SA048	44	48	Diethyl phthalate	4400		?	

Table 4.19. SVOA and PCB compounds detected in Sector 4 UCRS soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
			Top	Bottom					
Soil	SVOA	400202SA004	0	4	Acenaphthene	330	J	?	
			0	4	Anthracene	610	J	?	
			0	4	Benz(a)anthracene	1400		?	
			0	4	Benzo(a)pyrene	1200		?	
			0	4	Benzo(b)fluoranthene	1400		?	
			0	4	Benzo(ghi)perylene	720	J	?	
			0	4	Benzo(k)fluoranthene	940		?	
			0	4	Chrysene	1500		?	
			0	4	Dibenzofuran	180	J	?	
			0	4	Fluoranthene	3500		?	
			0	4	Fluorene	200	J	?	
			0	4	Indeno(1,2,3-cd)pyrene	700	J	?	
			0	4	Naphthalene	100	J	?	
			0	4	Phenanthrene	2800		?	
			0	4	Pyrene	2700		?	
		400202SA008	4	8	Anthracene	60	J	?	
			4	8	Benz(a)anthracene	120	J	?	
			4	8	Benzo(a)pyrene	110	J	?	
			4	8	Benzo(b)fluoranthene	80	J	?	
			4	8	Benzo(ghi)perylene	86	J	?	
			4	8	Benzo(k)fluoranthene	90	J	?	

Table 4.19. SVOA and PCB compounds detected in Sector 4 UCRS soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
Soil	SVOA	400202SA008	4	8	Chrysene	120	J	?	
			4	8	Fluoranthene	300	J	?	
			4	8	Indeno(1,2,3-cd)pyrene	72	J	?	
			4	8	Phenanthrene	250	J	?	
			4	8	Pyrene	250	J	?	
		400202SA016	12	16	Anthracene	40	J	?	
			12	16	Benz(a)anthracene	80	J	?	
			12	16	Benzo(a)pyrene	70	J	?	
			12	16	Benzo(b)fluoranthene	60	J	?	
			12	16	Benzo(k)fluoranthene	70	J	?	
			12	16	Chrysene	80	J	?	
			12	16	Fluoranthene	200	J	?	
			12	16	Phenanthrene	160	J	?	
			12	16	Pyrene	160	J	?	
		400202SA024	20	24	Fluoranthene	50	J	?	
			20	24	Phenanthrene	50	J	?	
		400205SA004	0	4	Diethyl phthalate	2500		?	
		400205SA008	4	8	Diethyl phthalate	3400		?	
		400205SA012	8	12	Diethyl phthalate	6100		?	
		400205SA016	12	16	Diethyl phthalate	3600		?	
		400205SA044	40	44	Diethyl phthalate	50	J	?	

Table 4.19. SVOA and PCB compounds detected in Sector 4 UCRS soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
			Top	Bottom					
Soil	SVOA	400211SA004	0	4	Acenaphthene	140	J	?	
			0	4	Anthracene	290	J	?	
			0	4	Benz(a)anthracene	2300		?	
			0	4	Benzo(a)pyrene	2400		?	
			0	4	Benzo(b)fluoranthene	2900		?	
			0	4	Benzo(ghi)perylene	1000		?	
			0	4	Benzo(k)fluoranthene	1200		?	
			0	4	Chrysene	2600		?	
			0	4	Dibenz(a,h)anthracene	460	J	?	
			0	4	Dibenzofuran	40	J	?	
			0	4	Diethyl phthalate	50	J	?	
			0	4	Fluoranthene	4000		?	
			0	4	Fluorene	90	J	?	
			0	4	Indeno(1,2,3-cd)pyrene	1100		?	
			0	4	Phenanthrene	1500		?	
			0	4	Pyrene	3300		?	
		400211SA020	16	20	Diethyl phthalate	50	J	?	
		400211SA028	24	28	Diethyl phthalate	70	J	?	
		400211SA036	32	36	Diethyl phthalate	60	J	?	
		400211SA048	44	48	Diethyl phthalate	60	J	?	
		400211SD032	28	32	Diethyl phthalate	150	J	?	

Table 4.19. SVOA and PCB compounds detected in Sector 4
UCRS soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
			Top	Bottom					
Soil	PPCB	400038SA001	0.3	1	PCB-1262	38		?	
		400200SA005	1	5	PCB-1254	730		=	

Note: Soil boring samples not containing any detectable SVOA compounds in Sector 4 are:

011003SA012, 011003SA028, 011003SA032, 011003SA036, 011003SA044, 011004SA008, 011004SA012, 011004SA016, 011004SA020, 011004SA024, 011004SA028, 011004SA032, 011004SA036, 011004SA040, 011004SA044, 011004SA048, 011004SA052, 011005SA024, 011005SA028, 011005SA030, 011005SA040, 011005SA044, 011005SA048, 011005SA052, 011006SA008, 011006SA016, 011006SA020, 011006SA024, 011006SA028, 011006SA032, 011006SA036, 011006SA040, 011006SA044, 011006SA048, 011007SA025, 011007SA037, 011008SA015, 400014SA012, 400014SA016, 400014SA020, 400014SA024, 400014SA028, 400014SA032, 400014SA036, 400014SA040, 400014SA044, 400014SA048, 400014SA052, 400016SA005, 400016SA010, 400016SA015, 400016SA020, 400016SA030, 400016SD005, 400037SA001, 400037SA015, 400066SA015, 400067SA015, 400068SA015, 400070SA015, 400091SA015, 400092SA015, 400101SA015, 400103SA015, 400104SA015, 400105SA015, 400116SA015, 400117SA015, 400134SA015, 400138SA008, 400138SA012, 400138SA016, 400138SA020, 400139SA008, 400139SA016, 400139SA020, 400163SA008, 400163SA012, 400163SA016, 400163SA020, 400163SA024, 400200SA005, 400200SA009, 400200SA013, 400200SA017, 400200SA021, 400200SA029, 400201SA008, 400201SA012, 400201SA016, 400201SA032, 400201SA044, 400202SA012, 400202SA020, 400202SA028, 400205SA020, 400205SA024, 400205SA028, 400205SA036, 400205SA040, 400205SA048, 400207SA030, 400207SD030, 400211SA012, 400211SA016, 400211SA024, 400211SA032, 400211SA040, 400211SA044, 400211SD048

Soil boring samples not containing any detectable PCB compounds in Sector 4 are:

011008SA015, 400016SA001, 400016SA005, 400016SA030, 400016SD005, 400066SA015, 400067SA015, 400068SA015, 400069SA015, 400091SA015, 400092SA015, 400101SA015, 400103SA015, 400104SA015, 400105SA015, 400200SA009, 400200SA013, 400200SA017, 400200SA021, 400200SA029, 400205SA020

Table 4.20. Metals detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	011003SA012	8	11	Antimony	0.8	B	?		0.21
		8	11	Beryllium	0.81		?		0.69
		8	11	Manganese	828		?		820
		8	11	Sodium	476		?		340
	011003SA016	13.5	17	Sodium	744		?		340
	011003SA020	17	20	Antimony	1.4	B	?		0.21
		17	20	Sodium	606		?		340
	011003SA024	20	24	Sodium	457		?		340
	011003SA032	28	32	Beryllium	0.85		?		0.69
	011003SA040	36	40	Sodium	425		?		340
	011003SA044	40	44	Sodium	354		?		340
	011003SA048	44	48	Sodium	571		?		340
	011004SA004	0	4	Antimony	0.6	B	?		0.21
		0	4	Calcium	7720		?		6100
		0	4	Sodium	695		?		340
	011004SA008	4	8	Aluminum	14000		?		12000
		4	8	Sodium	409		?		340
	011004SA012	8	12	Aluminum	14300		?		12000
		8	12	Sodium	712		?		340
	011004SA016	12	16	Aluminum	17200		?		12000
		12	16	Sodium	673		?		340

Table 4.20. Metals detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	011004SA020	16	20	Aluminum	17000		?		12000
		16	20	Sodium	663		?		340
	011004SA024	20	23.5	Antimony	1.2	B	?		0.21
		20	23.5	Sodium	359		?		340
	011004SA028	23.5	27	Sodium	491		?		340
	011004SA032	27	30.5	Antimony	0.6	B	?		0.21
		27	30.5	Arsenic	10.9		?		7.9
		27	30.5	Beryllium	1.06		?		0.69
		27	30.5	Sodium	666		?		340
	011004SA036	30.5	34	Antimony	0.6	B	?		0.21
		30.5	34	Sodium	516		?		340
	011004SA040	34	37.5	Sodium	389		?		340
	011004SA044	37.5	41	Aluminum	14100		?		12000
		37.5	41	Sodium	492		?		340
	011004SA048	41	44.5	Calcium	11200		?		6100
	011004SA052	44.5	48	Sodium	522		?		340
	011005SA008	4	8	Aluminum	12800		?		12000
		4	8	Calcium	11100		?		6100
		4	8	Sodium	553		?		340
	011005SA024	20	24	Sodium	452		?		340
	011005SA028	24	28	Sodium	515		?		340

Table 4.20. Metals detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	011005SA030	28	31.5	Antimony	0.8	B	?		0.21
		28	31.5	Beryllium	0.72		?		0.69
		28	31.5	Sodium	362		?		340
	011005SA044	38.5	41.5	Antimony	0.6	B	?		0.21
		38.5	41.5	Beryllium	0.85		?		0.69
	011006SA004	0	4	Aluminum	17100		?		12000
		0	4	Arsenic	9.93		?		7.9
		0	4	Sodium	629		?		340
	011006SA008	4	8	Aluminum	13500		?		12000
		4	8	Sodium	793		?		340
	011006SA012	8	12	Aluminum	12400		?		12000
		8	12	Magnesium	2150		?		2100
		8	12	Sodium	806		?		340
	011006SA016	12	16	Aluminum	13200		?		12000
		12	16	Sodium	751		?		340
		12	16	Thallium	0.7	B	?		0.34
	011006SA020	16	20	Aluminum	13300		?		12000
		16	20	Sodium	663		?		340
	011006SA024	20	24	Aluminum	12300		?		12000
		20	24	Antimony	0.8	B	?		0.21
		20	24	Sodium	625		?		340

Table 4.20. Metals detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	011006SA028	24	28	Aluminum	12100		?		12000
		24	28	Sodium	573		?		340
	011006SA032	28	32	Sodium	341		?		340
	011006SA036	32	36	Sodium	413		?		340
	011006SA040	36	40	Cobalt	126		?		13
		36	40	Lead	82.5		?		23
		36	40	Sodium	415		?		340
	011006SA044	40	44	Sodium	351		?		340
	011006SA048	44	48	Antimony	1	B	?		0.21
		44	48	Beryllium	0.85		?		0.69
		44	48	Sodium	608		?		340
		44	48	Vanadium	38.9		?		37
	011007SA025	24	28	Sodium	469		?		340
	011007SA037	36	40	Sodium	374		?		340
	011008SA015	13	17	Aluminum	19300		?		12000
		13	17	Sodium	471		?		340
	400014SA004	0	4	Calcium	13400		?		6100
		0	4	Mercury	0.149		?		0.13
		0	4	Sodium	678		?		340
	400014SA008	4	8	Sodium	429		?		340
	400014SA012	8	12	Aluminum	12600		?		12000

Table 4.20. Metals detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	400014SA012	8	12	Magnesium	2410		?		2100
		8	12	Sodium	420		?		340
	400014SA016	12	16	Sodium	379		?		340
	400014SA020	16	20	Sodium	357		?		340
	400014SA024	20	24	Sodium	571		?		340
	400014SA032	27.5	31	Antimony	1.1	B	?		0.21
		27.5	31	Beryllium	1.11		?		0.69
	400014SA052	45	49	Antimony	1	B	?		0.21
		45	49	Beryllium	1		?		0.69
	400016SA001	1	4	Antimony	0.8	B	=		0.21
		1	4	Cobalt	19.6		=		14
		1	4	Magnesium	27200		=		7700
	400016SA005	5	8	Aluminum	12200		=		12000
		5	8	Antimony	1.3	B	=		0.21
		5	8	Beryllium	0.77		=		0.69
		5	8	Sodium	389		=		340
	400016SA010	8	12	Aluminum	14500		=		12000
		8	12	Antimony	1.6	B	=		0.21
		8	12	Barium	185		=		170
		8	12	Beryllium	0.94		=		0.69
		8	12	Magnesium	2460		=		2100

Table 4.20. Metals detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	400016SA010	8	12	Sodium	487		=		340
	400016SA015	16	20	Cobalt	16.1		?		13
		16	20	Manganese	975		?		820
		16	20	Sodium	347		?		340
	400016SA020	20	24	Sodium	352		?		340
	400016SA030	30	34	Antimony	1.1	B	=		0.21
		30	34	Beryllium	0.75		=		0.69
	400016SD005	5	8	Aluminum	15700		=		12000
		5	8	Antimony	1.5	B	=		0.21
		5	8	Sodium	467		=		340
	400037SA001	1.2	1.7	Antimony	1	B	?		0.21
		1.2	1.7	Cadmium	0.37	B	?		0.21
		1.2	1.7	Calcium	279000		?		200000
		1.2	1.7	Magnesium	25200		?		7700
		1.2	1.7	Sodium	403		?		320
	400037SA015	6	10	Calcium	16600		?		6100
		6	10	Magnesium	2200		?		2100
		6	10	Sodium	526		?		340
	400038SA001	0.3	1	Aluminum	14200		?		13000
		0.3	1	Antimony	0.6	B	?		0.21
		0.3	1	Cadmium	0.35	B	?		0.21

Table 4.20. Metals detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	400038SA001	0.3	1	Chromium	23.6		?		16
		0.3	1	Sodium	400		?		320
	400038SA030	30	30	Sodium	342		?		340
	400065SA015	8.5	12.5	Aluminum	13300		?		12000
		8.5	12.5	Beryllium	0.72		?		0.69
		8.5	12.5	Cadmium	0.28	B	?		0.21
		8.5	12.5	Calcium	29400		?		6100
		8.5	12.5	Magnesium	2190		?		2100
		8.5	12.5	Sodium	537		?		340
		8.5	12.5	Vanadium	37.1		?		37
	400066SA015	13	17	Aluminum	20300		=		12000
		13	17	Antimony	0.6	B	=		0.21
		13	17	Thallium	0.9	B	=		0.34
	400067SA015	8	12	Sodium	405		?		340
	400068SA015	13	17	Aluminum	14500		=		12000
		13	17	Antimony	0.8	B	=		0.21
		13	17	Cobalt	14.2		=		13
	400069SA015	13	17	Aluminum	16600		=		12000
		13	17	Antimony	1.4	B	=		0.21
		13	17	Sodium	341		=		340
		13	17	Thallium	0.6	B	=		0.34

Table 4.20. Metals detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	400069SA015	13	17	Vanadium	38.3		=		37
	400070SA015	14	18	Sodium	405		?		340
	400091SA015	8	12	Aluminum	14700		?		12000
		8	12	Arsenic	8.24		?		7.9
		8	12	Barium	176		?		170
		8	12	Beryllium	0.84		?		0.69
		8	12	Cadmium	0.26	B	?		0.21
		8	12	Magnesium	2680		?		2100
		8	12	Nickel	23.1		?		22
		8	12	Sodium	532		?		340
	400092SA015	16	20	Aluminum	18200		?		12000
		16	20	Sodium	570		?		340
	400101SA015	7	11	Aluminum	14900		=		12000
		7	11	Sodium	442		=		340
	400103SA015	9	13	Beryllium	0.85		?		0.69
		9	13	Cadmium	0.33	B	?		0.21
		9	13	Sodium	406		?		340
		9	13	Vanadium	51.6		?		37
	400104SA015	15	19	Aluminum	13500		=		12000
		15	19	Antimony	0.7	B	=		0.21
		15	19	Sodium	454		=		340

Table 4.20. Metals detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
Soil	400105SA015	7	11	Antimony	3.8	B	?		0.21
		7	11	Barium	209		?		170
		7	11	Beryllium	0.8		?		0.69
		7	11	Cadmium	0.23	B	?		0.21
		7	11	Sodium	341		?		340
	400116SA015	8	12	Barium	279		?		170
		8	12	Beryllium	0.89		?		0.69
		8	12	Manganese	1020		?		820
		8	12	Sodium	451		?		340
	400117SA015	7	11	Aluminum	16900		?		12000
		7	11	Barium	216		?		170
		7	11	Magnesium	2690		?		2100
		7	11	Nickel	23.3		?		22
		7	11	Sodium	458		?		340
	400134SA015	12	16	Aluminum	13400		?		12000
		12	16	Sodium	489		?		340
	400138SA008	4	8	Aluminum	13000		?		12000
		4	8	Antimony	1.6	B	?		0.21
		4	8	Arsenic	8.89		?		7.9
		4	8	Beryllium	0.91		?		0.69
		4	8	Lead	24.5		?		23

Table 4.20. Metals detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	400138SA008	4	8	Sodium	703		?		340
	400138SA012	8	12	Sodium	698		?		340
	400138SA016	12	16	Aluminum	12400		?		12000
		12	16	Antimony	0.8	B	?		0.21
		12	16	Sodium	688		?		340
	400138SA020	16	20	Sodium	442		?		340
	400139SA004	0	4	Antimony	1.4	B	?		0.21
		0	4	Cadmium	0.59		?		0.21
		0	4	Calcium	333000		?		6100
		0	4	Magnesium	5200		?		2100
		0	4	Nickel	22.7		?		22
		0	4	Sodium	506		?		340
		0	4	Zinc	65.2		?		60
	400139SA008	4	8	Sodium	638		?		340
		4	8	Thallium	1.1	B	?		0.34
	400139SA012	8	12	Cadmium	0.24	B	?		0.21
		8	12	Sodium	661		?		340
	400139SA016	12	16	Sodium	749		?		340
	400139SA020	16	20	Sodium	667		?		340
	400163SA004	0	4	Antimony	4.2	B	?		0.21
		0	4	Cadmium	0.46	B	?		0.21

Table 4.20. Metals detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	400163SA004	0	4	Calcium	196000		?		6100
		0	4	Magnesium	10100		?		2100
		0	4	Sodium	492		?		340
	400163SA008	4	8	Aluminum	13000		?		12000
		4	8	Arsenic	14.8		?		7.9
		4	8	Beryllium	0.73		?		0.69
		4	8	Sodium	674		?		340
	400163SA012	8	12	Aluminum	17400		?		12000
		8	12	Barium	177		?		170
		8	12	Beryllium	1		?		0.69
		8	12	Iron	30100		?		28000
		8	12	Magnesium	2760		?		2100
		8	12	Sodium	993		?		340
		8	12	Vanadium	38.5		?		37
	400163SA016	12	16	Sodium	697		?		340
	400163SA020	16	20	Aluminum	15500		?		12000
		16	20	Sodium	710		?		340
	400163SA024	21	25	Sodium	454		?		340
	400200SA005	1	5	Antimony	1.7	B	=		0.21
		1	5	Calcium	14100		=		6100
		1	5	Lead	23.4		=		23

Table 4.20. Metals detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	400200SA005	1	5	Thallium	1.1	B	=		0.34
	400200SA009	5	9	Aluminum	14800		=		12000
		5	9	Antimony	0.7	B	=		0.21
		5	9	Sodium	355		=		340
	400200SA013	9	13	Aluminum	13400		=		12000
		9	13	Antimony	1	B	=		0.21
		9	13	Magnesium	2300		=		2100
		9	13	Sodium	367		=		340
	400200SA017	13	17	Antimony	0.7	B	=		0.21
		13	17	Sodium	407		=		340
	400200SA021	17	21	Antimony	1	B	=		0.21
		17	21	Sodium	404		=		340
	400200SA029	25	29	Antimony	0.9	B	=		0.21
		25	29	Thallium	0.6	B	=		0.34
	400201SA004	0	4	Calcium	51700		?		6100
		0	4	Magnesium	2650		?		2100
	400201SA008	4	8	Aluminum	14800		?		12000
		4	8	Arsenic	10.6		?		7.9
		4	8	Beryllium	0.77		?		0.69
		4	8	Calcium	6210		?		6100
		4	8	Magnesium	2370		?		2100

Table 4.20. Metals detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	400201SA008	4	8	Sodium	445		?		340
	400201SA012	8	12	Magnesium	2170		?		2100
		8	12	Sodium	456		?		340
	400201SA016	12	16	Sodium	415		?		340
	400201SA020	16	20	Sodium	655		?		340
	400201SA024	20	24	Sodium	559		?		340
	400201SA028	24	28	Sodium	632		?		340
	400201SA036	32	36	Sodium	423		?		340
	400201SA040	36	40	Sodium	359		?		340
	400201SA048	44	48	Sodium	378		?		340
	400202SA004	0	4	Antimony	1.2	B	?		0.21
		0	4	Calcium	11900		?		6100
		0	4	Sodium	456		?		340
	400202SA008	4	8	Arsenic	11.7		?		7.9
		4	8	Sodium	508		?		340
	400202SA012	8	12	Aluminum	14600		?		12000
		8	12	Beryllium	0.91		?		0.69
		8	12	Chromium	51.6		?		43
		8	12	Iron	31200		?		28000
		8	12	Magnesium	2280		?		2100
		8	12	Sodium	1000		?		340

Table 4.20. Metals detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	400202SA012	8	12	Vanadium	55		?		37
	400202SA016	12	16	Aluminum	15300		?		12000
		12	16	Sodium	725		?		340
	400202SA020	16	20	Sodium	474		?		340
		16	20	Thallium	0.6	B	?		0.34
	400202SA024	20	24	Sodium	591		?		340
	400202SA028	24	28	Beryllium	0.98		?		0.69
		24	28	Sodium	639		?		340
		24	28	Vanadium	37.7		?		37
	400205SA004	0	4	Calcium	25500		?		6100
		0	4	Magnesium	2180		?		2100
		0	4	Sodium	448		?		340
	400205SA008	4	8	Aluminum	15100		?		12000
		4	8	Beryllium	0.98		?		0.69
		4	8	Magnesium	2690		?		2100
		4	8	Sodium	937		?		340
	400205SA012	8	12	Aluminum	12200		?		12000
		8	12	Sodium	948		?		340
	400205SA016	12	16	Antimony	0.8	B	?		0.21
		12	16	Sodium	730		?		340
	400207SA030	28	30	Sodium	429		?		340

Table 4.20. Metals detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	400207SD030	28	30	Sodium	374		?		340
	400211SA004	0	4	Cadmium	0.23	B	?		0.21
		0	4	Calcium	55300		?		6100
	400211SA008	4	8	Antimony	0.7	B	?		0.21
		4	8	Calcium	11600		?		6100
		4	8	Magnesium	2140		?		2100
		4	8	Sodium	448		?		340

Note: Soil boring samples not containing any detectable metals at concentrations above background in Sector 4 are:

011003SA028, 011003SA036, 011005SA036, 011005SA040, 011005SA048, 011005SA052, 400014SA028, 400014SA036, 400014SA040, 400014SA044, 400014SA048, 400201SA032, 400201SA044

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Table 4.21. Radioactive isotopes detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/g	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/g
		Top	Bottom						
Soil	011003SA004	0	4	Cesium-137	0.4		?		0.28
	011003SA016	13.5	17	Cesium-137	0.3		?		0.28
	011003SA036	32	36	Cesium-137	0.3		?		0.28
	011003SA040	36	40	Neptunium-237	0.2		?		0
	011003SA048	44	48	Americium-241	0.2		?		0
		44	48	Neptunium-237	0.3		?		0
	011004SA004	0	4	Neptunium-237	0.2		?		0
		0	4	Uranium-238	2.9		?		1.2
	011004SA008	4	8	Cesium-137	0.4		?		0.28
		4	8	Neptunium-237	0.2		?		0
	011004SA016	12	16	Neptunium-237	0.3		?		0
	011004SA020	16	20	Neptunium-237	0.3		?		0
	011004SA028	23.5	27	Neptunium-237	0.4		?		0
	011004SA032	27	30.5	Neptunium-237	0.3		?		0
	011004SA040	34	37.5	Neptunium-237	0.3		?		0
	011004SA048	41	44.5	Cesium-137	0.4		?		0.28
	011005SA008	4	8	Neptunium-237	0.2		?		0
		4	8	Thorium-230	1.6		?		1.4
		4	8	Uranium-234	3.5		?		2.4
		4	8	Uranium-238	4.3		?		1.2
	011005SA024	20	24	Neptunium-237	0.5		?		0

Table 4.21. Radioactive isotopes detected in Sector 4 UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/g	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/g
		Top	Bottom						
Soil	011005SA028	24	28	Neptunium-237	0.3		?		0
	011005SA044	38.5	41.5	Cesium-137	0.3		?		0.28
		38.5	41.5	Neptunium-237	0.2		?		0
	011005SA048	41.5	45	Cesium-137	0.3		?		0.28
		41.5	45	Neptunium-237	0.4		?		0
	011005SA052	45	48.5	Neptunium-237	0.3		?		0
	011006SA004	0	4	Americium-241	0.2		?		0
	011006SA008	4	8	Neptunium-237	0.3		?		0
	011006SA012	8	12	Neptunium-237	0.3		?		0
	011006SA016	12	16	Neptunium-237	0.5		?		0
	011006SA024	20	24	Neptunium-237	0.4		?		0
	011006SA028	24	28	Neptunium-237	0.4		?		0
	011006SA032	28	32	Neptunium-237	0.3		?		0
		28	32	Uranium-238	1.4		?		1.2
	011006SA036	32	36	Neptunium-237	0.4		?		0
	011006SA044	40	44	Americium-241	0.5		?		0
		40	44	Neptunium-237	0.2		?		0
	011006SA048	44	48	Neptunium-237	0.2		?		0
	011007SA025	24	28	Neptunium-237	0.3		?		0
	011007SA037	36	40	Neptunium-237	0.2		?		0
	400014SA004	0	4	Neptunium-237	0.3		?		0

Table 4.21. Radioactive isotopes detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/g	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/g
		Top	Bottom						
Soil	400014SA004	0	4	Uranium-238	2.4		?		1.2
	400014SA008	4	8	Cesium-137	0.6		?		0.28
		4	8	Neptunium-237	0.4		?		0
	400014SA012	8	12	Neptunium-237	0.3		?		0
	400014SA016	12	16	Neptunium-237	0.3		?		0
	400014SA020	16	20	Cesium-137	0.3		?		0.28
	400014SA024	20	24	Neptunium-237	0.3		?		0
	400014SA044	38	41.5	Americium-241	0.2		?		0
	400014SA048	41.5	45	Cesium-137	0.3		?		0.28
		41.5	45	Plutonium-239	0.2		?		0
	400016SA001	1	4	Americium-241	0.2		=		0
		1	4	Neptunium-237	0.3		=		0.1
		1	4	Plutonium-239	0.2		=		0.025
	400016SA030	30	34	Americium-241	0.2		=		0
		30	34	Thorium-230	1.5		=		1.4
	400016SD005	5	8	Americium-241	0.2		=		0
		5	8	Neptunium-237	0.3		=		0
		5	8	Plutonium-239	0.2		=		0
	400066SA015	13	17	Cesium-137	0.5		=		0.28
	400092SA015	16	20	Neptunium-237	0.2		?		0
		16	20	Thorium-230	1.8		?		1.4

Table 4.21. Radioactive isotopes detected in Sector 4
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/g	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/g
		Top	Bottom						
Soil	400103SA015	9	13	Americium-241	0.2		?		0
		9	13	Neptunium-237	0.2		?		0
	400105SA015	7	11	Thorium-230	1.5		?		1.4
	400138SA004	1	4	Neptunium-237	0.3		?		0
		1	4	Uranium-238	1.3		?		1.2
	400138SA008	4	8	Neptunium-237	0.2		?		0
	400138SA012	8	12	Neptunium-237	0.3		?		0
	400138SA016	12	16	Neptunium-237	0.3		?		0
	400138SA020	16	20	Neptunium-237	0.2		?		0
	400139SA008	4	8	Neptunium-237	0.4		?		0
	400139SA012	8	12	Neptunium-237	0.2		?		0
	400139SA016	12	16	Neptunium-237	0.2		?		0
		12	16	Thorium-230	1.5		?		1.4
	400163SA004	0	4	Neptunium-237	0.6		?		0
		0	4	Technetium-99	3		?		2.8
		0	4	Uranium-238	2.8		?		1.2
	400163SA008	4	8	Neptunium-237	0.4		?		0
	400163SA012	8	12	Neptunium-237	0.5		?		0
	400163SA016	12	16	Neptunium-237	0.2		?		0
	400163SA020	16	20	Cesium-137	0.5		?		0.28
		16	20	Neptunium-237	0.2		?		0

Table 4.25. Metals detected in Sector 5
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	400041SA001	0	1	Thallium	0.9	B	=		0.21
	400041SA005	5	5	Antimony	0.8	B	?		0.21
		5	5	Sodium	521		?		340
	400041SA013	13	13	Aluminum	12100		?		12000
		13	13	Sodium	639		?		340
	400041SA030	29.9	29.9	Beryllium	0.85		?		0.69
		29.9	29.9	Sodium	708		?		340
	400045SA001	0	1	Antimony	1.1	B	?		0.21
		0	1	Cadmium	0.78		?		0.21
		0	1	Calcium	277000		?		200000
		0	1	Copper	20.7		?		19
		0	1	Magnesium	10800		?		7700
		0	1	Nickel	23.5		?		21
		0	1	Zinc	111		?		65
	400045SA015	6	10	Aluminum	13200		?		12000
		6	10	Beryllium	0.88		?		0.69
		6	10	Cadmium	0.26	B	?		0.21
		6	10	Magnesium	2770		?		2100
		6	10	Nickel	22.8		?		22
		6	10	Sodium	558		?		340
	400072SA015	13	17	Sodium	364		?		340

Table 4.25. Metals detected in Sector 5
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	400073SA015	13	17	Aluminum	12200		?		12000
		13	17	Sodium	395		?		340
	400074SA015	14	18	Aluminum	16500		?		12000
		14	18	Sodium	651		?		340
	400085SA015	13.5	17.5	Sodium	359		=		340
	400087SA015	4	8	Antimony	0.7	B	?		0.21
		4	8	Beryllium	1.02		?		0.69
		4	8	Cadmium	0.37	B	?		0.21
		4	8	Iron	29000		?		28000
		4	8	Sodium	493		?		340
		4	8	Vanadium	38.7		?		37
	400088SA015	6	10	Arsenic	25.8		?		7.9
		6	10	Beryllium	0.77		?		0.69
		6	10	Cadmium	0.25	B	?		0.21
		6	10	Sodium	371		?		340
	400089SA015	6	10	Beryllium	0.8	B	?		0.69
		6	10	Sodium	360	B	?		340
	400106SA015	13	17	Aluminum	14800		?		12000
		13	17	Sodium	462		?		340
	400107SA015	6	10	Arsenic	8.6		?		7.9
		6	10	Sodium	388		?		340

Table 4.25. Metals detected in Sector 5
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	400113SA015	13	14	Sodium	382		?		340
	400114SA015	6	10	Beryllium	0.72		?		0.69
		6	10	Magnesium	2520		?		2100
		6	10	Sodium	522		?		340
	400115SA015	14	18	Aluminum	13000		?		12000
		14	18	Sodium	429		?		340
	400141SA004	0	4	Sodium	582		?		340
	400141SA008	4	8	Antimony	1.5	B	?		0.21
		4	8	Arsenic	16		?		7.9
		4	8	Sodium	509		?		340
	400141SA012	8	12	Aluminum	12400		?		12000
		8	12	Barium	195		?		170
		8	12	Magnesium	2800		?		2100
		8	12	Sodium	661		?		340
	400142SA015	7	11	Magnesium	2370		?		2100
		7	11	Sodium	467		?		340
	400145SA008	4	8	Antimony	1	B	?		0.21
		4	8	Sodium	522		?		340
	400145SA012	8	12	Aluminum	14900		?		12000
		8	12	Barium	193		?		170
		8	12	Magnesium	2220		?		2100

Table 4.25. Metals detected in Sector 5
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	400145SA012	8	12	Sodium	605		?		340
		8	12	Thallium	0.6	B	?		0.34
	400145SA020	16	20	Sodium	524		?		340
		16	20	Thallium	1.6		?		0.34
	400145SA024	20	24	Sodium	378		?		340
	400145SA028	24	28	Aluminum	14700		?		12000
		24	28	Beryllium	0.94		?		0.69
		24	28	Sodium	598		?		340
		24	28	Thallium	0.7	B	?		0.34
	400145SA032	28	32	Sodium	485		?		340
		28	32	Thallium	0.8	B	?		0.34
	400145SA036	32	34	Sodium	400		?		340
	400145SA044	40	44	Beryllium	1.01		?		0.69
		40	44	Sodium	683		?		340
		40	44	Vanadium	59.5		?		37
	400146SA018	15	19	Sodium	433		?		340
	400159SA018	14	18	Sodium	644		?		340
	400172SA015	6	10	Aluminum	19600		?		12000
		6	10	Arsenic	12.5		?		7.9
		6	10	Sodium	684		?		340
	400192SA008	4	8	Aluminum	17100		?		12000

Table 4.25. Metals detected in Sector 5
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
Soil	400192SA008	4	8	Antimony	0.7	B	?		0.21
		4	8	Beryllium	0.87		?		0.69
		4	8	Magnesium	2270		?		2100
		4	8	Silver	25.1		?		2.7
		4	8	Sodium	858		?		340
	400192SA012	8	12	Aluminum	12100		?		12000
		8	12	Antimony	2.1	B	?		0.21
		8	12	Magnesium	2320		?		2100
		8	12	Sodium	738		?		340
	400194SA004	0	4	Sodium	671		?		340
	400194SA008	4	8	Sodium	645		?		340
	400204SA004	0	4	Antimony	1.2	B	?		0.21
		0	4	Cadmium	0.27	B	?		0.21
		0	4	Calcium	144000		?		6100
		0	4	Magnesium	4070		?		2100
	400204SA008	4	8	Beryllium	1.05		?		0.69
		4	8	Magnesium	2650		?		2100
		4	8	Sodium	630		?		340

Note: Soil boring samples not containing any detectable metals at concentrations above background in Sector 5 are:
400009SA030, 400010SA040, 400015SA040, 400036SA034, 400145SA016, 400145SA040

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Table 4.26. Radioactive isotopes detected in Sector 5 UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/g	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/g
		Top	Bottom						
Soil	400009SA001	0	1.5	Thorium-230	1.6		?		1.5
	400009SA033	31	34.5	Cesium-137	0.4		?		0.28
	400010SA001	0	1	Neptunium-237	0.3		?		0.1
		0	1	Thorium-230	2.2		?		1.5
		0	1	Uranium-238	2.5		?		1.2
	400010SA044	43.5	47	Neptunium-237	0.4		?		0
	400015SA040	39.5	43	Neptunium-237	0.2		?		0
	400036SA001	0	1	Plutonium-239	0.2		=		0.025
		0	1	Technetium-99	33		=		2.5
		0	1	Uranium-234	10.9		=		2.5
		0	1	Uranium-235	0.6		=		0.14
		0	1	Uranium-238	16.7		=		1.2
	400036SA014	14	14	Neptunium-237	0.2		?		0
	400041SA001	0	1	Uranium-238	1.8		=		1.2
	400041SA013	13	13	Cesium-137	0.3		?		0.28
		13	13	Neptunium-237	0.3		?		0
	400041SA030	29.9	29.9	Neptunium-237	0.2		?		0
	400041SA046	46	46	Neptunium-237	0.2		?		0
	400087SA015	4	8	Neptunium-237	0.2		?		0
		4	8	Thorium-230	1.6		?		1.4
	400088SA015	6	10	Neptunium-237	0.2		?		0

Table 4.26. Radioactive isotopes detected in Sector 5
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/g	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/g
		Top	Bottom						
Soil	400088SA015	6	10	Thorium-230	2		?		1.4
	400107SA015	6	10	Americium-241	1		?		0
		6	10	Neptunium-237	0.2		?		0
	400141SA004	0	4	Technetium-99	7.3		?		2.8
		0	4	Uranium-234	2.7		?		2.4
		0	4	Uranium-235	0.4		?		0.14
		0	4	Uranium-238	4.6		?		1.2
	400141SA012	8	12	Cesium-137	0.4		?		0.28
		8	12	Neptunium-237	0.3		?		0
	400141SA016	12	16	Neptunium-237	0.2		?		0
	400141SA020	16	20	Cesium-137	0.3		?		0.28
	400141SA028	24	28	Cesium-137	0.3		?		0.28
		24	28	Uranium-235	0.2		?		0.14
	400141SA032	28	32	Neptunium-237	0.2		?		0
	400141SA036	32	36	Cesium-137	0.3		?		0.28
	400141SA040	36	40	Cesium-137	0.3		?		0.28
		36	40	Neptunium-237	0.2		?		0
	400141SA048	44	48	Cesium-137	0.3		?		0.28
	400145SA008	4	8	Neptunium-237	0.4		?		0
		4	8	Uranium-238	1.4		?		1.2
	400145SA012	8	12	Neptunium-237	0.3		?		0

Table 4.26. Radioactive isotopes detected in Sector 5
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/g	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/g
		Top	Bottom						
Soil	400145SA012	8	12	Thorium-230	1.7		?		1.4
	400145SA016	12	16	Cesium-137	0.4		?		0.28
	400145SA020	16	20	Neptunium-237	0.3		?		0
		16	20	Thorium-230	2		?		1.4
	400145SA032	28	32	Neptunium-237	0.2		?		0
	400145SA040	36	40	Cesium-137	0.3		?		0.28
		36	40	Neptunium-237	0.3		?		0
	400145SA044	40	44	Neptunium-237	0.2		?		0
	400146SA018	15	19	Cesium-137	0.5		?		0.28
		15	19	Neptunium-237	0.3		?		0
	400192SA012	8	12	Cesium-137	0.4		?		0.28
		8	12	Neptunium-237	0.3		?		0
	400192SA020	16	20	Technetium-99	3.1		?		2.8
	400192SA024	20	24	Cesium-137	0.4		?		0.28
	400192SA028	24	28	Cesium-137	0.6		?		0.28
		24	28	Neptunium-237	0.2		?		0
	400192SA032	28	32	Neptunium-237	0.2		?		0
	400192SA036	32	36	Neptunium-237	0.3		?		0
	400192SA040	36	40	Cesium-137	0.3		?		0.28
		36	40	Neptunium-237	0.2		?		0
	400192SA044	40	44	Cesium-137	0.4		?		0.28

Table 4.26. Radioactive isotopes detected in Sector 5
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results pCi/g	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/g
Soil	400192SA044	40	44	Neptunium-237	0.2		?		0
	400194SA008	4	8	Neptunium-237	0.2		?		0
	400194SA024	20	24	Neptunium-237	0.2		?		0
	400194SA044	40	44	Neptunium-237	0.3		?		0
	400204SA004	0	4	Cesium-137	0.3		?		0.28
		0	4	Thorium-230	1.5		?		1.4
	400204SA008	4	8	Cesium-137	0.4		?		0.28
	400204SA032	28	32	Cesium-137	0.4		?		0.28

Note: Soil boring samples not containing any detectable radioactive isotopes at concentrations above background in Sector 5 are:

400041SA005, 400041SA039, 400085SA015, 400141SA008, 400141SA024, 400141SA044, 400145SA024, 400145SA028, 400145SA036, 400192SA008, 400192SA016, 400192SA048, 400194SA004, 400194SA012, 400194SA016, 400194SA020, 400194SA028, 400194SA032, 400194SA036, 400194SA040, 400204SA012, 400204SA016, 400204SA020, 400204SA024, 400204SA028, 400204SA036, 400204SA040

Table 4.27. Frequency of detection of organic compounds, metals, and radioactive isotopes in Sector 5 UCRS soil

Analytical Group	Analytical Compound	No. of Detects	No. of Analyses	Maximum Result	Minimum Result	Average Result	Units
VOA	cis-1,2-Dichloroethene	25	107	1000.00	1.41	165.68	ug/kg
	Trichloroethene	22	106	168200.00	1.45	9436.49	ug/kg
	Toluene	18	81	5.50	1.20	2.19	ug/kg
	trans-1,2-Dichloroethene	9	107	15300.00	2.20	7933.46	ug/kg
	Vinyl chloride	6	107	35.00	1.90	12.55	ug/kg
	Chloroform	4	81	5.60	1.90	2.98	ug/kg
	1,1,2-Trichloroethane	1	81	3.90	3.90	3.90	ug/kg
	2-Hexanone	1	81	4.40	4.40	4.40	ug/kg
	Carbon tetrachloride	1	81	13.00	13.00	13.00	ug/kg
	Iodomethane	1	81	700.00	700.00	700.00	ug/kg
	Vinyl acetate	1	81	55.00	55.00	55.00	ug/kg
SVOA	Fluoranthene	10	92	30000.00	40.00	4671.00	ug/kg
	Pyrene	10	92	26000.00	40.00	3902.95	ug/kg
	Benz(a)anthracene	9	92	14000.00	21.00	2402.44	ug/kg
	Benzo(b)fluoranthene	9	92	14000.00	18.00	2683.72	ug/kg
	Benzo(k)fluoranthene	9	92	8751.00	16.00	2153.28	ug/kg
	Chrysene	9	92	12000.00	22.00	2374.67	ug/kg
	Diethyl phthalate	9	92	5000.00	40.00	606.67	ug/kg
	Benzo(a)pyrene	8	92	13000.00	19.00	2750.88	ug/kg
	Benzo(ghi)perylene	8	92	6100.00	12.00	1692.88	ug/kg
	Phenanthrene	8	92	16000.00	46.00	3113.88	ug/kg
	Anthracene	7	92	5323.00	10.00	1214.79	ug/kg
	Indeno(1,2,3-cd)pyrene	7	92	3900.00	11.00	1539.86	ug/kg
	Acenaphthene	6	92	2800.00	6.10	657.10	ug/kg
	Fluorene	5	92	1200.00	4.80	446.96	ug/kg
	Dibenz(a,h)anthracene	4	92	1300.00	77.00	744.25	ug/kg
	Dibenzofuran	4	92	700.00	2.80	243.20	ug/kg
	Naphthalene	2	92	120.00	2.40	61.20	ug/kg
	Acenaphthylene	1	92	220.00	220.00	220.00	ug/kg
	Di-n-octylphthalate	1	92	606.00	606.00	606.00	ug/kg
	N-Nitroso-di-n-propylamine	1	92	582.00	582.00	582.00	ug/kg
	N-Nitrosodiphenylamine	1	92	582.00	582.00	582.00	ug/kg

Table 4.27. Frequency of detection of organic compounds, metals, and radioactive isotopes in Sector 5 UCRS soil

Analytical Group	Analytical Compound	No. of Detects	No. of Analyses	Maximum Result	Minimum Result	Average Result	Units
PCB	PCB-1260	3	11	38.00	3.00	15.03	ug/kg
Metals	Sodium	46	60	858.00	359.00	540.57	mg/kg
	Aluminum	16	60	19600.00	12100.00	14156.25	mg/kg
	Beryllium	14	60	1.05	0.70	0.87	mg/kg
	Antimony	13	60	7.50	0.70	1.82	mg/kg
	Magnesium	11	60	10800.00	2130.00	3356.36	mg/kg
	Cadmium	10	60	0.78	0.22	0.34	mg/kg
	Thallium	6	60	1.60	0.60	1.02	mg/kg
	Arsenic	5	60	25.80	8.60	14.33	mg/kg
	Vanadium	4	60	59.50	38.70	45.95	mg/kg
	Barium	3	60	195.00	179.00	189.00	mg/kg
	Calcium	3	60	277000.00	13000.00	144666.67	mg/kg
	Iron	3	60	37000.00	28100.00	31366.67	mg/kg
	Chromium	2	60	48.00	20.80	34.40	mg/kg
	Nickel	2	60	23.50	22.80	23.15	mg/kg
	Silver	2	60	25.10	7.48	16.29	mg/kg
	Copper	1	60	20.70	20.70	20.70	mg/kg
	Manganese	1	60	860.00	860.00	860.00	mg/kg
	Selenium	1	60	1.30	1.30	1.30	mg/kg
	Zinc	1	60	111.00	111.00	111.00	mg/kg
Radioactive isotopes	Neptunium-237	30	72	0.40	0.20	0.25	pCi/g
	Cesium-137	19	72	0.60	0.30	0.37	pCi/g
	Thorium-230	7	72	2.20	1.50	1.80	pCi/g
	Uranium-238	5	72	16.70	1.40	5.40	pCi/g
	Technetium-99	3	72	33.00	3.10	14.47	pCi/g
	Uranium-235	3	72	0.60	0.20	0.40	pCi/g
	Uranium-234	2	72	10.90	2.70	6.80	pCi/g
	Americium-241	1	72	1.00	1.00	1.00	pCi/g
	Plutonium-239	1	72	0.20	0.20	0.20	pCi/g

Table 4.28. VOA compounds detected in Sector 6
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Soil	047002SA004	1	4.5	Toluene	2	J	?	
	047002SA012	8.5	12	cis-1,2-Dichloroethene	82		?	
		8.5	12	Toluene	5.6	J	?	
		8.5	12	trans-1,2-Dichloroethene	2500		?	
		8.5	12	Trichloroethene	1400		?	
	047002SA019	15.5	19	2-Propanol	220		?	
		15.5	19	cis-1,2-Dichloroethene	2.9	J	?	
		15.5	19	Toluene	1.5	J	?	
		15.5	19	trans-1,2-Dichloroethene	2300		?	
		15.5	19	Trichloroethene	1700		?	
	047002SA030	26	29.5	2-Propanol	170		?	
		26	29.5	Trichloroethene	1500		?	

Note: Soil boring samples not containing any detectable VOA compounds in Sector 6 are:
400076SA015, 400083SA015, 400084SA015, 400108SA015, 400148SA015, 400169SA007, 400169SA014

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Table 4.29. SVOA and PCB compounds detected in Sector 6
UCRS soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
			Top	Bottom					
Soil	SVOA	047002SA001	0	1	Acenaphthene	3700	J	?	
			0	1	Anthracene	7300		?	
			0	1	Benz(a)anthracene	18000		?	
			0	1	Benzo(a)pyrene	16000		?	
			0	1	Benzo(b)fluoranthene	17000		?	
			0	1	Benzo(ghi)perylene	5500	J	?	
			0	1	Benzo(k)fluoranthene	11000		?	
			0	1	Chrysene	19000		?	
			0	1	Dibenz(a,h)anthracene	3200	J	?	
			0	1	Dibenzofuran	1500	J	?	
			0	1	Fluoranthene	48000		?	
			0	1	Fluorene	2700	J	?	
			0	1	Indeno(1,2,3-cd)pyrene	5800	J	?	
			0	1	Naphthalene	800	J	?	
			0	1	Phenanthrene	34000		?	
			0	1	Pyrene	34000		?	
		047002SA004	1	4.5	Fluoranthene	40	J	?	
		047003SA001	0	1	2-Methylnaphthalene	900	J	?	
			0	1	Acenaphthene	7074	J	?	
			0	1	Anthracene	84314		?	
			0	1	Benz(a)anthracene	39198		?	

Table 4.29. SVOA and PCB compounds detected in Sector 6
UCRS soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
			Top	Bottom					
Soil	SVOA	047003SA001	0	1	Benzo(a)pyrene	37686	J	?	
			0	1	Benzo(b)fluoranthene	62446	J	?	
			0	1	Benzo(ghi)perylene	8838	J	?	
			0	1	Benzo(k)fluoranthene	94149	J	?	
			0	1	Chrysene	43652		?	
			0	1	Dibenz(a,h)anthracene	4268	J	?	
			0	1	Dibenzofuran	3600	J	?	
			0	1	Fluoranthene	96773		?	
			0	1	Fluorene	4539	J	?	
			0	1	Indeno(1,2,3-cd)pyrene	9688	J	?	
			0	1	Naphthalene	1900	J	?	
			0	1	Phenanthrene	77492		?	
			0	1	Pyrene	110585		?	
		047004SA001	0	1	Anthracene	771	J	?	
			0	1	Benz(a)anthracene	497	J	?	
			0	1	Benzo(a)pyrene	504	J	?	
			0	1	Benzo(b)fluoranthene	819	J	?	
			0	1	Chrysene	554	J	?	
			0	1	Fluoranthene	1109	J	?	
			0	1	Phenanthrene	709	J	?	
			0	1	Pyrene	1435	J	?	

Table 4.29. SVOA and PCB compounds detected in Sector 6
UCRS soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
Soil	SVOA	047007SA001	0	1	Acenaphthene	1900	J	?	
			0	1	Anthracene	3769		?	
			0	1	Benz(a)anthracene	9900		?	
			0	1	Benzo(a)pyrene	8900		?	
			0	1	Benzo(b)fluoranthene	9500		?	
			0	1	Benzo(ghi)perylene	4600	J	?	
			0	1	Benzo(k)fluoranthene	7600	J	?	
			0	1	Chrysene	11000		?	
			0	1	Dibenzofuran	1100	J	?	
			0	1	Fluoranthene	27000		?	
			0	1	Fluorene	1000	J	?	
			0	1	Indeno(1,2,3-cd)pyrene	4400	J	?	
			0	1	Naphthalene	500	J	?	
			0	1	Phenanthrene	20000		?	
			0	1	Pyrene	20000		?	
		047007SD001	0	1	Benz(a)anthracene	140	J	?	
			0	1	Benzo(a)pyrene	130	J	?	
			0	1	Benzo(b)fluoranthene	110	J	?	
			0	1	Benzo(ghi)perylene	91	J	?	
			0	1	Benzo(k)fluoranthene	130	J	?	
			0	1	Chrysene	160	J	?	

Table 4.29. SVOA and PCB compounds detected in Sector 6 UCRS soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
Soil	SVOA	047007SD001	0	1	Fluoranthene	350	J	?	
			0	1	Indeno(1,2,3-cd)pyrene	81	J	?	
			0	1	Phenanthrene	230	J	?	
			0	1	Pyrene	290	J	?	
		047008SA001	0	1	Benzo(k)fluoranthene	195	J	?	
			0	1	Fluoranthene	700	J	?	
			0	1	Phenanthrene	400	J	?	
			0	1	Pyrene	600	J	?	
		047009SA001	0	1	Anthracene	359	J	?	
			0	1	Benz(a)anthracene	700	J	?	
			0	1	Benzo(a)pyrene	600	J	?	
			0	1	Benzo(b)fluoranthene	700	J	?	
			0	1	Benzo(k)fluoranthene	700	J	?	
			0	1	Chrysene	800	J	?	
			0	1	Fluoranthene	1600	J	?	
			0	1	Phenanthrene	1200	J	?	
			0	1	Pyrene	1500	J	?	
		047010SA001	0	1	Acenaphthene	1800	J	?	
			0	1	Anthracene	2800	J	?	
			0	1	Benz(a)anthracene	7700	J	?	
			0	1	Benzo(a)pyrene	6600	J	?	

Table 4.29. SVOA and PCB compounds detected in Sector 6
UCRS soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
Soil	SVOA	047010SA001	0	1	Benzo(b)fluoranthene	7300	J	?	
			0	1	Benzo(ghi)perylene	2400	J	?	
			0	1	Benzo(k)fluoranthene	6800	J	?	
			0	1	Chrysene	8200		?	
			0	1	Dibenzofuran	1200	J	?	
			0	1	Fluoranthene	20000		?	
			0	1	Fluorene	900	J	?	
			0	1	Indeno(1,2,3-cd)pyrene	2600	J	?	
			0	1	Naphthalene	600	J	?	
			0	1	Phenanthrene	16000		?	
			0	1	Pyrene	15000		?	
		400044SA001	0	1	2-Methylnaphthalene	44	J	=	
			0	1	Benz(a)anthracene	80	J	=	
			0	1	Benzo(a)pyrene	90	J	=	
			0	1	Benzo(b)fluoranthene	90	J	=	
			0	1	Benzo(ghi)perylene	62	J	=	
			0	1	Benzo(k)fluoranthene	70	J	=	
			0	1	Chrysene	90	J	=	
			0	1	Fluoranthene	170	J	=	
			0	1	Indeno(1,2,3-cd)pyrene	60	J	=	
			0	1	Phenanthrene	110	J	=	

Table 4.29. SVOA and PCB compounds detected in Sector 6
UCRS soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
			Top	Bottom					
Soil	SVOA	400044SA001	0	1	Pyrene	130	J	=	
	PPCB	047002SA001	0	1	PCB-1254	77		?	
		047007SA001	0	1	PCB-1254	960		?	
		047007SD001	0	1	PCB-1254	120		?	
		400044SA001	0	1	PCB-1260	16	J	=	

Note: Soil boring samples not containing any detectable SVOA compounds in Sector 6 are:

047002SA012, 047002SA019, 047002SA030, 047005SA001, 400076SA015, 400083SA015, 400084SA015, 400108SA015, 400148SA015, 400169SA007, 400169SA014

Soil boring samples not containing any detectable PCB compounds in Sector 6 are:

047002SA004, 047002SA012, 047002SA019, 047002SA030, 400084SA015, 400108SA015, 400169SA007, 400169SA014

Table 4.30. Metals detected in Sector 6
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Bottom	Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
Soil	047002SA001	0	1	Antimony	0.7	B	?		0.21
		0	1	Arsenic	45.2		?		12
		0	1	Cadmium	4.25		?		0.21
		0	1	Nickel	25.5		?		21
	047002SA004	1	4.5	Antimony	0.9	B	?		0.21
		1	4.5	Calcium	7490		?		6100
	047002SA012	8.5	12	Antimony	0.7	B	?		0.21
		8.5	12	Arsenic	8.35		?		7.9
		8.5	12	Magnesium	2220		?		2100
		8.5	12	Sodium	449		?		340
	047002SA019	15.5	19	Sodium	374		?		340
	047002SA030	26	29.5	Antimony	0.6	B	?		0.21
	047003SA001	0	1	Chromium	45.8		?		16
		0	1	Copper	27.9		?		19
		0	1	Sodium	491		?		320
		0	1	Zinc	75.7		?		65
	047004SA001	0	1	Antimony	0.9	B	?		0.21
		0	1	Cadmium	0.23	B	?		0.21
		0	1	Chromium	17.1		?		16
		0	1	Sodium	516		?		320
	047005SA001	0	1	Aluminum	14900		?		13000

Table 4.30. Metals detected in Sector 6
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	047005SA001	0	1	Arsenic	22.2		?		12
		0	1	Chromium	18.3		?		16
		0	1	Sodium	592		?		320
	047007SA001	0	1	Chromium	17.9		?		16
		0	1	Copper	24.4		?		19
		0	1	Sodium	664		?		320
		0	1	Zinc	66.2		?		65
	047007SD001	0	1	Aluminum	15000		?		13000
		0	1	Chromium	19.8		?		16
		0	1	Cobalt	14.3		?		14
		0	1	Copper	20.2		?		19
		0	1	Sodium	681		?		320
	047008SA001	0	1	Antimony	0.8	B	?		0.21
		0	1	Cadmium	0.22	B	?		0.21
		0	1	Sodium	431		?		320
	047009SA001	0	1	Sodium	535		?		320
	047010SA001	0	1	Arsenic	32.2		?		12
		0	1	Cadmium	0.22	B	?		0.21
		0	1	Chromium	17.6		?		16
		0	1	Sodium	529		?		320
	400044SA001	0	1	Aluminum	17700		=		13000

Table 4.30. Metals detected in Sector 6
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	400044SA001	0	1	Antimony	1.3	B	=		0.21
		0	1	Beryllium	0.8		=		0.67
		0	1	Cadmium	0.47	B	=		0.21
		0	1	Chromium	22.5		=		16
		0	1	Sodium	348		=		320
	400076SA015	14	18	Aluminum	12800		?		12000
		14	18	Beryllium	0.7		?		0.69
		14	18	Chromium	49.3		?		43
		14	18	Sodium	758		?		340
		14	18	Vanadium	53.5		?		37
	400083SA015	4.5	8.5	Aluminum	14500		?		12000
		4.5	8.5	Cadmium	0.26	B	?		0.21
		4.5	8.5	Sodium	399		?		340
	400084SA015	10	14	Aluminum	14100		=		12000
		10	14	Sodium	371		=		340
	400108SA015	4	8	Aluminum	23400		?		12000
		4	8	Barium	235		?		170
		4	8	Beryllium	0.71		?		0.69
		4	8	Magnesium	2290		?		2100
		4	8	Sodium	489		?		340
	400148SA015	9	12	Aluminum	15700		?		12000

Table 4.30. Metals detected in Sector 6
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Bottom	Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
Soil	400148SA015	9	12	Beryllium	0.72		?		0.69
		9	12	Vanadium	39.1		?		37
	400169SA007	3	7	Aluminum	12300		=		12000
	400169SA014	10	14	Aluminum	14000		=		12000
		10	14	Magnesium	2170		=		2100
		10	14	Sodium	495		=		340

Note: Soil boring samples not containing any detectable metals at concentrations above background in Sector 6 are:

None

Table 4.31. Radioactive isotopes detected in Sector 6 UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/g	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/g
		Top	Bottom						
Soil	047002SA001	0	1	Americium-241	0.2		?		0
		0	1	Cesium-137	1.5		?		0.49
		0	1	Neptunium-237	1		?		0.1
		0	1	Plutonium-239	0.8		?		0.025
		0	1	Technetium-99	53		?		2.5
		0	1	Thorium-230	6.4		?		1.5
		0	1	Uranium-234	31.1		?		2.5
		0	1	Uranium-235	1.9		?		0.14
		0	1	Uranium-238	39.5		?		1.2
	047002SA004	1	4.5	Technetium-99	8.1		?		2.8
		1	4.5	Uranium-234	41.7		?		2.4
		1	4.5	Uranium-235	2.2		?		0.14
		1	4.5	Uranium-238	42.8		?		1.2
	047002SA012	8.5	12	Neptunium-237	0.2		?		0
	047002SA019	15.5	19	Neptunium-237	0.2		?		0
	047003SA001	0	1	Americium-241	0.2		?		0
		0	1	Cesium-137	0.5		?		0.49
		0	1	Neptunium-237	3		?		0.1
		0	1	Plutonium-239	1.7		?		0.025
		0	1	Technetium-99	37		?		2.5
		0	1	Thorium-230	10.9		?		1.5

Table 4.31. Radioactive isotopes detected in Sector 6 UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/g	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/g
		Top	Bottom						
Soil	047003SA001	0	1	Uranium-234	6.1		?		2.5
		0	1	Uranium-235	0.5		?		0.14
		0	1	Uranium-238	6.8		?		1.2
	047004SA001	0	1	Neptunium-237	0.7		?		0.1
		0	1	Technetium-99	5.9		?		2.5
		0	1	Thorium-230	2.1		?		1.5
		0	1	Uranium-234	3		?		2.5
		0	1	Uranium-238	4.1		?		1.2
	047005SA001	0	1	Neptunium-237	0.3		?		0.1
		0	1	Technetium-99	4.7		?		2.5
		0	1	Thorium-230	1.6		?		1.5
		0	1	Uranium-234	2.6		?		2.5
		0	1	Uranium-235	0.2		?		0.14
		0	1	Uranium-238	2.9		?		1.2
	047007SA001	0	1	Neptunium-237	0.4		?		0.1
		0	1	Technetium-99	14.9		?		2.5
		0	1	Thorium-230	2.2		?		1.5
		0	1	Uranium-238	2.7		?		1.2
	047007SD001	0	1	Neptunium-237	0.7		?		0.1
		0	1	Plutonium-239	0.2		?		0.025
		0	1	Technetium-99	22.2		?		2.5

Table 4.31. Radioactive isotopes detected in Sector 6 UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/g	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/g
		Top	Bottom						
Soil	047007SD001	0	1	Thorium-230	5.7		?		1.5
		0	1	Uranium-234	3.4		?		2.5
		0	1	Uranium-235	0.2		?		0.14
		0	1	Uranium-238	4.6		?		1.2
	047008SA001	0	1	Neptunium-237	0.7		?		0.1
		0	1	Technetium-99	4.6		?		2.5
		0	1	Thorium-230	3		?		1.5
		0	1	Uranium-234	2.6		?		2.5
		0	1	Uranium-238	2.6		?		1.2
	047009SA001	0	1	Neptunium-237	0.2		?		0.1
		0	1	Technetium-99	4.5		?		2.5
		0	1	Thorium-230	2.4		?		1.5
		0	1	Uranium-235	0.2		?		0.14
		0	1	Uranium-238	3.1		?		1.2
	047010SA001	0	1	Neptunium-237	0.5		?		0.1
		0	1	Technetium-99	9.1		?		2.5
		0	1	Thorium-230	2.3		?		1.5
		0	1	Uranium-234	3.8		?		2.5
		0	1	Uranium-235	0.2		?		0.14
		0	1	Uranium-238	5.5		?		1.2
	400044SA001	0	1	Uranium-238	3		=		1.2

Table 4.31. Radioactive isotopes detected in Sector 6
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results pCi/g	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/g
Soil	400084SA015	10	14	Americium-241	0.4		=		0
	400169SA014	10	14	Thorium-230	3.4		=		1.4

Note: Soil boring samples not containing any detectable radioactive isotopes at concentrations above background in Sector 6 are:
047002SA030, 400108SA015, 400169SA007

Table 4.33. VOA compounds detected in Sector 7
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Soil	203003SA015	11	14.5	1,1-Dichloroethene	1.4	J	?	
		11	14.5	Trichloroethene	4	J	?	
	203003SA030	28.5	32	Trichloroethene	4500		?	
	400004SA010	10.5	14	Toluene	6	J	?	
	400040SD030	30	31	cis-1,2-Dichloroethene	1.6	J	?	
		30	31	Trichloroethene	5.4	J	?	

Note: Soil boring samples not containing any detectable VOA compounds in Sector 7 are:

203001SA015, 203002SA030, 203004SA030, 203006SA015, 203007SA015, 203007SD015, 203008SA015, 400004SA005, 400004SA020, 400004SA030, 400004SA040, 400021SA019, 400040SA005, 400040SA030, 400054SA015, 400077SA015, 400080SA015, 400109SA015, 400111SA015, 400119SA015, 400155SA015, 400188SA015, 400210SA010, 400210SA024, 400210SA030, 400210SA045

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Table 4.32. Frequency of detection of organic compounds, metals, and radioactive isotopes in Sector 6 UCRS soil

Analytical Group	Analytical Compound	No. of Detects	No. of Analyses	Maximum Result	Minimum Result	Average Result	Units
VOA	Toluene	3	8	5.60	1.50	3.03	ug/kg
	Trichloroethene	3	11	1700.00	26.00	1304.33	ug/kg
	2-Propanol	2	8	220.00	170.00	195.00	ug/kg
	cis-1,2-Dichloroethene	2	11	82.00	2.90	42.45	ug/kg
	trans-1,2-Dichloroethene	2	11	2500.00	2300.00	2400.00	ug/kg
SVOA	Fluoranthene	10	21	96773.00	40.00	15799.30	ug/kg
	Phenanthrene	9	21	77492.00	110.00	13170.11	ug/kg
	Pyrene	9	21	110585.00	130.00	15725.94	ug/kg
	Benz(a)anthracene	8	21	39198.00	80.00	7613.94	ug/kg
	Benzo(a)pyrene	8	21	37686.00	90.00	7031.88	ug/kg
	Benzo(b)fluoranthene	8	21	62446.00	90.00	10116.00	ug/kg
	Benzo(k)fluoranthene	8	21	94149.00	70.00	9609.38	ug/kg
	Chrysene	8	21	43652.00	90.00	8482.13	ug/kg
	Anthracene	6	21	84314.00	359.00	9995.83	ug/kg
	Benzo(ghi)perylene	6	21	8838.00	62.00	3152.83	ug/kg
	Indeno(1,2,3-cd)pyrene	6	21	9688.00	60.00	3372.25	ug/kg
	Acenaphthene	4	21	7074.00	1800.00	3446.75	ug/kg
	Dibenzofuran	4	21	3600.00	1100.00	1850.00	ug/kg
	Fluorene	4	21	4539.00	900.00	2142.38	ug/kg
	Naphthalene	4	21	1900.00	500.00	950.00	ug/kg
	2-Methylnaphthalene	2	21	900.00	44.00	472.00	ug/kg
	Dibenz(a,h)anthracene	2	21	4268.00	3200.00	3734.00	ug/kg
PCB	PCB-1254	3	12	960.00	77.00	385.67	ug/kg
	PCB-1260	1	12	16.00	16.00	16.00	ug/kg
Metals	Sodium	16	21	758.00	348.00	507.63	mg/kg
	Aluminum	10	21	23400.00	12300.00	15440.00	mg/kg
	Chromium	8	21	49.30	17.10	26.04	mg/kg
	Antimony	7	21	1.30	0.60	0.84	mg/kg
	Cadmium	6	21	4.25	0.22	0.94	mg/kg
	Arsenic	4	21	45.20	8.35	26.99	mg/kg
	Beryllium	4	21	0.80	0.70	0.73	mg/kg
	Copper	3	21	27.90	20.20	24.17	mg/kg

Table 4.32. Frequency of detection of organic compounds, metals, and radioactive isotopes in Sector 6 UCRS soil

Analytical Group	Analytical Compound	No. of Detects	No. of Analyses	Maximum Result	Minimum Result	Average Result	Units
Metals	Magnesium	3	21	2290.00	2170.00	2226.67	mg/kg
	Vanadium	2	21	53.50	39.10	46.30	mg/kg
	Zinc	2	21	75.70	66.20	70.95	mg/kg
	Barium	1	21	235.00	235.00	235.00	mg/kg
	Calcium	1	21	7490.00	7490.00	7490.00	mg/kg
	Cobalt	1	21	14.30	14.30	14.30	mg/kg
	Nickel	1	21	25.50	25.50	25.50	mg/kg
Radioactive isotopes	Neptunium-237	11	18	3.00	0.20	0.72	pCi/g
	Uranium-238	11	18	42.80	2.60	10.69	pCi/g
	Technetium-99	10	18	53.00	4.50	16.40	pCi/g
	Thorium-230	10	18	10.90	1.60	4.00	pCi/g
	Uranium-234	8	18	41.70	2.60	11.79	pCi/g
	Uranium-235	7	18	2.20	0.20	0.77	pCi/g
	Americium-241	3	18	0.40	0.20	0.27	pCi/g
	Plutonium-239	3	18	1.70	0.20	0.90	pCi/g
	Cesium-137	2	18	1.50	0.50	1.00	pCi/g

Table 4.34. SVOA and PCB compounds detected in Sector 7 UCRS soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
			Top	Bottom					
Soil	SVOA	400004SA001	0	1.5	Benz(a)anthracene	70	J	?	
			0	1.5	Benzo(a)pyrene	80	J	?	
			0	1.5	Benzo(b)fluoranthene	120	J	?	
			0	1.5	Benzo(k)fluoranthene	70	J	?	
			0	1.5	Chrysene	80	J	?	
			0	1.5	Fluoranthene	140	J	?	
			0	1.5	Phenanthrene	50	J	?	
			0	1.5	Pyrene	120	J	?	
		400004SA010	10.5	14	N-Nitroso-di-n-propylamin	522	J	?	
		400111SA001	0	1	Benz(a)anthracene	300	J	?	
			0	1	Benzo(a)pyrene	400	J	?	
			0	1	Benzo(b)fluoranthene	600	J	?	
			0	1	Benzo(k)fluoranthene	300	J	?	
			0	1	Chrysene	290	J	?	
			0	1	Fluoranthene	400	J	?	
			0	1	Pyrene	400	J	?	
	PPCB	203006SA015	12.5	16.5	PCB-1260	7.9	J	?	

Table 4.34. SVOA and PCB compounds detected in Sector 7
UCRS soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
			Top	Bottom					

Note: Soil boring samples not containing any detectable SVOA compounds in Sector 7 are:

203001SA015, 203002SA001, 203002SA030, 203003SA001, 203003SA015, 203003SA030, 203004SA001, 203004SA030, 203006SA015, 203007SA015, 203007SD015, 203008SA015, 400001SA001, 400004SA005, 400004SA020, 400004SA030, 400004SA040, 400035SA001, 400040SA030, 400040SD030, 400054SA015, 400077SA015, 400080SA015, 400109SA015, 400111SA015, 400119SA015, 400155SA015, 400188SA015, 400210SA030

Soil boring samples not containing any detectable PCB compounds in Sector 7 are:

203001SA015, 203002SA030, 203003SA030, 203004SA030, 203007SA015, 203007SD015, 203008SA015, 400001SA001, 400004SA001, 400004SA005, 400004SA010, 400004SA020, 400004SA030, 400004SA040, 400054SA015, 400080SA015, 400109SA015, 400111SA001, 400111SA015, 400210SA030

Table 4.35. Metals detected in Sector 7
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Bottom	Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
Soil	203001SA015	12	15	Aluminum	16100		=		12000
		12	15	Beryllium	0.71		=		0.69
		12	15	Sodium	433		=		340
		12	15	Vanadium	38.1		=		37
	203002SA001	1.3	3.6	Beryllium	0.79		?		0.67
		1.3	3.6	Cadmium	0.32	B	?		0.21
		1.3	3.6	Chromium	27.5		?		16
		1.3	3.6	Sodium	532		?		320
	203002SA030	28	31	Antimony	0.7	B	?		0.21
	203003SA001	0.5	1.5	Antimony	1.4	B	?		0.21
		0.5	1.5	Cadmium	0.29	B	?		0.21
		0.5	1.5	Chromium	22.4		?		16
		0.5	1.5	Mercury	8.3		?		0.2
	203003SA015	11	14.5	Antimony	0.6	B	?		0.21
		11	14.5	Cadmium	0.22	B	?		0.21
		11	14.5	Sodium	503		?		340
	203004SA001	1.4	4	Antimony	0.7	B	?		0.21
		1.4	4	Sodium	466		?		320
	203006SA015	12.5	16.5	Sodium	373		?		340
	203007SD015	10	14	Aluminum	17400		?		12000
		10	14	Beryllium	0.7		?		0.69

Table 4.35. Metals detected in Sector 7
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	203007SD015	10	14	Sodium	372		?		340
	203008SA015	11	15	Aluminum	12800		=		12000
		11	15	Cobalt	17.7		=		13
		11	15	Manganese	887		=		820
		11	15	Sodium	372		=		340
	400001SA001	0.5	1.5	Aluminum	14500		=		13000
		0.5	1.5	Beryllium	0.68		=		0.67
		0.5	1.5	Chromium	18.1		=		16
		0.5	1.5	Sodium	787		=		320
	400004SA001	0	1.5	Antimony	9.4		?		0.21
		0	1.5	Chromium	30.1		?		16
	400004SA010	10.5	14	Sodium	461		?		340
	400035SA001	0	1	Beryllium	0.69		?		0.67
		0	1	Chromium	22.8		?		16
	400040SA030	30	31	Sodium	440		?		340
	400040SD030	30	31	Sodium	420		?		340
	400054SA015	10	14	Antimony	0.6	B	=		0.21
	400077SA015	10	14	Aluminum	16600		?		12000
		10	14	Antimony	1.1	B	?		0.21
		10	14	Beryllium	0.75		?		0.69
		10	14	Vanadium	50.5		?		37

Table 4.35. Metals detected in Sector 7
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	400080SA015	5	9	Beryllium	0.84		?		0.69
		5	9	Cadmium	0.22	B	?		0.21
		5	9	Sodium	375		?		340
	400109SA015	9	13	Arsenic	9.5		?		7.9
	400111SA001	0	1	Antimony	1	B	?		0.21
		0	1	Beryllium	0.71	B	?		0.67
		0	1	Cadmium	0.75	B	?		0.21
		0	1	Chromium	66		?		16
		0	1	Iron	30500		?		28000
		0	1	Lead	42		?		36
		0	1	Vanadium	42.4		?		38
	400111SA015	10	14	Beryllium	1.19	B	?		0.69
		10	14	Cadmium	0.52	B	?		0.21
		10	14	Cobalt	15.5		?		13
		10	14	Iron	37400		?		28000
		10	14	Nickel	29.1		?		22
		10	14	Sodium	457		?		340
		10	14	Vanadium	67.2		?		37
	400119SA015	9	13	Aluminum	15400		?		12000
	400155SA015	4	8	Aluminum	15500		?		12000
		4	8	Beryllium	0.89		?		0.69

Table 4.35. Metals detected in Sector 7
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
Soil	400188SA015	5	9	Antimony	0.8	B	?		0.21
		5	9	Arsenic	10.3		?		7.9
		5	9	Beryllium	0.75		?		0.69
		5	9	Sodium	445		?		340
		5	9	Thallium	0.7	B	?		0.34
	400210SA030	33.5	34	Antimony	3.8	B	?		0.21
		33.5	34	Silver	3.03		?		2.7
		33.5	34	Sodium	488		?		340
	400216SA001	0	0.5	Sodium	483		?		320
	400217SA001	0	0.5	Sodium	410		?		320
	400218SA001	0	0.5	Sodium	491		?		320
	400219SA001	0	0.5	Antimony	0.6	B	?		0.21
		0	0.5	Sodium	420		?		320

Note: Soil boring samples not containing any detectable metals at concentrations above background in Sector 7 are: 203003SA030, 203004SA030, 203007SA015, 400004SA005, 400004SA020, 400004SA040, 400040SD030

Table 4.36. Radioactive isotopes detected in Sector 7 UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/g	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/g
		Top	Bottom						
Soil	203002SA030	28	31	Americium-241	0.2		?		0
	203003SA001	0.5	1.5	Neptunium-237	0.8		?		0.1
		0.5	1.5	Plutonium-239	0.2		?		0.025
		0.5	1.5	Technetium-99	43.3		?		2.5
		0.5	1.5	Thorium-230	5.6		?		1.5
		0.5	1.5	Uranium-234	7.4		?		2.5
		0.5	1.5	Uranium-235	0.4		?		0.14
		0.5	1.5	Uranium-238	14.8		?		1.2
	203003SA015	11	14.5	Americium-241	0.4		?		0
		11	14.5	Neptunium-237	0.4		?		0
		11	14.5	Technetium-99	3.1		?		2.8
	203003SA030	28.5	32	Neptunium-237	0.3		?		0
	203004SA030	29	32.5	Neptunium-237	0.2		?		0
	203007SA015	10	14	Americium-241	0.12		?		0
	400001SA001	0.5	1.5	Uranium-235	0.3		=		0.14
		0.5	1.5	Uranium-238	2.9		=		1.2
	400040SA030	30	31	Cesium-137	0.3		?		0.28
	400080SA015	5	9	Thorium-230	1.5		?		1.4
	400111SA001	0	1	Technetium-99	4.2		?		2.5
		0	1	Uranium-234	2.8		?		2.5
		0	1	Uranium-238	3.2		?		1.2

Table 4.36. Radioactive isotopes detected in Sector 7
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/g	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/g
		Top	Bottom						
Soil	400111SA015	10	14	Thorium-230	1.8		?		1.4
	400210SA030	33.5	34	Cesium-137	0.3		?		0.28

Note: Soil boring samples not containing any detectable radioactive isotopes at concentrations above background in Sector 7 are: 203001SA015, 203004SA001, 203007SD015, 203008SA015, 400040SD030, 400054SA015, 400109SA015

Table 4.37. Frequency of detection of organic compounds, metals, and radioactive isotopes in Sector 7 UCRS soil

Analytical Group	Analytical Compound	No. of Detects	No. of Analyses	Maximum Result	Minimum Result	Average Result	Units
VOA	Trichloroethene	3	30	4500.00	2.10	753.48	ug/kg
	1,1-Dichloroethene	1	30	1.40	1.40	1.40	ug/kg
	cis-1,2-Dichloroethene	1	30	1.60	1.60	1.60	ug/kg
	Toluene	1	20	6.00	6.00	6.00	ug/kg
SVOA	Benz(a)anthracene	2	32	300.00	70.00	185.00	ug/kg
	Benzo(a)pyrene	2	32	400.00	80.00	240.00	ug/kg
	Benzo(b)fluoranthene	2	32	600.00	120.00	360.00	ug/kg
	Benzo(k)fluoranthene	2	32	300.00	70.00	185.00	ug/kg
	Chrysene	2	32	290.00	80.00	185.00	ug/kg
	Fluoranthene	2	32	400.00	140.00	270.00	ug/kg
	Pyrene	2	32	400.00	120.00	260.00	ug/kg
	N-Nitroso-di-n-propylamine	1	32	522.00	522.00	522.00	ug/kg
	Phenanthrene	1	32	50.00	50.00	50.00	ug/kg
PCB	PCB-1260	1	21	7.90	7.90	7.90	ug/kg
Metals	Sodium	19	36	787.00	372.00	459.37	mg/kg
	Antimony	11	36	9.40	0.60	1.88	mg/kg
	Beryllium	11	36	1.19	0.68	0.79	mg/kg
	Aluminum	7	36	17400.00	12800.00	15471.43	mg/kg
	Cadmium	6	36	0.75	0.22	0.39	mg/kg
	Chromium	6	36	66.00	18.10	31.15	mg/kg
	Vanadium	4	36	67.20	38.10	49.55	mg/kg
	Arsenic	2	36	10.30	9.50	9.90	mg/kg
	Cobalt	2	36	17.70	15.50	16.60	mg/kg
	Iron	2	36	37400.00	30500.00	33950.00	mg/kg
	Lead	1	36	42.00	42.00	42.00	mg/kg
	Manganese	1	36	887.00	887.00	887.00	mg/kg
	Mercury	1	36	8.30	8.30	8.30	mg/kg
	Nickel	1	36	29.10	29.10	29.10	mg/kg
	Silver	1	36	3.03	3.03	3.03	mg/kg
	Thallium	1	36	0.70	0.70	0.70	mg/kg
Radioactive isotopes	Neptunium-237	4	19	0.80	0.20	0.43	pCi/g
	Americium-241	3	19	0.40	0.12	0.24	pCi/g

Table 4.37. Frequency of detection of organic compounds, metals, and radioactive isotopes in Sector 7 UCRS soil

Analytical Group	Analytical Compound	No. of Detects	No. of Analyses	Maximum Result	Minimum Result	Average Result	Units
Radioactive isotopes	Technetium-99	3	19	43.30	3.10	16.87	pCi/g
	Thorium-230	3	19	5.60	1.50	2.97	pCi/g
	Uranium-238	3	19	14.80	2.90	6.97	pCi/g
	Cesium-137	2	19	0.30	0.30	0.30	pCi/g
	Uranium-234	2	19	7.40	2.80	5.10	pCi/g
	Uranium-235	2	19	0.40	0.30	0.35	pCi/g
	Plutonium-239	1	19	0.20	0.20	0.20	pCi/g

Table 4.38. VOA compounds detected in Sector 8 UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
Soil	026001SA002	1.5	1.5	Toluene	1.6	J	?	
	026003SA007	4	8	cis-1,2-Dichloroethene	15		=	
		4	8	Trichloroethene	34		=	
	026005SA007	5	9	Toluene	320		=	
	026006SA007	4.5	8.5	cis-1,2-Dichloroethene	4.4	J	?	
		4.5	8.5	Trichloroethene	3.1	J	?	
	026007SA007	5	9	Toluene	310		=	
	040010SA030	30	33	Vinyl acetate	41	J	?	BH-SS

Note: Soil boring samples not containing any detectable VOA compounds in Sector 8 are:

026001SA010, 026001SA026, 026001SA045, 026004SA007, 026008SA007, 026009SA007, 026020SA003*, 026025SA015, 400043SA022, 400208SA010, 400208SA030, 400208SA045

*** Sample 026020SA003 was collected from sludge inside pipeline**

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Table 4.39. SVOA and PCB compounds detected in Sector 8 UCRS soil

Sample Type*	Analytical Group	Sample ID	Sample Interval (ft bgs) Top	Bottom	Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
Sludge	SVOA	026020SA003	3.5	3.5	Benz(a)anthracene	140	J	?	
			3.5	3.5	Benzo(a)pyrene	140	J	?	
			3.5	3.5	Benzo(b)fluoranthene	130	J	?	
			3.5	3.5	Benzo(ghi)perylene	92	J	?	
			3.5	3.5	Benzo(k)fluoranthene	130	J	?	
			3.5	3.5	Chrysene	140	J	?	
			3.5	3.5	Fluoranthene	290	J	?	
			3.5	3.5	Indeno(1,2,3-cd)pyrene	77	J	?	
			3.5	3.5	Phenanthrene	160	J	?	
			3.5	3.5	Pyrene	240	J	?	
Soil		026004SA007	5	9	2,4-Dinitrotoluene	457	J	?	
		026007SA007	5	9	N-Nitrosodiphenylamine	823		?	
		026009SA007	3.5	7.5	Benz(a)anthracene	80	J	=	
			3.5	7.5	Benzo(a)pyrene	80	J	=	
			3.5	7.5	Benzo(b)fluoranthene	90	J	=	
			3.5	7.5	Benzo(ghi)perylene	55	J	=	
			3.5	7.5	Benzo(k)fluoranthene	70	J	=	
			3.5	7.5	Chrysene	90	J	=	
			3.5	7.5	Fluoranthene	190	J	=	
			3.5	7.5	Indeno(1,2,3-cd)pyrene	50	J	=	
			3.5	7.5	Phenanthrene	110	J	=	

Table 4.39. SVOA and PCB compounds detected in Sector 8 UCRS soil

Sample Type*	Analytical Group	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
			Top	Bottom					
Soil	SVOA	026009SA007	3.5	7.5	Pyrene	150	J	=	
		400034SA001	0	1	Fluoranthene	40	J	?	
		400043SA001	0	1	Acenaphthene	50	J	?	
			0	1	Anthracene	160	J	?	
			0	1	Benz(a)anthracene	340	J	?	
			0	1	Benzo(a)pyrene	280	J	?	
			0	1	Benzo(b)fluoranthene	260	J	?	
			0	1	Benzo(ghi)perylene	130	J	?	
			0	1	Benzo(k)fluoranthene	290	J	?	
			0	1	Chrysene	350	J	?	
			0	1	Fluoranthene	840		?	
			0	1	Fluorene	50	J	?	
			0	1	Indeno(1,2,3-cd)pyrene	140	J	?	
			0	1	Phenanthrene	700	J	?	
			0	1	Pyrene	710		?	
	PPCB	026009SA007	3.5	7.5	PCB-1260	63	J	=	
		026025SA015	3.5	3.5	PCB-1254	32		?	

Table 4.39. SVOA and PCB compounds detected in Sector 8
UCRS soil

Sample Type*	Analytical Group	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
			Top	Bottom					

Note: **Soil boring samples not containing any detectable SVOA compounds in Sector 8 are:**

026001SA002, 026001SA026, 026003SA007, 026005SA007, 026006SA007, 026008SA007, 026025SA015, 040010SA030, 400208SA030

Soil boring samples not containing any detectable PCB compounds in Sector 8 are:

026003SA007, 026004SA007, 026005SA007, 026006SA007, 026007SA007, 040010SA030, 400034SA001, 400043SA001

* **Sample 026020SA003 was collected from sludge inside pipeline**

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Table 4.40. Metals detected in Sector 8
UCRS soil

Sample Type*	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Sludge	026020SA003	3.5	3.5	Aluminum	14400		?		12000
		3.5	3.5	Antimony	1.1	B	?		0.21
		3.5	3.5	Arsenic	9.44		?		7.9
		3.5	3.5	Cadmium	0.9		?		0.21
		3.5	3.5	Calcium	10600		?		6100
		3.5	3.5	Chromium	141		?		43
		3.5	3.5	Cobalt	16		?		13
		3.5	3.5	Copper	9520		?		25
		3.5	3.5	Iron	51700		?		28000
		3.5	3.5	Lead	87.5		?		23
		3.5	3.5	Mercury	0.457		?		0.13
		3.5	3.5	Nickel	17600		?		22
		3.5	3.5	Selenium	1	B	?		0.7
		3.5	3.5	Silver	4.12		?		2.7
		3.5	3.5	Sodium	1170		?		340
		3.5	3.5	Zinc	181		?		60
Soil	026001SA002	1.5	1.5	Aluminum	13200		?		12000
		1.5	1.5	Antimony	1.4	B	?		0.21
		1.5	1.5	Arsenic	8.22		?		7.9
		1.5	1.5	Calcium	15200		?		6100
		1.5	1.5	Magnesium	2120		?		2100

Table 4.40. Metals detected in Sector 8
UCRS soil

Sample Type*	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	026001SA002	1.5	1.5	Manganese	890		?		820
		1.5	1.5	Sodium	588		?		340
	026001SA026	26	26	Sodium	581		?		340
	026003SA007	4	8	Aluminum	13300		=		12000
		4	8	Antimony	0.8	B	=		0.21
		4	8	Arsenic	8.77		=		7.9
		4	8	Beryllium	0.77		=		0.69
		4	8	Nickel	31.8		=		22
	026004SA007	5	9	Aluminum	16100		=		12000
		5	9	Arsenic	9.2		=		7.9
	026005SA007	5	9	Aluminum	14200		=		12000
		5	9	Antimony	1	B	=		0.21
		5	9	Calcium	13500		=		6100
	026006SA007	4.5	8.5	Aluminum	14600		?		12000
		4.5	8.5	Antimony	0.7	B	?		0.21
		4.5	8.5	Arsenic	10.8		?		7.9
		4.5	8.5	Beryllium	0.98		?		0.69
		4.5	8.5	Calcium	7710		?		6100
		4.5	8.5	Manganese	852		?		820
		4.5	8.5	Selenium	0.9	B	?		0.7
		4.5	8.5	Sodium	352		?		340

Table 4.40. Metals detected in Sector 8
UCRS soil

Sample Type*	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	026007SA007	5	9	Aluminum	13500		=		12000
		5	9	Antimony	0.8	B	=		0.21
		5	9	Sodium	417		=		340
		5	9	Zinc	61.6		=		60
	026009SA007	3.5	7.5	Aluminum	13900		=		12000
		3.5	7.5	Copper	146		=		25
		3.5	7.5	Nickel	113		=		22
	026025SA015	3.5	3.5	Aluminum	15700		?		12000
		3.5	3.5	Antimony	1	B	?		0.21
		3.5	3.5	Chromium	140		?		43
		3.5	3.5	Copper	390		?		25
		3.5	3.5	Nickel	467		?		22
		3.5	3.5	Sodium	661		?		340
	040010SA030	30	33	Thallium	0.7	B	?		0.34
	400034SA001	0	1	Antimony	0.6	B	?		0.21
		0	1	Beryllium	0.69		?		0.67
		0	1	Cadmium	0.3	B	?		0.21
		0	1	Chromium	27.2		?		16
	400043SA001	0	1	Antimony	1.4	B	?		0.21
		0	1	Thallium	0.6	B	?		0.21
	400208SA030	34.5	35.5	Beryllium	0.87		?		0.69

Table 4.40. Metals detected in Sector 8
UCRS soil

Sample Type*	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	400208SA030	34.5	35.5	Sodium	553		?		340
		34.5	35.5	Vanadium	52.5		?		37

Note: Soil boring samples not containing any detectable metals at concentrations above background in Sector 8 are:

None

*** Sample 026020SA003 was collected from sludge inside pipeline**

Table 4.41. Radioactive isotopes detected in Sector 8 UCRS soil

Sample Type*	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/g	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/g
		Top	Bottom						
Sludge	026020SA003	3.5	3.5	Americium-241	0.6		?		0
		3.5	3.5	Cesium-137	3.8		?		0.28
		3.5	3.5	Neptunium-237	52.6		?		0
		3.5	3.5	Plutonium-239	11.2		?		0
		3.5	3.5	Technetium-99	4840		?		2.8
		3.5	3.5	Thorium-230	18.8		?		1.4
		3.5	3.5	Uranium-234	102		?		2.4
		3.5	3.5	Uranium-235	4.9		?		0.14
		3.5	3.5	Uranium-238	142		?		1.2
Soil	026001SA002	1.5	1.5	Neptunium-237	0.4		?		0
		1.5	1.5	Uranium-238	1.6		?		1.2
	026001SA026	26	26	Neptunium-237	0.2		?		0
	026003SA007	4	8	Cesium-137	1.4		=		0.28
		4	8	Uranium-234	7		=		2.4
		4	8	Uranium-238	53.2		=		1.2
	026007SA007	5	9	Cesium-137	0.4		=		0.28
		5	9	Neptunium-237	0.2		=		0
		5	9	Thorium-230	1.8		=		1.4
	026025SA015	3.5	3.5	Americium-241	0.2		?		0
		3.5	3.5	Cesium-137	11.1		?		0.28
		3.5	3.5	Neptunium-237	2.6		?		0

Table 4.41. Radioactive isotopes detected in Sector 8
UCRS soil

Sample Type*	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/g	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/g
		Top	Bottom						
Soil	026025SA015	3.5	3.5	Plutonium-239	0.8		?		0
		3.5	3.5	Technetium-99	265		?		2.8
		3.5	3.5	Thorium-230	3		?		1.4
		3.5	3.5	Uranium-234	28.2		?		2.4
		3.5	3.5	Uranium-235	1.1		?		0.14
		3.5	3.5	Uranium-238	36.5		?		1.2
	040010SA030	30	33	Americium-241	0.6		?		0
	400034SA001	0	1	Neptunium-237	0.6		?		0.1
		0	1	Plutonium-239	0.4		?		0.025
		0	1	Technetium-99	17		?		2.5
		0	1	Thorium-230	1.6		?		1.5
		0	1	Uranium-234	3.1		?		2.5
		0	1	Uranium-235	0.2		?		0.14
		0	1	Uranium-238	4.6		?		1.2
	400043SA001	0	1	Plutonium-239	0.2		?		0.025
		0	1	Technetium-99	3.1		?		2.5
		0	1	Thorium-230	1.6		?		1.5
		0	1	Uranium-238	2.7		?		1.2

Table 4.41. Radioactive isotopes detected in Sector 8
UCRS soil

Sample Type*	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/g	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/g
		Top	Bottom						

Note: Soil boring samples not containing any detectable radioactive isotopes at concentrations above background in Sector 8 are: 026005SA007, 026006SA007, 400208SA030

* Sample 026020SA003 was collected from sludge inside pipeline

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Table 4.42. Frequency of detection of organic compounds, metals, and radioactive isotopes in Sector 8 UCRS soil

Analytical Group	Analytical Compound	No. of Detects	No. of Analyses	Maximum Result	Minimum Result	Average Result	Units
VOA	Toluene	3	13	320.00	1.60	210.53	ug/kg
	cis-1,2-Dichloroethene	2	18	15.00	4.40	9.70	ug/kg
	Trichloroethene	2	18	34.00	3.10	18.55	ug/kg
	Vinyl acetate	1	13	41.00	41.00	41.00	ug/kg
SVOA	Fluoranthene	4	15	840.00	40.00	340.00	ug/kg
	Benz(a)anthracene	3	15	340.00	80.00	186.67	ug/kg
	Benzo(a)pyrene	3	15	280.00	80.00	166.67	ug/kg
	Benzo(b)fluoranthene	3	15	260.00	90.00	160.00	ug/kg
	Benzo(ghi)perylene	3	15	130.00	55.00	92.33	ug/kg
	Benzo(k)fluoranthene	3	15	290.00	70.00	163.33	ug/kg
	Chrysene	3	15	350.00	90.00	193.33	ug/kg
	Indeno(1,2,3-cd)pyrene	3	15	140.00	50.00	89.00	ug/kg
	Phenanthrene	3	15	700.00	110.00	323.33	ug/kg
	Pyrene	3	15	710.00	150.00	366.67	ug/kg
	2,4-Dinitrotoluene	1	15	457.00	457.00	457.00	ug/kg
	Acenaphthene	1	15	50.00	50.00	50.00	ug/kg
	Anthracene	1	15	160.00	160.00	160.00	ug/kg
	Fluorene	1	15	50.00	50.00	50.00	ug/kg
	N-Nitrosodiphenylamine	1	15	823.00	823.00	823.00	ug/kg
PCB	PCB-1254	1	10	32.00	32.00	32.00	ug/kg
	PCB-1260	1	10	63.00	63.00	63.00	ug/kg
Metals	Aluminum	9	14	16100.00	13200.00	14322.22	mg/kg
	Antimony	9	14	1.40	0.60	0.98	mg/kg
	Sodium	7	14	1170.00	352.00	617.43	mg/kg
	Arsenic	5	14	10.80	8.22	9.29	mg/kg
	Beryllium	4	14	0.98	0.69	0.83	mg/kg
	Calcium	4	14	15200.00	7710.00	11752.50	mg/kg
	Nickel	4	14	17600.00	31.80	4552.95	mg/kg
	Chromium	3	14	141.00	27.20	102.73	mg/kg
	Copper	3	14	9520.00	146.00	3352.00	mg/kg
	Cadmium	2	14	0.90	0.30	0.60	mg/kg
	Manganese	2	14	890.00	852.00	871.00	mg/kg

Table 4.42. Frequency of detection of organic compounds, metals, and radioactive isotopes in Sector 8 UCRS soil

Analytical Group	Analytical Compound	No. of Detects	No. of Analyses	Maximum Result	Minimum Result	Average Result	Units
Metals	Selenium	2	14	1.00	0.90	0.95	mg/kg
	Thallium	2	14	0.70	0.60	0.65	mg/kg
	Zinc	2	14	181.00	61.60	121.30	mg/kg
	Cobalt	1	14	16.00	16.00	16.00	mg/kg
	Iron	1	14	51700.00	51700.00	51700.00	mg/kg
	Lead	1	14	87.50	87.50	87.50	mg/kg
	Magnesium	1	14	2120.00	2120.00	2120.00	mg/kg
	Mercury	1	14	0.46	0.46	0.46	mg/kg
	Silver	1	14	4.12	4.12	4.12	mg/kg
	Vanadium	1	14	52.50	52.50	52.50	mg/kg
Radioactive isotopes	Neptunium-237	6	12	52.60	0.20	9.43	pCi/g
	Uranium-238	6	12	142.00	1.60	40.10	pCi/g
	Thorium-230	5	12	18.80	1.60	5.36	pCi/g
	Cesium-137	4	12	11.10	0.40	4.18	pCi/g
	Plutonium-239	4	12	11.20	0.20	3.15	pCi/g
	Technetium-99	4	12	4840.00	3.10	1281.28	pCi/g
	Uranium-234	4	12	102.00	3.10	35.08	pCi/g
	Americium-241	3	12	0.60	0.20	0.47	pCi/g
	Uranium-235	3	12	4.90	0.20	2.07	pCi/g

Table 4.43. SVOA and PCB compounds detected in Sector 9 UCRS soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
Soil	SVOA	400039SA001	0	1	Benz(a)anthracene	40	J	=	
			0	1	Benzo(a)pyrene	40	J	=	
			0	1	Benzo(b)fluoranthene	40	J	=	
			0	1	Benzo(k)fluoranthene	50	J	=	
			0	1	Chrysene	40	J	=	
			0	1	Fluoranthene	90	J	=	
			0	1	Phenanthrene	40	J	=	
			0	1	Pyrene	70	J	=	
		400049SA001	0.5	1.5	Benz(a)anthracene	130	J	?	
			0.5	1.5	Benzo(a)pyrene	150	J	?	
			0.5	1.5	Benzo(b)fluoranthene	180	J	?	
			0.5	1.5	Benzo(ghi)perylene	62	J	?	
			0.5	1.5	Benzo(k)fluoranthene	150	J	?	
			0.5	1.5	Chrysene	150	J	?	
			0.5	1.5	Fluoranthene	220	J	?	
			0.5	1.5	Indeno(1,2,3-cd)pyrene	67	J	?	
			0.5	1.5	Phenanthrene	70	J	?	
			0.5	1.5	Pyrene	220	J	?	
		400052SA001	0	1	Fluoranthene	60	J	?	
			0	1	Pyrene	60	J	?	
	PPCB	400039SA001	0	1	PCB-1260	5.6	J	=	

Table 4.43. SVOA and PCB compounds detected in Sector 9 UCRS soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
Soil	PPCB	400049SA001	0.5	1.5	PCB-1254	38	J	?	
			0.5	1.5	PCB-1260	38	J	?	

Note: Soil boring samples not containing any detectable SVOA compounds in Sector 9 are:
400048SA001, 400050SA001, 400051SA001, 400053SA001
Soil boring samples not containing any detectable PCB compounds in Sector 9 are:
400050SA001, 400051SA001, 400052SA001, 400053SA001

Table 4.44. Metals detected in Sector 9
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	400039SA001	0	1	Aluminum	15700		=		13000
		0	1	Antimony	2.9	B	=		0.21
		0	1	Chromium	16.8		=		16
	400048SA001	0.5	1.5	Antimony	0.9	B	?		0.21
		0.5	1.5	Cadmium	0.22	B	?		0.21
		0.5	1.5	Chromium	23.4		?		16
		0.5	1.5	Copper	20.3		?		19
		0.5	1.5	Sodium	503		?		320
	400049SA001	0.5	1.5	Antimony	1.4	B	?		0.21
		0.5	1.5	Chromium	18.4		?		16
		0.5	1.5	Sodium	420		?		320
	400050SA001	1	2	Arsenic	16.2		?		12
		1	2	Beryllium	1		?		0.67
		1	2	Cadmium	0.25	B	?		0.21
		1	2	Chromium	21.8		?		16
		1	2	Iron	30900		?		28000
		1	2	Sodium	582		?		320
		1	2	Vanadium	52.5		?		38
	400051SA001	1	2	Aluminum	14800		?		13000
		1	2	Arsenic	18.3		?		12
		1	2	Beryllium	1.2		?		0.67

Table 4.44. Metals detected in Sector 9
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Bottom	Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
Soil	400051SA001	1	2	Cadmium	0.41	B	?		0.21
		1	2	Chromium	24.9		?		16
		1	2	Iron	34400		?		28000
		1	2	Sodium	674		?		320
		1	2	Vanadium	59.8		?		38
	400052SA001	0	1	Antimony	0.6	B	?		0.21
	400053SA001	0.4	1.4	Aluminum	14800		=		13000
		0.4	1.4	Antimony	2.7	B	=		0.21
		0.4	1.4	Chromium	19.6		=		16
		0.4	1.4	Sodium	340		=		320
		0.4	1.4	Thallium	0.9	B	=		0.21

Note: Soil boring samples not containing any detectable metals at concentrations above background in Sector 9 are:

None

Table 4.45. Radioactive isotopes detected in Sector 9
UCRS soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/g	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/g
		Top	Bottom						
Soil	400039SA001	0	1	Americium-241	1		=		0
		0	1	Uranium-234	7.9		=		2.5
		0	1	Uranium-235	0.5		=		0.14
		0	1	Uranium-238	8.7		=		1.2
	400049SA001	0.5	1.5	Technetium-99	2.9		?		2.5
		0.5	1.5	Uranium-234	5.4		?		2.5
		0.5	1.5	Uranium-235	0.3		?		0.14
		0.5	1.5	Uranium-238	5.7		?		1.2
	400050SA001	1	2	Americium-241	1.3		?		0
		1	2	Uranium-234	2.6		?		2.5
		1	2	Uranium-238	3.2		?		1.2
	400051SA001	1	2	Uranium-238	2.7		?		1.2
	400052SA001	0	1	Uranium-238	2		?		1.2
	400053SA001	0.4	1.4	Americium-241	0.2		=		0

Note: Soil boring samples not containing any detectable radioactive isotopes at concentrations above background in Sector 9 are:

None

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Table 4.46. Frequency of detection of organic compounds, metals, and radioactive isotopes in Sector 9 UCRS soil

Analytical Group	Analytical Compound	No. of Detects	No. of Analyses	Maximum Result	Minimum Result	Average Result	Units
SVOA	Fluoranthene	3	7	220.00	60.00	123.33	ug/kg
	Pyrene	3	7	220.00	60.00	116.67	ug/kg
	Benz(a)anthracene	2	7	130.00	40.00	85.00	ug/kg
	Benzo(a)pyrene	2	7	150.00	40.00	95.00	ug/kg
	Benzo(b)fluoranthene	2	7	180.00	40.00	110.00	ug/kg
	Benzo(k)fluoranthene	2	7	150.00	50.00	100.00	ug/kg
	Chrysene	2	7	150.00	40.00	95.00	ug/kg
	Phenanthrene	2	7	70.00	40.00	55.00	ug/kg
	Benzo(ghi)perylene	1	7	62.00	62.00	62.00	ug/kg
	Indeno(1,2,3-cd)pyrene	1	7	67.00	67.00	67.00	ug/kg
PCB	PCB-1260	2	6	38.00	5.60	21.80	ug/kg
	PCB-1254	1	6	38.00	38.00	38.00	ug/kg
Metals	Chromium	6	7	24.90	16.80	20.82	mg/kg
	Antimony	5	7	2.90	0.60	1.70	mg/kg
	Sodium	5	7	674.00	340.00	503.80	mg/kg
	Aluminum	3	7	15700.00	14800.00	15100.00	mg/kg
	Cadmium	3	7	0.41	0.22	0.29	mg/kg
	Arsenic	2	7	18.30	16.20	17.25	mg/kg
	Beryllium	2	7	1.20	1.00	1.10	mg/kg
	Iron	2	7	34400.00	30900.00	32650.00	mg/kg
	Vanadium	2	7	59.80	52.50	56.15	mg/kg
	Copper	1	7	20.30	20.30	20.30	mg/kg
	Thallium	1	7	0.90	0.90	0.90	mg/kg
Radioactive isotopes	Uranium-238	5	6	8.70	2.00	4.46	pCi/g
	Americium-241	3	6	1.30	0.20	0.83	pCi/g
	Uranium-234	3	6	7.90	2.60	5.30	pCi/g
	Uranium-235	2	6	0.50	0.30	0.40	pCi/g
	Technetium-99	1	6	2.90	2.90	2.90	pCi/g

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Table 4.47. VOA compounds detected in RGA/McNairy soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Soil	400036SA065	65	65	Trichloroethene	2.3	J	?	
	400036SA070	69	69	Trichloroethene	1500		?	
	400036SA080	79	79	Trichloroethene	600		?	
	400036SA087	87	87	Trichloroethene	300	J	?	
	400038SA060	60.5	61	Trichloroethene	11000		?	
	400038SA070	71	73	Trichloroethene	40000		?	BL-T
	400038SA140	140.5	141	Toluene	2.3	J	?	
	400038SD140	140.5	141	Toluene	1.6	J	?	
	400040SA075	73	74	Trichloroethene	13		?	
	400040SA085	83	84	Trichloroethene	1400		?	
	400041SA085	84.4	84.4	Trichloroethene	2900		?	BH-RB
	400041SA095	86	86	2-Propanol	70		?	
		86	86	Trichloroethene	5000		?	BH-RB
	400207SA060	66	67	Trichloroethene	4500		?	
	400207SA070	71	72	Trichloroethene	56000		?	
	400207SA080	82	83	Trichloroethene	24000		?	
	400207SA090	94	95	Toluene	6.4	J	?	
		94	95	Trichloroethene	24000		?	
	400207SD070	71	72	Trichloroethene	65000		?	
	400207SD090	94	95	Chloroform	1.6	J	?	

Table 4.47. VOA compounds detected in RGA/McNairy soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Soil	400207SD090	94	95	Trichloroethene	25000		?	
	400208SA070	70	71	Trichloroethene	5300		?	
	400208SA080	80	81	Trichloroethene	4300		?	
	400208SA100	114	115	Benzene	1.8	J	?	
		114	115	Toluene	1.7	J	?	
	400208SD100	114	115	Benzene	1.2	J	?	
	400210SA070	73	73.5	Trichloroethene	400	J	?	
	400210SA110	115.5	116	Benzene	1.9	J	?	
		115.5	116	Toluene	2.2	J	?	
	400210SA140	136.5	137	Benzene	1.3	J	?	
		136.5	137	Toluene	1.4	J	?	
	400212SA063	63	64	Trichloroethene	2.8	J	?	
	400212SA100	117	119.5	2-Hexanone	6	J	?	
		117	119.5	Toluene	20		?	
		117	119.5	Trichloroethene	2.8	J	?	
	400212SD100	115	116	2-Hexanone	5.2	J	?	
		115	116	Toluene	15		?	

Table 4.47. VOA compounds detected in RGA/McNairy soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					

Note: Soil boring samples not containing any detectable VOA compounds in RGA/McNairy soil are:

026001SA056, 026001SA070, 026001SA072, 026001SA080, 026001SA090, 026001SA100, 026001SA120, 026001SA140, 400036SA060, 400036SA090, 400036SA095, 400036SA110, 400036SA120, 400036SA140, 400038SA055, 400038SA080, 400038SA090, 400038SA100, 400038SA120, 400040SA060, 400040SA095, 400040SA100, 400040SA110, 400040SD095, 400041SA055, 400041SA060, 400041SA075, 400041SA110, 400041SA120, 400207SA095, 400207SA120, 400207SA140, 400207SD095, 400208SA060, 400208SA095, 400208SA140, 400208SD140, 400210SA060, 400210SA080, 400210SA090, 400210SD110, 400210SD140, 400212SA045, 400212SA060, 400212SA070, 400212SA080. 400212SA090. 400212SA095. 400212SA120

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Table 4.48. SVOA and PCB compounds detected in RGA/McNairy soil

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results ug/kg	Lab Qualifier	Validation Qualifier	Data Assessment
Soil	SVOA	400036SA087	87	87	Di-n-octylphthalate	721	J	?	
		400041SA055	55	55	Diethyl phthalate	50	J	?	
		400041SA110	112	112	Diethyl phthalate	60	J	?	
		400041SA120	224	225	Diethyl phthalate	80	J	?	

Note: Soil boring samples not containing any detectable SVOA compounds in RGA/McNairy soil are:
026001SA056, 026001SA072, 400036SA065, 400041SA060, 400041SA075, 400041SA085, 400041SA095

Soil boring samples not containing any detectable PCB compounds in RGA/McNairy soil are:
400036SA065, 400036SA087, 400041SA060

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Table 4.49. Metals detected in RGA/McNairy soil

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
Soil	026001SA056	56	56	Barium	313		?		170
		56	56	Cobalt	28.7		?		13
		56	56	Manganese	2000		?		820
	026001SA072	72	72	Sodium	467		?		340
	400036SA087	87	87	Beryllium	1.1		?		0.69
		87	87	Iron	48400		?		28000
		87	87	Nickel	26.7		?		22
		87	87	Zinc	89.1		?		60
	400040SA060	62	63	Antimony	0.6	B	?		0.21
		62	63	Barium	571		?		170
		62	63	Beryllium	0.76		?		0.69
		62	63	Cobalt	70.2		?		13
		62	63	Manganese	3320		?		820
		62	63	Sodium	730		?		340
	400040SA075	73	74	Antimony	1.1	B	?		0.21
		73	74	Beryllium	0.76		?		0.69
		73	74	Iron	30100		?		28000
		73	74	Sodium	765		?		340
	400040SA085	83	84	Sodium	558		?		340
	400040SA095	87	88	Barium	699		?		170
		87	88	Beryllium	3	B	?		0.69

Table 4.49. Metals detected in RGA/McNairy soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	400040SA095	87	88	Chromium	56		?		43
		87	88	Cobalt	44		?		13
		87	88	Iron	380000		?		28000
		87	88	Manganese	7240		?		820
		87	88	Nickel	46	B	?		22
		87	88	Silver	3	B	?		2.7
		87	88	Sodium	6900		?		340
		87	88	Vanadium	59		?		37
		87	88	Zinc	133		?		60
	400040SA100	99	100	Beryllium	0.77		?		0.69
		99	100	Magnesium	2430		?		2100
		99	100	Potassium	2600		?		950
		99	100	Sodium	567		?		340
	400040SA110	109	110	Sodium	417		?		340
	400040SD095	87	88	Barium	546		?		170
		87	88	Beryllium	2.9	B	?		0.69
		87	88	Cobalt	18	B	?		13
		87	88	Iron	336000		?		28000
		87	88	Manganese	5050		?		820
		87	88	Nickel	35	B	?		22
		87	88	Sodium	6100		?		340

Table 4.49. Metals detected in RGA/McNairy soil

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/kg	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/kg
		Top	Bottom						
Soil	400040SD095	87	88	Vanadium	39		?		37
		87	88	Zinc	99		?		60

Note: **Soil boring samples not containing any detectable metals at concentrations above background in RGA/McNairy soil are:**
400036SA065

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Table 4.50. Radioactive isotopes detected in RGA/McNairy soil

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results pCi/g	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/g
Soil	400036SA087	87	87	Neptunium-237	0.2		?		0
	400040SA095	87	88	Cesium-137	0.4		?		0.28
	400040SA100	99	100	Cesium-137	0.4		?		0.28
	400041SA055	55	55	Neptunium-237	0.2		?		0
	400041SA060	66	66	Neptunium-237	0.3		?		0
	400207SA095	97	99	Cesium-137	0.4		?		0.28
	400210SA140	136.5	137	Neptunium-237	0.3		?		0
	400210SD110	115.5	116	Cesium-137	0.5		?		0.28
	400212SA120	137	137.5	Uranium-235	0.2		?		0.14

Note: Soil boring samples not containing any detectable radioactive isotopes at concentrations above background in RGA/McNairy soil are:

026001SA056, 026001SA072, 026001SA090, 400036SA065, 400036SA070, 400038SA140, 400038SD140, 400040SA075, 400040SA085, 400040SA110, 400040SD095, 400041SA075, 400041SA085, 400041SA095, 400041SA110, 400041SA120, 400207SA070, 400207SA090, 400207SA140, 400207SD070, 400207SD090, 400207SD095, 400208SA100, 400208SA140, 400208SD100, 400208SD140, 400210SA060, 400210SA110, 400210SD140, 400212SA100, 400212SD100

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Table 4.51. Frequency of detection of organic compounds, metals, and radioactive isotopes in RGA/McNairy soil

Analytical Group	Analytical Compound	No. of Detects	No. of Analyses	Maximum Result	Minimum Result	Average Result	Units
VOA	Trichloroethene	21	76	65000.00	1.20	6772.43	ug/kg
	Toluene	8	44	20.00	1.40	6.33	ug/kg
	Benzene	4	44	1.90	1.20	1.55	ug/kg
	2-Hexanone	2	44	6.00	5.20	5.60	ug/kg
	2-Propanol	1	44	70.00	70.00	70.00	ug/kg
	Chloroform	1	44	1.60	1.60	1.60	ug/kg
SVOA	Diethyl phthalate	3	11	80.00	50.00	63.33	ug/kg
	Di-n-octylphthalate	1	11	721.00	721.00	721.00	ug/kg
Metals	Sodium	8	11	6900.00	417.00	2063.00	mg/kg
	Beryllium	6	11	3.00	0.76	1.55	mg/kg
	Barium	4	11	699.00	313.00	532.25	mg/kg
	Cobalt	4	11	70.20	18.00	40.23	mg/kg
	Iron	4	11	380000.00	30100.00	198625.00	mg/kg
	Manganese	4	11	7240.00	2000.00	4402.50	mg/kg
	Nickel	3	11	46.00	26.70	35.90	mg/kg
	Zinc	3	11	133.00	89.10	107.03	mg/kg
	Antimony	2	11	1.10	0.60	0.85	mg/kg
	Vanadium	2	11	59.00	39.00	49.00	mg/kg
	Chromium	1	11	56.00	56.00	56.00	mg/kg
	Magnesium	1	11	2430.00	2430.00	2430.00	mg/kg
	Potassium	1	11	2600.00	2600.00	2600.00	mg/kg
	Silver	1	11	3.00	3.00	3.00	mg/kg
Radioactive isotopes	Cesium-137	4	40	0.50	0.40	0.43	pCi/g
	Neptunium-237	4	40	0.30	0.20	0.25	pCi/g
	Uranium-235	1	40	0.20	0.20	0.20	pCi/g

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Table 4.52. VOA compounds detected in UCRS water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/L	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Groundwater	011008WP040	33	43	Trichloroethene	107087		?	
	011011WA040	35	40	Trichloroethene	438324		?	
	040001WP040	31	41	Trichloroethene	2.3	J	?	
	040009WA040	15	19	2-Butanone	4.7	J	?	
		15	19	4-Methyl-2-pentanone	2.6	J	?	
		15	19	cis-1,2-Dichloroethene	3.3	J	?	
		15	19	Trichloroethene	3.9	J	?	
	203001WP040	31	41	1,1-Dichloroethene	1.6	J	?	
		31	41	trans-1,2-Dichloroethene	3.4	J	?	
		31	41	Trichloroethene	22		?	
	400003WP040	34	44	Trichloroethene	1120		?	
	400016WP040	33	43	trans-1,2-Dichloroethene	500	J	?	
		33	43	Trichloroethene	32998		?	
	400017WP040	33	43	Trichloroethene	230		?	
	400018WA040	37.5	40	Trichloroethene	101		?	
	400025WP040	31	41	Trichloroethene	2.4	J	?	
	400026WP040	33	43	Trichloroethene	2481		?	
	400027WP040	34	44	Trichloroethene	61		?	
	400063WP040	29	39	Trichloroethene	74		?	
	400083WP040	30	40	Trichloroethene	5		?	

Table 4.52. VOA compounds detected in UCRS water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/L	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					

Note: Groundwater samples not containing any detectable VOA compounds in UCRS water are:
026002WP040, 026018WA003, 203005WA015, 400021WP040, 400033WP040

Table 4.53. SVOA compounds detected in UCRS water

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/L	Lab Qualifier	Validation Qualifier	Data Assessment
			Top	Bottom					
Groundwater	SVOA	040009WA040	15	19	Diethyl phthalate	4.1	JH	?	

Note: Groundwater samples not containing any detectable SVOA compounds in UCRS water are:
011011WA040

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Table 4.54. Metals detected in UCRS water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/L	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/L
		Top	Bottom						
Groundwater	400018WA040	37.5	40	Manganese	0.281		?		0.16
		37.5	40	Sodium	101		?		60
		37.5	40	Zinc	0.19		?		0.027

Note: Groundwater samples not containing any detectable metals at concentrations above background in UCRS water are:

None

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Table 4.55. Radioactive isotopes detected in UCRS water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/L	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/L
		Top	Bottom						
Groundwater	040009WA040	15	19	Actinium-228	5.3		?		0
		15	19	Bismuth-214	3.5		?		0
		15	19	Lead-212	4.9		?		0
		15	19	Lead-214	2.6		?		0
		15	19	Potassium-40	20		?		0
		15	19	Thallium-208	2.1		?		0
		15	19	Thorium-234	113		?		0
		15	19	Uranium-235	11.3		?		0.15
	400018WA040	37.5	40	Actinium-228	18.8		?		0
		37.5	40	Bismuth-212	8.3		?		0
		37.5	40	Bismuth-214	14.1		?		0
		37.5	40	Lead-212	16		?		0
		37.5	40	Lead-214	16.7		?		0
		37.5	40	Potassium-40	69		?		0
		37.5	40	Technetium-99	22		?		0
		37.5	40	Thallium-208	5.4		?		0
		37.5	40	Thorium-228	11.27		?		0
		37.5	40	Thorium-230	6.6		?		1.4
		37.5	40	Thorium-232	10.29		?		0
		37.5	40	Uranium-233/234	7.86		?		0
		37.5	40	Uranium-235	0.4		?		0.15

Table 4.55. Radioactive isotopes detected in UCRS water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/L	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/L
		Top	Bottom						
Groundwater	400018WA040	37.5	40	Uranium-238	9.1		?		1.1

Note: **Groundwater samples not containing any detectable radioactive isotopes at concentrations above background in UCRS water are:**

None

Table 4.56. Frequency of detection of organic compounds, metals, and radioactive isotopes in UCRS water

Analytical Group	Analytical Compound	No. of Detects	No. of Analyses	Maximum Result	Minimum Result	Average Result	Units
VOA	Trichloroethene	14	19	438324.00	2.30	38810.65	ug/L
	trans-1,2-Dichloroethene	2	19	500.00	3.40	251.70	ug/L
	1,1-Dichloroethene	1	19	1.60	1.60	1.60	ug/L
	2-Butanone	1	2	4.70	4.70	4.70	ug/L
	4-Methyl-2-pentanone	1	2	2.60	2.60	2.60	ug/L
	cis-1,2-Dichloroethene	1	19	3.30	3.30	3.30	ug/L
SVOA	Diethyl phthalate	1	2	4.10	4.10	4.10	ug/L
Metals	Iron	3	3	635.00	5.43	225.68	mg/L
	Zinc	3	3	2.74	0.05	0.56	mg/L
	Aluminum	2	3	415.00	43.90	229.45	mg/L
	Copper	2	3	0.25	0.03	0.14	mg/L
	Manganese	2	3	2.45	0.28	0.89	mg/L
	Arsenic	1	3	0.04	0.04	0.04	mg/L
	Barium	1	3	1.54	1.54	1.54	mg/L
	Beryllium	1	3	0.03	0.03	0.03	mg/L
	Calcium	1	3	63.90	63.90	63.90	mg/L
	Chromium	1	3	0.78	0.78	0.78	mg/L
	Cobalt	1	3	0.24	0.24	0.24	mg/L
	Lead	1	3	0.25	0.25	0.25	mg/L
	Magnesium	1	3	31.10	31.10	31.10	mg/L
	Mercury	1	3	0.00	0.00	0.00	mg/L
	Nickel	1	3	0.26	0.26	0.26	mg/L
	Potassium	1	3	13.70	13.70	13.70	mg/L
	Sodium	1	3	109.00	101.00	105.00	mg/L
	Vanadium	1	3	1.51	1.51	1.51	mg/L
Radioactive isotopes	Actinium-228	2	2	18.80	5.30	12.05	pCi/L
	Bismuth-214	2	2	14.10	3.50	8.80	pCi/L
	Lead-212	2	2	16.00	4.90	10.45	pCi/L
	Lead-214	2	2	16.70	2.60	9.65	pCi/L
	Potassium-40	2	2	69.00	20.00	44.50	pCi/L
	Thallium-208	2	2	5.40	2.10	3.75	pCi/L
	Uranium-235	2	2	11.30	0.40	5.85	pCi/L
	Bismuth-212	1	2	8.30	8.30	8.30	pCi/L

Table 4.56. Frequency of detection of organic compounds, metals, and radioactive isotopes in UCRS water

Analytical Group	Analytical Compound	No. of Detects	No. of Analyses	Maximum Result	Minimum Result	Average Result	Units
Radioactive isotopes	Technetium-99	1	1	22.00	22.00	22.00	pCi/L
	Thorium-228	1	1	11.27	11.27	11.27	pCi/L
	Thorium-230	1	1	6.60	6.60	6.60	pCi/L
	Thorium-232	1	1	10.29	10.29	10.29	pCi/L
	Thorium-234	1	2	113.00	113.00	113.00	pCi/L
	Uranium-233/234	1	1	7.86	7.86	7.86	pCi/L
	Uranium-238	1	1	9.10	9.10	9.10	pCi/L

Table 4.57. VOA compounds detected in RGA water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/L	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Groundwater	011010WA070	70	70	trans-1,2-Dichloroethene	1200	J	?	
		70	70	Trichloroethene	250000	D	?	
	026001WA060	62	62	Trichloroethene	834		?	
	026001WA065	67	67	Trichloroethene	5331		?	
	026001WA070	67	72	Trichloroethene	3873		?	
	026001WA075	72	77	Trichloroethene	2871		?	
	026001WA080	82	82	Trichloroethene	3517		?	
	026001WA085	87	87	Trichloroethene	6214		?	
	026001WA090	92	92	Trichloroethene	17.7		?	
	040011WA060	70	70	Trichloroethene	11363		?	
	047012WA060	60	61	Carbon tetrachloride	120	JD		
		60	61	cis-1,2-Dichloroethene	220	JD		
		60	61	Trichloroethene	15000	D		
	400034WA060	60	61	1,1-Dichloroethene	2.7	J	?	BH-RB
		60	61	cis-1,2-Dichloroethene	12	J	?	BH-RB
		60	61	trans-1,2-Dichloroethene	3	J	?	BH-RB
		60	61	Trichloroethene	139		?	BH-RB
	400034WA065	65	66	Trichloroethene	16550	J	?	BH-RB
	400034WA070	70	71	Trichloroethene	23933	J	?	BH-RB
	400034WA075	75	76	Trichloroethene	40766		?	BH-RB

Table 4.57. VOA compounds detected in RGA water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/L	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Groundwater	400034WA080	80	81	Trichloroethene	91736		?	BH-RB
	400034WA085	85	86	Trichloroethene	22284	J	?	BH-RB
	400035WA060	60	61	Trichloroethene	447		?	BH-RB
	400035WA065	65	66	cis-1,2-Dichloroethene	370	J	?	BH-RB
		65	66	Trichloroethene	446	J	?	BH-RB
	400035WA070	70	71	Trichloroethene	8795		?	BH-RB
	400035WA075	75	76	Trichloroethene	26905		?	BH-RB
	400035WA080	80	81	Trichloroethene	17672		?	BH-RB
	400035WA085	85	86	Trichloroethene	12510		?	BH-RB
	400036WA065	67	67	trans-1,2-Dichloroethene	3	J	?	BL-PURGE
		67	67	Trichloroethene	480		?	BL-PURGE
	400036WA070	72	72	trans-1,2-Dichloroethene	53		?	
		72	72	Trichloroethene	10300		?	
	400036WA075	77	77	trans-1,2-Dichloroethene	5		?	BL-PURGE
		77	77	Trichloroethene	1300		?	BL-PURGE
	400036WA080	82	82	trans-1,2-Dichloroethene	21		?	
		82	82	Trichloroethene	4300		?	
	400036WA085	87	87	trans-1,2-Dichloroethene	2	J	?	
		87	87	Trichloroethene	600		?	
	400036WA090	92	92	Trichloroethene	840		?	

Table 4.57. VOA compounds detected in RGA water

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results ug/L	Lab Qualifier	Validation Qualifier	Data Assessment
Groundwater	400037WA060	60	61	Trichloroethene	79078		?	
	400037WA065	65	66	Trichloroethene	172858		?	
	400037WA070	70	74	Trichloroethene	701184		?	
	400037WA075	75	76	Trichloroethene	638576		?	
	400037WA080	80	81	Trichloroethene	419380		?	
	400037WA085	85	86	Trichloroethene	42072		?	
	400037WA090	90	91	Trichloroethene	39096		?	
	400038WA060	61	61	Trichloroethene	60		?	BL-PURGE
	400038WA065	66	66	Trichloroethene	3656		?	BL-PURGE
	400038WA070	71	71	Trichloroethene	4464		?	BL-PURGE
	400038WA075	76	76	1,1-Dichloroethene	154		?	BL-PURGE
		76	76	cis-1,2-Dichloroethene	195		?	BL-PURGE
		76	76	trans-1,2-Dichloroethene	305		?	BL-PURGE
		76	76	Trichloroethene	745		?	BL-PURGE
		76	76	Vinyl chloride	133		?	BL-PURGE
	400038WA080	81	81	Trichloroethene	1010		?	BL-PURGE
	400038WA085	86	86	Trichloroethene	19373		?	BL-PURGE
	400038WA090	87	87.5	Trichloroethene	1352		?	BL-PURGE
	400038WD085	86	86	Trichloroethene	19736		?	BL-PURGE
	400039WA060	60	61	Trichloroethene	88		?	

Table 4.57. VOA compounds detected in RGA water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/L	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Groundwater	400039WA065	65	66	Trichloroethene	236		?	
	400039WA070	70	71	Trichloroethene	1063		?	
	400039WA075	75	76	Trichloroethene	1256		?	
	400039WA080	80	81	Trichloroethene	975		?	
	400039WA085	85	86	1,1-Dichloroethene	3	JD	=	
		85	86	Carbon tetrachloride	270	D	=	
		85	86	Chloroform	26	D	=	
		85	86	cis-1,2-Dichloroethene	46	D	=	
		85	86	Tetrachloroethene	3	JD	=	
		85	86	Trichloroethene	1000	D	=	
	400039WA090	90	91	Trichloroethene	840		?	
	400040WA065	63	69	1,1,1-Trichloroethane	12	JD	?	
		63	69	1,1-Dichloroethene	70	D	?	
		63	69	Bromodichloromethane	4	JD	?	
		63	69	Chloroform	20	JD	?	
		63	69	Trichloroethene	990	D	?	
	400040WA070	69	70	Trichloroethene	28000	D	?	BL-PURGE
	400040WA075	74	75	Chloroform	15	JD	?	BL-PURGE
		74	75	Trichloroethene	1998		?	BL-PURGE
	400040WA080	79	80	Trichloroethene	57639		?	BL-PURGE

Table 4.57. VOA compounds detected in RGA water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/L	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Groundwater	400040WA085	85	86	Bromodichloromethane	3	JD	?	BL-PURGE
		85	86	Chloroform	20	JD	?	BL-PURGE
		85	86	Trichloroethene	620	D	?	BL-PURGE
	400040WD075	74	75	Chloroform	15	JD	?	
		74	75	Trichloroethene	1500	D	?	
	400041WA065	68	68	Carbon tetrachloride	1	JD	=	
		68	68	Chloroform	17	D	=	
		68	68	Toluene	36	D	=	
		68	68	Trichloroethene	553		?	BH-RB
	400041WA070	73.5	73.5	Trichloroethene	898		?	BL-PURGE,BH-RB
	400041WA075	78.9	78.9	Trichloroethene	20386		?	BH-RB
	400041WA080	84.4	84.4	Trichloroethene	33000	D	=	
	400041WA085	90	90	Trichloroethene	126012		?	BH-RB
	400042WA065	65	65	Trichloroethene	2381		?	
	400042WA070	70	71	Trichloroethene	26900		?	
	400042WA075	75	76	Trichloroethene	24625		?	
	400042WA080	80	81	Trichloroethene	20471	J	?	
	400042WA085	85	86	Trichloroethene	7885	J	?	
	400043WA070	72	72	Trichloroethene	13		?	BL-PURGE
	400043WA075	77	77	Trichloroethene	187		?	BL-PURGE

Table 4.57. VOA compounds detected in RGA water

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results ug/L	Lab Qualifier	Validation Qualifier	Data Assessment
Groundwater	400043WA080	82	82	Trichloroethene	14580		?	BL-PURGE
	400043WA085	87	87	Trichloroethene	6557		?	BL-PURGE
	400043WA090	92	92	Trichloroethene	79.99		?	BL-PURGE
	400044WA065	67	67	Trichloroethene	633		?	
	400044WA070	72	72	1,1-Dichloroethene	4		?	
		72	72	cis-1,2-Dichloroethene	2.9	J	?	
		72	72	trans-1,2-Dichloroethene	195	J	?	
		72	72	Trichloroethene	9031		?	
	400044WA075	77	77	trans-1,2-Dichloroethene	10		?	BL-PURGE
		77	77	Trichloroethene	298		?	BL-PURGE
	400044WA080	82	82	1,1-Dichloroethene	16.9		?	
		82	82	trans-1,2-Dichloroethene	299	J	?	
		82	82	Trichloroethene	10694		?	
	400044WA085	87	87	1,1-Dichloroethene	11.2		?	
		87	87	trans-1,2-Dichloroethene	41		?	
		87	87	Trichloroethene	2444		?	
	400044WA090	92	92	1,1-Dichloroethene	10		?	
		92	92	trans-1,2-Dichloroethene	77	J	?	
		92	92	Trichloroethene	6684		?	
	400045WA065	63	64	Trichloroethene	24473		?	

Table 4.57. VOA compounds detected in RGA water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/L	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Groundwater	400045WA070	68	69	Trichloroethene	13549		?	
	400045WA075	73	74	trans-1,2-Dichloroethene	49	J	?	BH-RB
		73	74	Trichloroethene	630	J	?	BH-RB
	400045WA080	78	79	1,1-Dichloroethene	5.2	J	?	
		78	79	trans-1,2-Dichloroethene	4.2	J	?	
		78	79	Trichloroethene	246		?	
		78	79	Vinyl chloride	8		?	
	400045WA085	83	84	Trichloroethene	129		?	BH-ER
	400045WA090	88	89	1,1-Dichloroethene	3.6	J	?	
		88	89	Trichloroethene	137		?	BH-ER
	400045WD080	78	79	1,1-Dichloroethene	3.3	J	?	
		78	79	trans-1,2-Dichloroethene	4	J	?	
		78	79	Trichloroethene	227		?	
	400046WA060	60	60	Trichloroethene	15094	J	?	
	400046WA065	65	65	Trichloroethene	77489		?	
	400046WA070	70	70	Trichloroethene	143034	J	?	
	400046WA075	75	75	Trichloroethene	54052		?	BH-RB
	400046WA080	80	80	Trichloroethene	3386		?	
	400046WA085	84	85	1,1-Dichloroethene	35	J	?	BH-RB
		84	85	Trichloroethene	843		?	BH-RB

Table 4.57. VOA compounds detected in RGA water

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results ug/L	Lab Qualifier	Validation Qualifier	Data Assessment
Groundwater	400047WA060	60	60	Trichloroethene	5813		?	
	400047WA065	65	65	Trichloroethene	17458	J	?	
	400047WA070	70	70	Trichloroethene	18563		?	
	400047WA075	75	75	Trichloroethene	8678	J	?	
	400047WA080	80	80	Trichloroethene	6689		?	
	400047WA085	85	85	Trichloroethene	1019		?	
	400048WA055	52	52	trans-1,2-Dichloroethene	8.6		?	
		52	52	Trichloroethene	1.9	J	?	
	400048WA060	57	57	trans-1,2-Dichloroethene	29.4		?	BL-PURGE
		57	57	Trichloroethene	3.4	J	?	BL-PURGE
	400048WA065	62	62	trans-1,2-Dichloroethene	12.4		?	BL-PURGE
		62	62	Trichloroethene	1.5	J	?	BL-PURGE
	400048WA070	67	67	trans-1,2-Dichloroethene	13.5		?	BL-PURGE
		67	67	Trichloroethene	1.6	J	?	BL-PURGE
	400048WA075	72	72	1,1-Dichloroethene	59.8		?	
		72	72	trans-1,2-Dichloroethene	5.4	J	?	
		72	72	Trichloroethene	539		?	
	400048WA080	77	77	1,1-Dichloroethene	16		?	BL-PURGE
		77	77	Trichloroethene	129		?	BL-PURGE
	400048WA085	82	82	1,1-Dichloroethene	35.1		?	

Table 4.57. VOA compounds detected in RGA water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/L	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Groundwater	400048WA085	82	82	trans-1,2-Dichloroethene	1.7	J	?	
		82	82	Trichloroethene	172		?	
	400048WA090	87	87	1,1-Dichloroethene	74.9		?	
		87	87	trans-1,2-Dichloroethene	3.1	J	?	
		87	87	Trichloroethene	548		?	
	400048WA095	92	92	1,1-Dichloroethene	1.6	J	?	BL-PURGE
		92	92	trans-1,2-Dichloroethene	17		?	BL-PURGE
		92	92	Trichloroethene	17		?	BL-PURGE
	400049WA080	72	77	1,1-Dichloroethene	1.2	J	?	BL-PURGE
		72	77	Trichloroethene	149		?	BL-PURGE
	400049WA090	82	87	Trichloroethene	12		?	BL-PURGE
	400049WA095	87	92	1,1-Dichloroethene	1	J	?	BL-PURGE
		87	92	cis-1,2-Dichloroethene	1.3	J	?	BL-PURGE
		87	92	trans-1,2-Dichloroethene	4.6		?	BL-PURGE
		87	92	Trichloroethene	127		?	BL-PURGE
		87	92	Vinyl chloride	1	J	?	BL-PURGE
	400052WA065	65	65	Trichloroethene	21		?	
	400052WA070	70	70	Trichloroethene	410		?	
	400052WA075	75	75	Trichloroethene	650		?	
	400052WA080	80	80	Trichloroethene	1229		?	

Table 4.57. VOA compounds detected in RGA water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/L	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Groundwater	400052WA085	85	85	trans-1,2-Dichloroethene	6.4	J	?	
		85	85	Trichloroethene	764		?	
	400052WA090	90	90	trans-1,2-Dichloroethene	8	J	?	
		90	90	Trichloroethene	307		?	
	400053WA065	66	66	1,1-Dichloroethene	11	J	?	BL-PURGE
		66	66	Trichloroethene	44	J	?	BL-PURGE
	400053WA070	71	71	Trichloroethene	9	J	?	
	400053WA075	76	76	Trichloroethene	22.5		?	BL-PURGE
	400053WA080	81	81	Trichloroethene	1888.6		?	
	400053WA085	86	86	Trichloroethene	6	J	?	BL-PURGE
	400053WA090	90	90	Trichloroethene	87.6		?	BL-PURGE
	400206WA060	60	61	Trichloroethene	212		?	
	400206WA065	65	66	Trichloroethene	4881		?	
	400206WA070	70	71	Trichloroethene	5310		?	
	400206WA075	75	76	Trichloroethene	7536		?	
	400206WA080	80	81	Trichloroethene	9549		?	
	400206WA085	85	86	Trichloroethene	9752		?	
	400208WA080	80	81	Trichloroethene	48815		?	
	400208WB085	85	85	Trichloroethene	99000	D		
	400210WB085	85	86	Trichloroethene	29000	D		

Table 4.57. VOA compounds detected in RGA water

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results ug/L	Lab Qualifier	Validation Qualifier	Data Assessment
Groundwater	400212WB085	85	86	Carbon tetrachloride	80	D		
		85	86	Chloroform	36	JD		
		85	86	cis-1,2-Dichloroethene	57	D		
		85	86	Trichloroethene	1400	D		
	400213WA065	65	66	Trichloroethene	97		?	
	400213WA070	70	71	Trichloroethene	65		?	
	400213WA075	74	75	Trichloroethene	208		?	
	400213WA080	79	80	Trichloroethene	167		?	
	400213WA085	84	85	Trichloroethene	145		?	
	400213WA090	89	90	1,1-Dichloroethene	2	J	?	
		89	90	Trichloroethene	127		?	
	400214WA065	65	66	Trichloroethene	69		?	
	400214WA070	70	71	Trichloroethene	524		?	
	400214WA075	75	76	Trichloroethene	989		?	
	400214WA080	80	81	Trichloroethene	872		?	
	400214WA090	90	91	trans-1,2-Dichloroethene	1.5	J	?	
		90	91	Trichloroethene	137		?	
	400214WD065	65	66	Trichloroethene	77		?	
	400214WD075	75	79	Trichloroethene	1007		?	
	400214WD080	80	81	Trichloroethene	882		?	

Table 4.57. VOA compounds detected in RGA water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/L	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Groundwater	400214WD085	85	86	Trichloroethene	196		?	
	400215WA065	65	66	Tetrachloroethene	11	D	?	
		65	66	Trichloroethene	388		?	
	400215WA070	70	71	Tetrachloroethene	13	JD	?	
		70	71	Trichloroethene	4131		?	
	400215WA075	75	76	Trichloroethene	6252		?	
	400215WA080	80	81	Tetrachloroethene	17	JD	?	
		80	81	Trichloroethene	4389		?	
	400215WA085	85	86	cis-1,2-Dichloroethene	7	JD	?	
		85	86	Tetrachloroethene	30	JD	?	
		85	86	Trichloroethene	2306		?	
	400215WA090	90	91	cis-1,2-Dichloroethene	5	JD		
		90	91	Tetrachloroethene	13	JD		
		90	91	Trichloroethene	610	D		

Note: Groundwater samples not containing any detectable VOA compounds in RGA water are:

400044WA055, 400044WA060, 400049WA055, 400049WA060, 400049WA065, 400049WA070, 400049WA075, 400049WA085, 400052WA060, 400053WA060, 400214WA085

Table 4.58. SVOA compounds detected in RGA water

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results ug/L	Lab Qualifier	Validation Qualifier	Data Assessment
Groundwater	SVOA	400040WA065	63	69	Benzoic acid	4	J		
			63	69	Diethyl phthalate	1	J		
			63	69	Phenol	2	J		
		400040WA075	74	75	Benzoic acid	5	J		BL-PURGE
			74	75	Di-n-octylphthalate	1	J	?	BL-PURGE
			74	75	Phenol	40			BL-PURGE
		400040WA080	79	80	Benzoic acid	1	J		BL-PURGE
			79	80	Phenol	14			BL-PURGE
		400040WA085	85	86	Benzoic acid	1	J	?	BL-PURGE
			85	86	Phenol	1	J		BL-PURGE
		400040WD075	74	75	Benzoic acid	4	J		
			74	75	Phenol	40			
		400041WA070	73.5	73.5	Benzoic acid	2	J	=	BL-PURGE
			73.5	73.5	Phenol	4	J	=	BL-PURGE
		400041WA075	78.9	78.9	N-Nitroso-di-n-propylamin	1	J	=	
		400041WA085	90	90	Phenol	1	J	=	

Note: Groundwater samples not containing any detectable SVOA compounds in RGA water are:
011010WA070, 040011WA060, 047012WA060, 400040WA070, 400041WA065, 400041WA080, 400208WB085, 400210WB085, 400212WB085

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Table 4.59. Metals detected in RGA water

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results mg/L	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/L
Groundwater	011010WA070	70	70	Manganese	8.13				0.16
		70	70	Silver	0.00631	J		R-C	0.0041
	026001WA070	67	72	Manganese	0.705		?		0.16
		67	72	Sodium	60.8		?		60
		67	72	Zinc	0.573		?		0.027
	047012WA060	60	61	Barium	0.34				0.29
	400034WA060	60	61	Manganese	0.446		=		0.16
		60	61	Sodium	77.7		J		60
	400034WA065	65	66	Barium	0.525		=		0.29
		65	66	Manganese	1.07		=		0.16
	400034WA070	70	71	Barium	0.669		=		0.29
		70	71	Calcium	51.7		=		44
		70	71	Magnesium	19.5		=		17
		70	71	Manganese	1.07		=		0.16
	400034WA075	75	76	Barium	0.575		=		0.29
		75	76	Calcium	47.9		=		44
		75	76	Magnesium	18.1		=		17
		75	76	Manganese	1.41		=		0.16
	400034WA080	80	81	Barium	0.802		=		0.29
		80	81	Calcium	54.7		=		44
		80	81	Magnesium	20.8		=		17

Table 4.59. Metals detected in RGA water

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results mg/L	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/L
Groundwater	400034WA080	80	81	Manganese	3.15		=		0.16
	400034WA085	85	86	Barium	0.526		?		0.29
		85	86	Calcium	60.8		?		44
		85	86	Magnesium	25.4		?		17
		85	86	Manganese	2.27		?		0.16
	400035WA075	75	76	Barium	0.442		?		0.29
		75	76	Manganese	0.332		?		0.16
		75	76	Nickel	0.125		?		0.062
	400035WA085	85	86	Barium	0.418		?		0.29
		85	86	Magnesium	17.3		?		17
		85	86	Manganese	1.9		?		0.16
	400036WA070	72	72	Manganese	0.68		?		0.16
		72	72	Zinc	2.13		?		0.027
	400036WA080	82	82	Zinc	0.991		?		0.027
	400037WA060	60	61	Iron	8.52				5.1
		60	61	Manganese	0.324				0.16
	400037WA065	65	66	Manganese	0.25				0.16
	400037WA070	70	74	Barium	0.427				0.29
		70	74	Manganese	1.72				0.16
	400037WA075	75	76	Barium	0.301				0.29
		75	76	Manganese	0.197				0.16

Table 4.59. Metals detected in RGA water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/L	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/L
		Top	Bottom						
Groundwater	400037WA080	80	81	Barium	0.324				0.29
		80	81	Manganese	0.246				0.16
	400037WA085	85	86	Barium	0.327				0.29
	400037WA090	90	91	Barium	0.321				0.29
	400039WA065	65	66	Barium	0.538		=		0.29
		65	66	Calcium	45		=		44
		65	66	Magnesium	17.1		=		17
		65	66	Manganese	2.79		=		0.16
	400039WA070	70	71	Arsenic	0.0112				0.011
		70	71	Manganese	0.771				0.16
	400039WA075	75	76	Arsenic	0.0134		=		0.011
		75	76	Barium	0.332		=		0.29
		75	76	Manganese	0.647		=		0.16
	400039WA080	80	81	Arsenic	0.0144		=		0.011
		80	81	Barium	0.488		=		0.29
		80	81	Manganese	1.73		=		0.16
	400041WA085	90	90	Barium	0.349		=		0.29
		90	90	Manganese	0.505		=		0.16
		90	90	Zinc	0.493		=		0.027
	400042WA065	65	65	Barium	0.317		?		0.29
		65	65	Manganese	0.8		?		0.16

Table 4.59. Metals detected in RGA water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/L	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/L
		Top	Bottom						
Groundwater	400042WA070	70	71	Barium	0.359		?		0.29
		70	71	Manganese	1.59		?		0.16
	400042WA075	75	76	Manganese	0.269		?		0.16
	400042WA080	80	81	Manganese	0.184		?		0.16
	400042WA085	85	86	Barium	0.389		?		0.29
		85	86	Manganese	0.812		?		0.16
		85	86	Sodium	63.2		?	R-C	60
	400043WA080	82	82	Barium	1.48		?	BH-PURGE	0.29
		82	82	Calcium	47.8		?	BH-PURGE	44
		82	82	Magnesium	17.4		?	BH-PURGE	17
		82	82	Manganese	8.33		?	BH-PURGE	0.16
		82	82	Zinc	0.0818		?	BH-PURGE	0.027
	400043WA085	87	87	Barium	0.913		?	BH-PURGE	0.29
		87	87	Copper	0.0934		?	BH-PURGE	0.022
		87	87	Iron	79.4		?	BH-PURGE	5.1
		87	87	Manganese	7.64		?	BH-PURGE	0.16
		87	87	Nickel	0.0711		?	BH-PURGE	0.062
		87	87	Zinc	7.16		?	BH-PURGE	0.027
	400044WA060	62	62	Sodium	1850		?	R-C	60
	400044WA080	82	82	Barium	0.311		?		0.29
		82	82	Iron	21.9		?		5.1

Table 4.59. Metals detected in RGA water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/L	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/L
		Top	Bottom						
Groundwater	400044WA080	82	82	Manganese	1.62		?		0.16
		82	82	Zinc	1.04		?		0.027
	400044WA085	87	87	Barium	0.308		?		0.29
		87	87	Iron	7.47		?		5.1
		87	87	Manganese	0.943		?		0.16
		87	87	Nickel	0.629		?		0.062
		87	87	Zinc	0.347		?		0.027
	400044WA090	92	92	Barium	0.301		?		0.29
		92	92	Manganese	1.7		?		0.16
		92	92	Nickel	0.434		?		0.062
		92	92	Zinc	0.403		?		0.027
	400045WA075	73	74	Barium	0.318		?		0.29
		73	74	Manganese	0.769		?		0.16
	400045WA080	78	79	Manganese	0.635		?		0.16
	400045WD080	78	79	Barium	0.316		?		0.29
		78	79	Manganese	0.745		?		0.16
	400046WA060	60	60	Manganese	0.184		=		0.16
		60	60	Sodium	61.3		J		60
	400046WA065	65	65	Manganese	0.258		=		0.16
	400046WA070	70	70	Barium	0.307		=		0.29
		70	70	Manganese	0.465		=		0.16

Table 4.59. Metals detected in RGA water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/L	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/L
		Top	Bottom						
Groundwater	400046WA085	84	85	Manganese	0.418		=		0.16
	400047WA060	60	60	Manganese	0.202		?		0.16
	400047WA065	65	65	Manganese	0.896		?		0.16
	400047WA075	75	75	Zinc	0.19		?		0.027
	400047WA085	85	85	Barium	0.294		?		0.29
		85	85	Copper	0.0242	J	?	R-C	0.022
		85	85	Manganese	0.308		?		0.16
	400048WA075	72	72	Manganese	0.387		?		0.16
	400048WA090	87	87	Manganese	0.217		?		0.16
	400052WA060	60	60	Barium	0.312		?		0.29
		60	60	Manganese	0.248		?		0.16
	400052WA065	65	65	Barium	0.525		?		0.29
		65	65	Manganese	0.674		?		0.16
	400052WA070	70	70	Arsenic	0.0425		?		0.011
	400052WA090	90	90	Barium	0.335		?		0.29
		90	90	Manganese	0.319		?		0.16
	400053WA065	66	66	Barium	0.711		?		0.29
		66	66	Iron	34.7	C	?		5.1
		66	66	Manganese	5.62		?		0.16
		66	66	Zinc	0.407		?		0.027
	400053WA070	71	71	Arsenic	0.0143		?		0.011

Table 4.59. Metals detected in RGA water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/L	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/L
		Top	Bottom						
Groundwater	400053WA070	71	71	Barium	1.17		?		0.29
		71	71	Cobalt	0.16		?		0.096
		71	71	Copper	0.0729		?	R-C	0.022
		71	71	Iron	32.9		?		5.1
		71	71	Manganese	2.89		?		0.16
		71	71	Zinc	0.588		?		0.027
	400206WA070	70	71	Barium	0.317				0.29
		70	71	Manganese	1.16				0.16
	400206WA075	75	76	Barium	0.333				0.29
		75	76	Manganese	0.342				0.16
	400206WA080	80	81	Barium	0.393				0.29
		80	81	Manganese	0.87				0.16
	400206WA085	85	86	Manganese	0.696				0.16
	400208WB085	85	85	Barium	0.5				0.29
		85	85	Calcium	53.5				44
		85	85	Magnesium	20.4				17
		85	85	Manganese	1.92			R-C	0.16
	400210WB085	85	86	Barium	0.609				0.29
		85	86	Manganese	4.69				0.16
		85	86	Nickel	0.165				0.062
	400212WB085	85	86	Arsenic	0.0114				0.011

Table 4.59. Metals detected in RGA water

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results mg/L	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/L
Groundwater	400212WB085	85	86	Barium	0.32				0.29
		85	86	Manganese	2.95				0.16
	400213WA065	65	66	Sodium	79				60
	400213WA070	70	71	Sodium	67.6				60
	400213WA075	74	75	Barium	0.295				0.29
		74	75	Calcium	47				44
		74	75	Magnesium	18.5				17
		74	75	Sodium	77				60
	400213WA080	79	80	Calcium	48.3				44
		79	80	Magnesium	19.6				17
	400213WA090	89	90	Manganese	0.31				0.16
	400214WA065	65	66	Barium	0.627				0.29
		65	66	Calcium	47.3				44
		65	66	Magnesium	18.6				17
		65	66	Manganese	1.55				0.16
		65	66	Sodium	81.8				60
	400214WA070	70	71	Manganese	0.557				0.16
	400214WA075	75	76	Manganese	1.17				0.16
	400214WA080	80	81	Barium	0.336				0.29
		80	81	Manganese	0.99				0.16
	400214WA090	90	91	Manganese	0.438				0.16

Table 4.59. Metals detected in RGA water

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results mg/L	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/L
Groundwater	400214WD065	65	66	Barium	0.641				0.29
		65	66	Calcium	45.9				44
		65	66	Magnesium	17.9				17
		65	66	Manganese	1.53				0.16
		65	66	Sodium	79.9				60
	400214WD075	75	79	Manganese	0.801				0.16
	400214WD080	80	81	Barium	0.397				0.29
		80	81	Cobalt	0.099				0.096
		80	81	Manganese	1.6				0.16

Note: Groundwater samples not containing any detectable metals at concentrations above background in RGA water are:

040011WA060, 400044WA070, 400045WA085, 400045WA090, 400046WA075, 400046WA080, 400047WA080, 400214WA085, 400214WD085, 400215WA090

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Table 4.60. Radioactive isotopes detected in RGA water

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Sample Interval (ft bgs) Bottom	Analytical Compound	Results pCi/L	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/L
Groundwater	011010WA070	70	70	Cesium-137	11.1				0
		70	70	Neptunium-237	14.4	B			0
	040011WA060	70	70	Neptunium-237	2.33	B			0
		70	70	Technetium-99	442				0
	047012WA060	60	61	Technetium-99	824				0
	400034WA085	85	86	Cesium-137	14.3		=		0
		85	86	Neptunium-237	4.45	BT	=		0
		85	86	Technetium-99	17000		=		0
		85	86	Thorium-230	3.61		=		1.4
		85	86	Uranium-234	2.81	T	=		1.2
	400039WA065	65	66	Cesium-137	13.7		=		0
		65	66	Neptunium-237	1.34	B	=		0
		65	66	Technetium-99	68.7		=		0
		65	66	Uranium-234	1.31		=		1.2
	400039WA070	70	71	Cesium-137	8.75				0
		70	71	Neptunium-237	5.55	B			0
		70	71	Technetium-99	178				0
		70	71	Uranium-234	9.49				1.2
		70	71	Uranium-235	0.19				0.15
	400039WA075	75	76	Cesium-137	14.46		=		0
		75	76	Technetium-99	276		=		0

Table 4.60. Radioactive isotopes detected in RGA water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/L	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/L
		Top	Bottom						
Groundwater	400039WA080	80	81	Cesium-137	6.95		=		0
		80	81	Neptunium-237	7.27	B	=		0
		80	81	Technetium-99	281		=		0
	400039WA085	85	86	Cesium-137	11.2		=		0
		85	86	Neptunium-237	6.9	B	=		0
		85	86	Technetium-99	229		=		0
	400039WA090	90	91	Cesium-137	7.53		=		0
		90	91	Neptunium-237	1.44	B	=		0
		90	91	Technetium-99	168		=		0
		90	91	Uranium-234	1.31		=		1.2
	400040WA065	63	69	Cesium-137	9.71				0
		63	69	Neptunium-237	9.37	B			0
		63	69	Technetium-99	537				0
	400040WA070	69	70	Americium-241	1.68			BL-PURGE	0
		69	70	Cesium-137	4.43			BL-PURGE	0
		69	70	Neptunium-237	2.64	B		BL-PURGE	0
		69	70	Technetium-99	519			BL-PURGE	0
	400040WA075	74	75	Neptunium-237	6.8	B		BL-PURGE	0
		74	75	Technetium-99	0.61			BL-PURGE	0
	400040WA080	79	80	Neptunium-237	5.12	B		BL-PURGE	0
		79	80	Technetium-99	85.2			BL-PURGE	0

Table 4.60. Radioactive isotopes detected in RGA water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/L	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/L
		Top	Bottom						
Groundwater	400040WA085	85	86	Neptunium-237	7.98	B		BL-PURGE	0
		85	86	Technetium-99	2			BL-PURGE	0
	400040WD075	74	75	Neptunium-237	3.31	B			0
		74	75	Technetium-99	3.68				0
	400041WA065	68	68	Cesium-137	6.6		=		0
		68	68	Neptunium-237	1.33	B	=		0
		68	68	Plutonium-239	0.06		=		0
		68	68	Technetium-99	13.2		=		0
	400041WA070	73.5	73.5	Neptunium-237	9.65	B	=	BL-PURGE	0
	400041WA075	78.9	78.9	Neptunium-237	2.14	B	=		0
		78.9	78.9	Technetium-99	15.9		=		0
	400041WA080	84.4	84.4	Cesium-137	10.6		=		0
		84.4	84.4	Neptunium-237	1.06	B	=		0
		84.4	84.4	Technetium-99	44.2		=		0
	400041WA085	90	90	Cesium-137	10.4		=		0
		90	90	Neptunium-237	2.89	B	=		0
		90	90	Technetium-99	113		=		0
	400045WA080	78	79	Americium-241	0.047		=		0
		78	79	Lead-214	7.4		=		0
		78	79	Technetium-99	60.6	Y	=		0
		78	79	Thorium-228	0.76		=		0

Table 4.60. Radioactive isotopes detected in RGA water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/L	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/L
		Top	Bottom						
Groundwater	400045WA080	78	79	Thorium-232	0.76		=		0
		78	79	Uranium-233/234	0.65		=		0
	400045WD080	78	79	Americium-241	0.077		=		0
		78	79	Bismuth-212	42		=		0
		78	79	Lead-210	100		=		0
		78	79	Technetium-99	80.8		=		0
		78	79	Thorium-228	0.73		=		0
		78	79	Thorium-232	0.52		=		0
		78	79	Uranium-233/234	0.63		=		0
	400046WA075	75	75	Cesium-137	5.71		=		0
		75	75	Neptunium-237	7.23	BT	=		0
		75	75	Plutonium-239	0.13	T	=		0
		75	75	Technetium-99	125		=		0
		75	75	Thorium-230	5.88		=		1.4
		75	75	Uranium-234	8.73	T	=		1.2
		75	75	Uranium-238	8.73	T	=		1.1
	400208WB085	85	85	Technetium-99	11600				0
	400210WB085	85	86	Technetium-99	6420				0
		85	86	Uranium-234	2.08				1.2
	400212WB085	85	86	Technetium-99	242				0
	400215WA065	65	66	Technetium-99	18.9				0

Table 4.60. Radioactive isotopes detected in RGA water

Sample Type	Sample ID	Sample Interval (ft bgs) Top	Bottom	Analytical Compound	Results pCi/L	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/L
Groundwater	400215WA065	65	66	Thorium-230	8.4	T			1.4
		65	66	Uranium-234	17				1.2
		65	66	Uranium-235	0.77				0.15
		65	66	Uranium-238	16.6				1.1
	400215WA085	85	86	Neptunium-237	1.82	B			0
		85	86	Technetium-99	179				0
		85	86	Uranium-234	1.59				1.2
		85	86	Uranium-238	1.55				1.1
	400215WA090	90	91	Cesium-137	3.33				0
		90	91	Neptunium-237	1.99	B			0
		90	91	Plutonium-239	0.06				0
		90	91	Technetium-99	443				0

Note: Groundwater samples not containing any detectable radioactive isotopes at concentrations above background in RGA water are: 026001WA065, 026001WA070, 026001WA075

Table 4.61. Frequency of detection of organic compounds, metals, and radioactive isotopes in RGA water

Analytical Group	Analytical Compound	No. of Detects	No. of Analyses	Maximum Result	Minimum Result	Average Result	Units
VOA	Trichloroethene	151	162	701184.00	1.50	24382.98	ug/L
	trans-1,2-Dichloroethene	28	162	1200.00	1.50	85.10	ug/L
	1,1-Dichloroethene	21	162	154.00	1.00	23.90	ug/L
	cis-1,2-Dichloroethene	10	162	370.00	1.30	91.62	ug/L
	Chloroform	7	24	36.00	15.00	21.29	ug/L
	Tetrachloroethene	6	24	30.00	3.00	14.50	ug/L
	Carbon tetrachloride	4	24	270.00	1.00	117.75	ug/L
	Vinyl chloride	3	162	133.00	1.00	47.33	ug/L
	Bromodichloromethane	2	24	4.00	3.00	3.50	ug/L
	1,1,1-Trichloroethane	1	24	12.00	12.00	12.00	ug/L
	Toluene	1	24	36.00	36.00	36.00	ug/L
SVOA	Phenol	7	17	40.00	1.00	14.57	ug/L
	Benzoic acid	6	17	5.00	1.00	2.83	ug/L
	Diethyl phthalate	1	17	1.00	1.00	1.00	ug/L
	Di-n-octylphthalate	1	17	1.00	1.00	1.00	ug/L
	N-Nitroso-di-n-propylamine	1	17	1.00	1.00	1.00	ug/L
Metals	Iron	79	85	2240.00	5.34	248.35	mg/L
	Manganese	79	85	57.90	0.18	2.37	mg/L
	Zinc	76	85	81.80	0.03	1.29	mg/L
	Barium	70	85	6.93	0.29	0.69	mg/L
	Nickel	47	85	4.88	0.06	0.32	mg/L
	Arsenic	42	85	0.44	0.01	0.05	mg/L
	Copper	39	85	10.50	0.02	0.44	mg/L
	Aluminum	37	85	250.00	24.30	83.43	mg/L
	Beryllium	27	85	0.11	0.01	0.02	mg/L
	Cobalt	24	85	0.48	0.10	0.21	mg/L
	Magnesium	24	85	33.30	17.10	20.95	mg/L
	Vanadium	23	85	1.35	0.15	0.47	mg/L
	Potassium	20	85	25.30	7.02	12.61	mg/L
	Calcium	17	85	78.70	44.40	51.72	mg/L
	Chromium	17	85	4.49	0.15	0.89	mg/L
	Sodium	14	85	1850.00	60.40	132.73	mg/L
	Lead	8	85	0.26	0.11	0.16	mg/L

Table 4.61. Frequency of detection of organic compounds, metals, and radioactive isotopes in RGA water

Analytical Group	Analytical Compound	No. of Detects	No. of Analyses	Maximum Result	Minimum Result	Average Result	Units
Metals	Silver	8	85	0.40	0.01	0.08	mg/L
	Mercury	3	85	0.00	0.00	0.00	mg/L
Radioactive isotopes	Technetium-99	28	30	17000.00	0.61	1427.49	pCi/L
	Neptunium-237	22	32	14.40	1.06	4.86	pCi/L
	Cesium-137	15	33	14.46	3.33	9.25	pCi/L
	Uranium-234	8	31	17.00	1.31	5.54	pCi/L
	Americium-241	3	32	1.68	0.05	0.60	pCi/L
	Plutonium-239	3	28	0.13	0.06	0.08	pCi/L
	Thorium-230	3	30	8.40	3.61	5.96	pCi/L
	Uranium-238	3	33	16.60	1.55	8.96	pCi/L
	Thorium-228	2	2	0.76	0.73	0.75	pCi/L
	Thorium-232	2	2	0.76	0.52	0.64	pCi/L
	Uranium-233/234	2	2	0.65	0.63	0.64	pCi/L
	Uranium-235	2	33	0.77	0.19	0.48	pCi/L
	Bismuth-212	1	2	42.00	42.00	42.00	pCi/L
	Lead-210	1	2	100.00	100.00	100.00	pCi/L
	Lead-214	1	2	7.40	7.40	7.40	pCi/L

Table 4.62. VOA compounds detected in McNairy water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/L	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Groundwater	011009WA100	100	100	1,1-Dichloroethene	24	J	?	
		100	100	Chloroform	2	JD	?	
		100	100	cis-1,2-Dichloroethene	4	JD	?	
		100	100	Tetrachloroethene	27	D	?	
		100	100	trans-1,2-Dichloroethene	2.9	J	?	
		100	100	Trichloroethene	524		?	
	026001WA095	97	97	Trichloroethene	1279		?	
	026001WA105	107	107	Trichloroethene	68		?	BL-PURGE
	026001WA115	112	117	Trichloroethene	14		?	
	026001WA120	122	122	Trichloroethene	1.6	J	?	BL-PURGE, BH-ER
	026001WA135	137	137	trans-1,2-Dichloroethene	18		?	
	400034WA095	95	96	Trichloroethene	2.6	J	?	BH-RB
	400034WA100	100	101	Trichloroethene	2.4	J	?	BH-RB
	400034WA105	105	106	Trichloroethene	14		?	BH-RB
	400034WA110	110	111	Trichloroethene	42		?	BH-RB
	400034WA115	115	116	Trichloroethene	46		?	BH-RB
	400034WA120	120	121	Trichloroethene	23		?	BH-RB
	400034WA125	125	126	Trichloroethene	1.7	J	?	BH-RB
	400035WA100	100	101	Trichloroethene	2.4	J	?	BH-RB
	400035WA105	105	106	Trichloroethene	24		?	BH-RB

Table 4.62. VOA compounds detected in McNairy water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/L	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Groundwater	400035WA110	110	110	Trichloroethene	1.8	J	?	BH-RB
	400035WA115	115	116	Trichloroethene	2.6	J	?	BH-RB
	400035WA125	125	126	Trichloroethene	1.1	J	?	BH-RB
	400035WA130	130	131	Trichloroethene	25		?	
	400035WA135	135	136	Trichloroethene	1.6	J	?	
	400036WA095	97	97	Trichloroethene	1	J	?	
	400036WA100	102	102	Trichloroethene	0.8	J	?	
	400036WA105	107	107	Trichloroethene	0.2	J	?	
	400036WA110	112	112	Trichloroethene	0.8	J	?	
	400036WA115	117	117	Trichloroethene	0.2	J	?	
	400036WA120	122	122	Trichloroethene	0.7	J	?	
	400036WA140	142	142	Trichloroethene	1	J	?	
	400037WA095	95	96	Trichloroethene	85597		?	
	400038WA100	101	101	Trichloroethene	62		?	
	400038WA110	111	111	Trichloroethene	17		?	
	400038WA130	131	131	Trichloroethene	13		?	BL-PURGE
	400039WA095	95	96	Trichloroethene	32		?	
	400039WA100	100	101	trans-1,2-Dichloroethene	1.5	J	?	
		100	101	Trichloroethene	46		?	
	400039WA110	110	111	Trichloroethene	4.7		?	

Table 4.62. VOA compounds detected in McNairy water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/L	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Groundwater	400039WA115	115	116	Trichloroethene	2.5	J	?	
	400039WA130	130	131	Trichloroethene	1.1	J	?	
	400040WA095	99	100	1,1-Dichloroethene	20		?	BL-PURGE
		99	100	1,2-Dichloroethane	1	JD	?	BL-PURGE
		99	100	Bromodichloromethane	8	JD	?	BL-PURGE
		99	100	Chloroform	19	D	?	BL-PURGE
		99	100	cis-1,2-Dichloroethene	20		?	BL-PURGE
		99	100	Dibromochloromethane	4	JD	?	BL-PURGE
		99	100	trans-1,2-Dichloroethene	20		?	BL-PURGE
		99	100	Trichloroethene	332		?	BL-PURGE
		99	100	Vinyl chloride	20		?	BL-PURGE
	400040WA110	109	110	Toluene	1	J	?	
		109	110	Trichloroethene	3	J	?	
	400040WD110	109	110	Trichloroethene	4	J	?	
	400041WA110	112	112	Chloroform	1	J	=	
		112	112	Trichloroethene	7		=	
	400041WA120	122	122	Bromodichloromethane	1	J	=	
		122	122	Chloroform	6		=	
		122	122	Dibromochloromethane	1	J	=	
		122	122	Toluene	4	J	=	

Table 4.62. VOA compounds detected in McNairy water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/L	Lab Qualifier	Validation Qualifier	Data Assessment
		Top	Bottom					
Groundwater	400041WA120	122	122	trans-1,2-Dichloroethene	9		?	
		122	122	Trichloroethene	7		=	
	400041WD110	112	112	Chloroform	1	J	=	
		112	112	Toluene	1	J	=	
		112	112	Trichloroethene	8		=	
	400053WA095	100	100	Trichloroethene	17.1		?	BL-PURGE
	400053WA100	113	113	Trichloroethene	2.1		?	BL-PURGE
	400206WA095	95	96	Trichloroethene	51		?	
	400206WD095	95	96	Trichloroethene	55		?	
	400207WA090	101	107	Trichloroethene	1.2	J	?	

Note: Groundwater samples not containing any detectable VOA compounds in McNairy water are:

026001WA100, 026001WA110, 026001WA125, 026001WA130, 400035WA120, 400035WD125, 400036WA125, 400036WA130, 400036WA135, 400038WA140, 400039WA120, 400039WA125, 400039WA140, 400207WA110, 400207WA130

Table 4.63. SVOA compounds detected in McNairy water

Sample Type	Analytical Group	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results ug/L	Lab Qualifier	Validation Qualifier	Data Assessment
			Top	Bottom					
Groundwater	SVOA	400040WA095	99	100	Benzoic acid	1	J		BL-PURGE
			99	100	Phenol	1	J		BL-PURGE
		400040WD110	109	110	Di-n-octylphthalate	6	J	?	
		400041WA120	122	122	Di-n-octylphthalate	1	J	=	BH-ER
			122	122	Phenol	5	J	=	BH-ER
		400041WD110	112	112	Phenol	1	J	=	

Note: Groundwater samples not containing any detectable SVOA compounds in McNairy water are:
011009WA100, 400040WA110, 400041WA110

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Table 4.64. Metals detected in McNairy water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results mg/L	Lab Qualifier	Validation Qualifier	Data Assessment	Background mg/L
		Top	Bottom						
Groundwater	400207WA090	101	107	Manganese	0.685				0.16
		101	107	Zinc	3.35				0.027
	400207WA110	126	127	Manganese	0.437				0.16
		126	127	Zinc	0.264				0.027

Note: Groundwater samples not containing any detectable metals at concentrations above background in McNairy water are:

None

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Table 4.65. Radioactive isotopes detected in McNairy water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/L	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/L
		Top	Bottom						
Groundwater	011009WA100	100	100	Cesium-137	12.9				0
		100	100	Neptunium-237	3.69	B			0
		100	100	Technetium-99	616				0
	400036WA105	107	107	Actinium-228	27.2		?		0
		107	107	Americium-241	0.053		?		0
		107	107	Bismuth-214	9		?		0
		107	107	Lead-210	421		?		0
		107	107	Lead-212	22.5		?		0
		107	107	Lead-214	12.1		?		0
		107	107	Potassium-40	68		?		0
		107	107	Thallium-208	6.7		?		0
		107	107	Thorium-228	1.23		?		0
		107	107	Thorium-232	1.15		?		0
		107	107	Thorium-234	719		?		0
		107	107	Uranium-233/234	0.61		?		0
		107	107	Uranium-235	23		?		0.15
	400040WA095	99	100	Neptunium-237	2.77	B		BL-PURGE	0
	400040WA110	109	110	Neptunium-237	13.1	B			0
		109	110	Plutonium-239	0.85				0
		109	110	Uranium-234	1.63				1.2
		109	110	Uranium-238	1.26				1.1

Table 4.65. Radioactive isotopes detected in McNairy water

Sample Type	Sample ID	Sample Interval (ft bgs)		Analytical Compound	Results pCi/L	Lab Qualifier	Validation Qualifier	Data Assessment	Background pCi/L
		Top	Bottom						
Groundwater	400040WD110	109	110	Cesium-137	2.49				0
		109	110	Neptunium-237	6.51	B			0
		109	110	Plutonium-239	2.12				0
		109	110	Technetium-99	0.66				0
		109	110	Uranium-234	1.73				1.2
		109	110	Uranium-238	1.32				1.1
	400041WA110	112	112	Cesium-137	16.5		=		0
		112	112	Neptunium-237	1.75	B	=		0
	400041WA120	122	122	Cesium-137	6.96		=		0
		122	122	Neptunium-237	3.8	B	=		0
		122	122	Technetium-99	1.88		=		0
		122	122	Thorium-230	1.88		=		1.4
		122	122	Uranium-234	2.23		=		1.2
		122	122	Uranium-238	1.82		=		1.1
	400041WD110	112	112	Cesium-137	6.3		=		0
		112	112	Neptunium-237	2.96	B	=		0

Note: Groundwater samples not containing any detectable radioactive isotopes at concentrations above background in McNairy water are:
None

Table 4.66. Frequency of detection of organic compounds, metals, and radioactive isotopes in McNairy water

Analytical Group	Analytical Compound	No. of Detects	No. of Analyses	Maximum Result	Minimum Result	Average Result	Units
VOA	Trichloroethene	46	62	85597.00	0.20	1918.28	ug/L
	Chloroform	5	7	19.00	1.00	5.80	ug/L
	trans-1,2-Dichloroethene	5	62	20.00	1.50	10.28	ug/L
	Toluene	3	7	4.00	1.00	2.00	ug/L
	1,1-Dichloroethene	2	62	24.00	20.00	22.00	ug/L
	Bromodichloromethane	2	7	8.00	1.00	4.50	ug/L
	cis-1,2-Dichloroethene	2	62	20.00	4.00	12.00	ug/L
	Dibromochloromethane	2	7	4.00	1.00	2.50	ug/L
	1,2-Dichloroethane	1	7	1.00	1.00	1.00	ug/L
	Tetrachloroethene	1	7	27.00	27.00	27.00	ug/L
	Vinyl chloride	1	62	20.00	20.00	20.00	ug/L
SVOA	Phenol	3	7	5.00	1.00	2.33	ug/L
	Di-n-octylphthalate	2	7	6.00	1.00	3.50	ug/L
	Benzoic acid	1	7	1.00	1.00	1.00	ug/L
Metals	Nickel	3	3	0.19	0.06	0.11	mg/L
	Aluminum	2	3	139.00	33.60	86.30	mg/L
	Arsenic	2	3	0.41	0.03	0.22	mg/L
	Barium	2	3	0.59	0.31	0.45	mg/L
	Iron	2	3	337.00	59.70	198.35	mg/L
	Manganese	2	3	2.44	0.44	1.04	mg/L
	Potassium	2	3	21.20	8.31	14.76	mg/L
	Zinc	2	3	12.10	0.26	4.08	mg/L
	Beryllium	1	3	0.01	0.01	0.01	mg/L
	Calcium	1	3	54.50	54.50	54.50	mg/L
	Chromium	1	3	0.39	0.39	0.39	mg/L
	Cobalt	1	3	0.11	0.11	0.11	mg/L
	Copper	1	3	0.10	0.10	0.10	mg/L
	Lead	1	3	0.18	0.18	0.18	mg/L
	Magnesium	1	3	31.90	31.90	31.90	mg/L
	Selenium	1	3	0.04	0.04	0.04	mg/L
	Vanadium	1	3	1.57	1.57	1.57	mg/L
Radioactive isotopes	Neptunium-237	7	8	13.10	1.75	4.94	pCi/L
	Cesium-137	5	8	16.50	2.49	9.03	pCi/L

Table 4.66. Frequency of detection of organic compounds, metals, and radioactive isotopes in McNairy water

Analytical Group	Analytical Compound	No. of Detects	No. of Analyses	Maximum Result	Minimum Result	Average Result	Units
Radioactive isotopes	Technetium-99	3	8	616.00	0.66	206.18	pCi/L
	Uranium-234	3	7	2.23	1.63	1.86	pCi/L
	Uranium-238	3	8	1.82	1.26	1.47	pCi/L
	Plutonium-239	2	7	2.12	0.85	1.49	pCi/L
	Actinium-228	1	1	27.20	27.20	27.20	pCi/L
	Americium-241	1	8	0.05	0.05	0.05	pCi/L
	Bismuth-214	1	1	9.00	9.00	9.00	pCi/L
	Lead-210	1	1	421.00	421.00	421.00	pCi/L
	Lead-212	1	1	22.50	22.50	22.50	pCi/L
	Lead-214	1	1	12.10	12.10	12.10	pCi/L
	Potassium-40	1	1	68.00	68.00	68.00	pCi/L
	Thallium-208	1	1	6.70	6.70	6.70	pCi/L
	Thorium-228	1	1	1.23	1.23	1.23	pCi/L
	Thorium-230	1	8	1.88	1.88	1.88	pCi/L
	Thorium-232	1	1	1.15	1.15	1.15	pCi/L
	Thorium-234	1	1	719.00	719.00	719.00	pCi/L
	Uranium-233/234	1	1	0.61	0.61	0.61	pCi/L
	Uranium-235	1	8	23.00	23.00	23.00	pCi/L

5. CONTAMINANT FATE AND TRANSPORT

5.1 INTRODUCTION

This section provides an overview of the potential migration pathways, mechanisms for transport, and behavior of radiological and chemical substances reported in the nine sectors and evaluated in this report. The fate and transport of site-related contaminants are important in assessing the potential for exposure to these contaminants, as well as the potential changes in concentration or migration if no actions are taken. Risk management decisions are based in part on the following issues:

- Potential for direct contact with chemicals in surface soil
- Potential for residual constituents in soils to impact groundwater
- Potential for continued migration of groundwater contaminants to impact downgradient receptors

The potential risks associated with residuals in the environmental media relate to changes in concentration over time (persistence) and migration to downslope or downgradient areas.

Physical, chemical, and biological processes affect the nature and distribution of chemicals in the environment. Because WAG 6 is composed of nine contiguous sectors, migration is addressed for the entire WAG 6 area. Although in many instances, the specific chemicals, sources, and concentrations differ across the nine sectors (five SWMUs and C-400 Site Evaluation Area), hydrogeologic conditions are similar.

This section presents the following:

- Overview of the conceptual site model, sources, and transport pathways for each sector
- Chemical-specific discussions of common constituents at WAG 6, including the properties that influence migration
- Discussion of the soil leachability analysis

Computer-based contaminant fate and transport modeling analyses (leachability analysis) were performed to predict the rate of contaminant migration in various media. These analyses indicate likely future contaminant concentrations at receptor locations via multiple media. The ultimate objectives of the analyses were to evaluate potential future impacts to human health and the environment and to provide a basis for evaluating the effectiveness of proposed remedial alternatives in the feasibility study (FS).

The principles of contaminant fate and transport analysis and the results of modeling activities are summarized in this section. Section 5.2 presents a conceptual model for potential contaminant migration pathways at WAG 6 that considers site topography, geology, hydrology, and site-related chemicals. Section 5.3 presents a discussion of the persistence of the contaminants in the environment and the physical and chemical properties of the site-related chemicals that were used in the fate and transport modeling. Contaminant release mechanisms and transport media are also described in this section. Chemical migration rates for the WAG 6 COCs are presented in

Sect. 5.4. Section 5.5 presents a soil leachability analysis, including its application and underlying assumptions. A discussion of uncertainties associated with the modeling results is also presented in Sect. 5.5.

5.2 CONCEPTUAL SITE MODEL

The conceptual site model (CSM) developed for WAG 6 is a representation of known site conditions that serves as the framework for quantitative modeling. Site conditions described by the CSM include waste source information, the surrounding geologic and hydrologic conditions, a listing of site-related chemicals, and current spatial distribution of the site-related chemicals. This information is combined to identify the likely chemical migration pathways.

Figure 5.1 depicts the CSM for WAG 6. Potential source areas include a TCE off-loading pump station, spills, overfills from sumps, and releases from tanks or underground piping. Releases from these sources would directly impact soils below or adjacent to the source and/or sediments and surface water in nearby drainageways. Continuing transport processes may also result in secondary releases that may impact larger areas or affect additional environmental media. Transport processes likely to be active at the site include vertical infiltration in soil, lateral and vertical migration in groundwater, soil erosion and surface runoff, volatilization, and mobilization of dust particles. Surface water is not a viable exposure pathway for the site because all runoff from the site flows into the storm sewer system and discharges to Outfall 8, which is currently monitored under a separate investigation.

Data were collected during the RI to characterize potential exposure pathways, including groundwater and surface and subsurface soil. Where data on source characteristics were lacking, sampling was also performed to evaluate the nature of the source. Based on this evaluation, a fate and transport model was developed and used to simulate vertical transport of contaminants from source areas to the UCRS and RGA (see Sect. 5.5).

5.2.1 Contaminant Sources, Release Mechanisms, and Migration Pathways

In accordance with historical process knowledge and the findings of sampling and analysis performed at WAG 6, several contaminant sources have been identified. Detections of chemicals in soil and groundwater confirm the potential for media-specific chemical transport. The migration pathways discussed below by sector appear to be the most viable exposure routes and include the potential for:

- Leaching of contaminants through soil to groundwater
- Migration of groundwater to downgradient receptors

As illustrated in Figure 5.3, extensive areas of soil surrounding WAG 6 have been impacted by releases of high concentrations of TCE and lower concentrations of other contaminants into the shallow subsurface UCRS soil. Due to the DNAPL characteristics of the TCE, the dominant dispersal pattern through the vadose soil to the top of the RGA is gravity-driven. Within the RGA, where spill volumes were sufficiently large, vertical DNAPL migration has penetrated to the base of the RGA. Lateral transport of dissolved phase contaminants within the RGA follows groundwater flow paths established by the regional groundwater gradient. Releases of TCE at WAG 6 are the source for the downgradient, off-site Northwest Plume and may be related to the smaller Northeast Plume.

The sources, release mechanisms, and pathways for migration by sector are as follows:

- **Sector 1 (Unknown Source).** No sources have been identified at this sector. Potential constituents have been identified in deep subsurface soils, but have probably migrated to Sector 1 from other adjacent sectors.
- **Sector 2 (SWMU 40).** The C-403 Neutralization Tank was used for the storage and treatment of acidic uranium-bearing waste solutions generated during cleaning operations at the C-400 Building. The operation of this tank to store and treat uranium-bearing wastes was limited to the period between 1952 and 1957. During the period between 1957 and 1990, effluents from the C-400 Cleaning Facility were discharged to the tank. These discharges included UF_6 cylinder hydrostatic test water, overflow and runoff from cleaning tanks, discharge from floor drains, and unknown sources. The process activities at the C-400 Building and C-403 Building are thought to be the origin of metals contamination in this sector. During the processing of uranium ore and the metals plating operations at the C-400 Building, the primary waste byproducts contained cadmium and thallium (uranium ore processing) and antimony (plating operations). The sources of contamination for the C-403 Neutralization Tank are subsurface releases from the tank or transfer line; it should be noted that the pipes from the tank have been plugged. Contaminants released from these sources have infiltrated the soil surrounding the tank and line.
- **Sector 3 (Unknown Source).** Soils data indicate that a release of chlorinated hydrocarbons has occurred and has impacted the upper portion (vadose zone) of the UCRS. Contaminants released from the Degreaser Fan Plenum area (along the east wall of the C-400 Building) are the likely source of these organic compounds, and they may have migrated from exterior floor drains to the soil surrounding the C-400 Building. The contaminants in the soil have impacted groundwater through further infiltration and percolation and are migrating off-site via groundwater. The release mechanism is not known.
- **Sector 4 (SWMU 11).** Two sources exist in Sector 4: (1) the sump and associated piping and (2) the TCE off-loading pump station and associated piping. The TCE off-loading pump station was used to transfer TCE from tanker trucks to the TCE day holding tank. TCE was inadvertently released from the sump in the adjacent TCE degreaser pit basement (SWMU 98), along with wastewater, to the storm sewer line east of the C-400 Building. During excavation to construct a discharge pipe, TCE was discovered leaking from the joints of the storm sewer line. Although the actual duration of the leak is unknown, it is believed that TCE may have been discharged to the storm sewer as early as the 1950s. The sources of contamination for SWMU 11 are subsurface releases in piping leading from the sump to a storm sewer, the storm sewer itself, and the TCE off-loading pump station and piping. Releases associated with the off-loading pump and associated piping are believed to be the source of most of the TCE in Sector 4. Contaminants released from these sources have infiltrated the soil surrounding the piping and the storm sewer. The contaminants in soil have impacted groundwater through further infiltration and percolation and are being transported to off-site locations by groundwater.
- **Sector 5 (Southwest Source Area).** Soils data indicate that a release of chlorinated hydrocarbons has occurred and has impacted the upper portion (vadose zone) of the UCRS near the southwest corner of the C-400 Building. The source of the organic compounds is suspected to be the floor drain lines that discharge to the underground sewer. Contaminants

released have infiltrated the soil surrounding the C-400 Building, have further migrated in the RGA, and are being transported to off-site locations by groundwater. The release mechanism is not known.

- **Sector 6 (SWMU 47).** The ^{99}Tc Storage Tank (SWMU 47) was situated within the bermed area on a concrete pad located on the west side of the C-400 Building. The tank was removed in 1986, but the concrete pad and bermed area are still present. The 4000-gal storage tank was used in the early 1960s to store a waste solution containing ^{99}Tc and chromium. No spills or releases are known to have occurred from the tank. Approximately 600 gal of residual waste was present in the tank at the time of its removal in 1986. The waste was composed of approximately 200 gal of solution and 400 gal of sludge. Analytical results from samples collected during the tank removal indicated that technetium, chromium, uranium, neptunium, plutonium, and thorium were present in the contents of the tank. The sources of contamination for the ^{99}Tc Storage Tank area are releases and spills from the tank and transfer lines.

  Contaminants released from these sources have infiltrated the surface soil. Subsequently, contaminants in surface soil have migrated downward into subsurface soil and have contaminated the groundwater; contaminant migration to off-site areas then occurs via groundwater flow.

- **Sector 7 (SWMU 203).** The Waste Discard Sump is a convergence point for effluent from the C-400 Cleaning Facility (primarily from the west side), located at the northwest corner of the building. The unit is a 6-ft-wide by 11-ft-long by 6-ft-deep concrete pit. The pit includes a 4-ft-diameter by 4-1/2-ft-deep sump in the floor. A pump discharged wastewater through the C-401 Transfer Line (SWMU 26) prior to 1957. Beginning in 1957, a drain in the sump was opened to allow gravity-fed discharge through a storm sewer line to the North-South Diversion Ditch. In the 1950s, the Waste Discard Sump (SWMU 203) handled discharges from a variety of processes conducted within the C-400 Building. Many of these discharges were discontinued after 1957. The sump continues to collect effluent from a high pressure, water-jet system on the C-400 Spray Booth and a vacuum pump on the C-400 Lime Precipitation Unit. The most likely sources of contamination for the Waste Discard Sump (SWMU 203) are releases and spills from transfer lines. The source of TCE is not known.

  Contaminants released from these sources have impacted surface and subsurface soil. Subsequently, contaminants in deeper soil may have migrated downward to the RGA and impacted groundwater quality. Contaminants in the RGA are migrating off-site.

- **Sector 8 (SWMU 26).** An abandoned subsurface transfer line located north of Virginia Avenue is the suspected source at this sector. The pipe material was reported to be 6-in. vitrified clay pipe and 4-in. iron pipe with leaded joints. During the field investigation, an excavation was performed and it was determined that the pipe is comprised of metal, probably iron. The transfer line lies 3 to 5 ft bgs and runs parallel to Virginia Avenue. Between 1952 and 1957, the C-401 Transfer Line conveyed liquid effluent from the C-403 Neutralization Pit (SWMU 40) and Waste System Discard Sump (SWMU 203) to the C-404 Holding Pond. The transfer line was abandoned in 1957. The sources of contamination for the C-401 Transfer Line are subsurface releases. Contaminants released from these sources have infiltrated the soil surrounding the line. The contaminants in soil have impacted the groundwater via further infiltration and percolation and are migrating off-site via groundwater.

- **Sector 9 (Unknown Source).** No source has been identified at this sector. Potential contaminants have been identified in surface soil.

5.2.2 Hydrologic Properties

A description of the site hydrogeology and hydrology is provided in Sect. 3. The North-South Diversion Ditch and storm drains capture stormwater runoff from WAG 6. Flow in these drainageways is in a westerly direction to several discharge points along Bayou Creek.

Three hydrogeologic units underlie PGDP and control the flow of groundwater and thus contaminant migration. These are, in descending order:

- UCRS: discontinuous and variable interfingerings of sand, clay, and gravel beneath an overlying clay
- RGA: gravel, sand, and silt deposits that overlie the McNairy Formation
- McNairy Formation: sandy silty confining clay unit

For modeling purposes, it was assumed that UCRS is not perennially saturated, as suggested in Sect. 3.7. Instead, it was assumed that groundwater infiltrates and migrates downward to recharge the RGA. This is a conservative assumption because, if saturated conditions in UCRS were assumed, contaminant transport through it would have been attenuated.

Computer simulations of vertical transport from the UCRS to the RGA and horizontal transport within the RGA to receptor locations were also performed.

5.2.2.1 Water Balance

A water balance is a way of quantitatively accounting for all of the components of the hydrologic cycle at a site. The components of a simple steady-state water balance model include: precipitation (P), evapotranspiration (ET), surface runoff (Sr), and groundwater recharge or deep percolation (Gr). The simple steady-state model is defined as follows:

$$P = ET + Sr + Gr$$

$$P\text{-}ET = Sr + Gr$$

The amount of rainfall that enters the surface runoff and groundwater recharge compartments (Sr + Gr) is the amount available to promote chemical migration away from a waste source. The annual average water balance estimates, derived primarily from the Geotrans (1992) model for PGDP, are:

- Evapotranspiration = 54% of total rainfall
- Surface runoff = 38% of total rainfall
- Groundwater recharge (percolation) = 8% of total rainfall; a small amount of which (7% of the recharged water) flows laterally through the top portion of surface soil and is discharged to the surface-water drainage system prior to reaching the saturated zone. For this analysis, the saturated zone is the UCRS.

Past studies (Geotrans 1992) have suggested that as much as 93% of the recharge to the UCRS may flow downward to recharge the RGA.

5.2.3 Site-related Chemicals

Site-related chemicals for WAG 6 are identified in Sect. 4 (Nature and Extent of Contamination). These chemicals were detected frequently and at elevated concentrations in various environmental media. It is important to note that all waste-source chemicals that were detected at least once (above screening criteria) are addressed in the quantitative fate and transport modeling. The primary site-related chemicals are:

- VOA including TCE and its degradation products (cis-1,2-DCE, trans-1,2-DCE, and vinyl chloride), carbon tetrachloride, 1,1-dichloroethene, 1,1,1-tetrachloroethane, and 1,1,2-tetrachloroethane
- ^{99}Tc, ^{137}Cs, ^{237}Np, ^{239}Pu, ^{230}Th, and uranium and its decay products ^{234}U, ^{235}U, and ^{238}U
- Twelve metals: arsenic, beryllium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, thallium, and vanadium
- PCBs
- Two classes of SVOAs including low molecular weight, fuel-related SVOAs such as naphthalene and pentachlorophenol (phenols); and high molecular weight combustion-related SVOAs such as benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, 2,4-dinitrotoluene, and indeno(1,2,3-cd)pyrene

5.3 CHEMICAL PROPERTIES

The physical and chemical properties of primary chemicals reported at WAG 6 that affect contaminant migration are presented in Tables 5.1 through 5.3. Organic and inorganic chemicals with high solubilities are more mobile in water than those that sorb more strongly to soils. Henry's Law constants are a measure of the partitioning of a chemical between the air phase and water phase. Because of the abundance of water in the environment, this property is best used to estimate the tendency to volatilize.

The following are properties that must be measured when identifying a compound's mobility within a specific medium:

- K_{oc}, the soil organic carbon partition coefficient, is a measure of the tendency for organic compounds to be adsorbed to the organic matter of soil and sediments. K_{oc} is expressed as the ratio of the amount of chemical adsorbed per unit weight of organic carbon to the chemical concentration in solution at equilibrium.
- K_{ow}, the octanol-water partition coefficient, is an indicator of hydrophobicity (the tendency of a chemical to avoid the aqueous phase) and is correlated with potential adsorption to soils. It is also used to estimate the potential for bioconcentration of chemicals into tissues.
- K_d, the soil/water partition coefficient, is a measure of the tendency of a chemical to adsorb to soil or sediment particles. For organic compounds, this coefficient is calculated as the product of the K_{oc} value and the fraction of organic carbon in the soils. In general, chemicals with higher K_d values sorb more strongly to soil/sediment particles and are less mobile than those with lower K_d values.

Chemical distributions in both soil and water are more difficult to predict for metals than for organic compounds. A direct relationship between the measured total metal concentration in soil and the extractable aqueous concentration cannot be assumed. The metal may be fixed in the interior of the soil and unavailable for exchange or release to water, or exchangeable metal may be present at the surface of the particles.

Published K_d values generally represent the potential relationship between water and exchangeable metal at the surface of the soil, which is as follows:

$$C_{total} = C_{fixed} + C_{absorbed}$$
$$K_d = C_{absorbed}/C_{water}$$

where

C_{total} = total concentration of metal (fixed plus absorbed)
C_{fixed} = fixed concentration of metal
$C_{absorbed}$ = absorbed concentration of metal
C_{water} = concentration of metal in water

This relationship is useful in determining retardation (the tendency for the metal to sorb to the surface of the soil), but it does not relate the total metal concentration in the solid to a dissolved concentration. Nevertheless, in the absence of site-specific measurements, the fate and transport modeling for this RI uses K_d values to approximate retardation

5.3.1 Polycyclic Aromatic Hydrocarbons

PAHs are common components of fuel oils and tar mixtures. Fuel use, vehicular traffic, and asphalt surfaces can contribute to detected levels of PAHs. PAHs are relatively persistent and represent a broad class of compounds ranging from low molecular weight components (such as naphthalene) to high molecular weight compounds [such as dibenz(a,h)anthracene]. Solubility, volatility, biodegradability, and toxicity vary widely across this class of compounds.

Volatility, as indicated by the Henry's Law constant, decreases as the molecular weight of PAHs increases. Particulate emissions to ambient air can result from adsorption onto soot particles that can be carried on wind currents and then returned to the surface (dry deposition). High molecular weight PAHs are more likely to be transported via particulate emissions, whereas low molecular weight PAHs have a higher tendency to volatilize.

The behavior of PAHs in tar and oil waste mixtures is determined to a large extent by the mobility and behavior of the waste itself. For example, as tar waste weathers, volatilization, degradation, and leaching of the more mobile constituents occur. The overall loss rate decreases exponentially over time, and the material left behind becomes richer in more viscous and persistent components. Therefore, low molecular weight PAHs can migrate from spills and continuous releases of tars and oils; however, as weathering occurs, the rate of release decreases. Higher molecular weight PAHs would persist in the vicinity of the original release.

Low molecular weight PAHs have higher water solubilities and are more likely to be released into groundwater than higher weight PAH compounds. The high molecular weight PAHs have relatively high K_{oc} values, indicating an increased tendency for adsorption to soil or other organic matter. A primary fate and transport mechanism is the migration of adsorbed PAHs with mobile soil and sediment. The erosion of soil and movement of suspended sediments may result in PAH migration to surface water. However, the low solubility of adsorbed PAHs indicates that they would not partition significantly to water. Most PAHs in aquatic environments are associated with particulate materials. Only about 33% are present in dissolved form.

Photolysis and biodegradation are common attenuation mechanisms for PAH compounds. Although all PAHs transform in the presence of light via photolysis, their transformation rates are highly variable. Photolysis may reduce the concentrations of these chemicals in surface waters or surface soils, but is not relevant for subsurface soils. Biodegradation of PAHs in soils is also extremely variable across the chemical class. Generally, the dicyclic and tricyclic PAHs biodegrade more readily than the higher molecular weight PAHs. Factors that affect the rate of biodegradation in soils include the types of microorganisms present, the availability of nutrients, the presence of oxygen, and the chemical concentration. The extent to which chemicals may biodegrade also can be affected by their presence in mixtures. Some PAHs are more degradable than others. If both stable and mobile PAHs are present in a mixture, the less degradable materials may be co-metabolized at rates similar to or greater than the rates of the more degradable compounds.

In surface water, PAHs can evaporate, disperse into the water column, become incorporated into bottom sediments, concentrate in aquatic biota, or undergo chemical oxidation and biodegradation. The most important processes for the degradation of PAHs in aquatic systems are photooxidation, chemical oxidation, and biological transformation by bacteria and animals. PAHs dissolved in the water column degrade rapidly through photooxidation. Generally, PAH degradation in aquatic environments occurs at a slower rate than in the atmosphere. PAHs degrade most rapidly at higher concentrations, elevated temperatures, elevated oxygen levels, and higher levels of solar radiation.

Literature values vary widely for half-life estimates for PAHs because of the numerous variables involved. Conservative half-life estimates for naphthalene, anthracene, and benzo(a)pyrene show an increase in half-life associated with an increase in molecular weight, as shown in Table 5.4.

The ultimate fate of PAHs that accumulate in sediments is believed to be biotransformation and biodegradation by benthic organisms. PAHs in aquatic sediments degrade slowly in the absence of penetrating radiation and oxygen and may persist indefinitely in oxygen-poor basins or in anoxic sediments. The burial of contaminated sediments deep beneath organic matter deposits can effectively remove these contaminants from interaction with surface water and biota.

Animals and microorganisms can metabolize PAHs to products that ultimately reach complete degradation. PAHs in soil may be assimilated by plants, degraded by soil microorganisms, or accumulated to relatively high levels in the soils. High PAH concentrations in soils can lead to increased populations of soil microorganisms that are capable of degrading the compounds. PAHs can be taken into the mammalian body by inhalation, skin contact, or ingestion (although they are poorly absorbed from the gastrointestinal tract). Specific enzymes present in mammals metabolize PAHs, making the PAHs water-soluble and available for excretion. Although metabolic pathways detoxify PAHs, some metabolic intermediates may be toxic, mutagenic, or carcinogenic to the host. Fish and most crustaceans possess the enzymes necessary for metabolic activation, but some mollusks and other invertebrates are unable to efficiently metabolize PAHs. The bioconcentration factor (BCF) for PAHs [used for development of Ambient Water Quality Criteria (AWQC)] is 30, indicating only limited accumulation potential.

In general, PAHs are not mobile in soil or groundwater. Model simulations of solute transport of PAHs in soil (Clausen 1996) and their physical properties (Table 5.1) indicate limited migration potential (Table 5.5).

5.3.2 Chlorinated VOAs

Chlorinated VOAs were detected at all WAG 6 sectors. These are related to the use of solvents such as TCE, PCE, or 1,1,1-TCA, which are typically used for degreasing activities. In addition to these solvents, common degradation products were detected, including 1,2-DCE (related to the degradation of PCE or TCE), 1,1-DCE, and 1,1-DCA (related to the degradation of 1,1,1-TCA).

The nature of the release is considered in interpreting constituent patterns. When releases are associated with aqueous discharges that contain trace amounts of solvents, migration is associated with the behavior of the aqueous phase. In some instances, the organic solvent itself could be spilled or released, in which case the migration of the organic phase must be considered. The presence of a solvent phase is generally suspected only when high concentrations of chlorinated VOAs are reported. These constituents were reported at various sites at levels typically ranging from trace amounts to as high as 701,184 μg/L of TCE at Sector 4. At Sectors 1, 3, 4, and 8, as concentrations of TCE exceed 90,000 μg/L, further consideration of the implications of a solvent phase would be relevant. EPA (1991) suggests that a groundwater concentration equal to 1% effective solubility (TCE = 11,000 μg/L) is a good indicator of DNAPL.

These chemicals have high vapor pressures and Henry's Law constants, indicating a potential for volatilization. Therefore, they are not expected to persist in surface soils. The rate of loss from volatilization depends on the compound, temperature, soil gas permeability, and chemical-specific vapor pressure.

Release and transport mechanisms include vertical migration through unsaturated soils toward the water table. The range of K_{oc} values indicates that chlorinated VOAs are mobile through soils and tend not to partition significantly from water to soil. As these compounds migrate through soil, some are retained in the pore spaces. Some VOAs may spread across layers of lower permeability. Lateral migration may occur if a low-permeability zone is reached, in which case the non-aqueous-phase liquids (NAPLs) will migrate, depending in part on the contours of the layer surface. Generally, the flow is predominantly vertical through more permeable zones, such as those formed by sandy materials.

Biodegradation and chemical degradation are important considerations in evaluating chlorinated solvents because of the potential formation of chemicals of potential concern (COPCs) and/or losses of COPCs. The redox conditions in the RGA appear to be somewhat variable; however, the groundwater chemistry indicates that only slight anaerobic degradation is occurring.

Aerobic and anaerobic biodegradation are important transformation processes for chlorinated aliphatic compounds in natural water systems and soil. Considerable research has been done on the degradation mechanisms and pathways for this class of compounds. Although several degradation pathways could occur for these constituents, the following patterns have been identified for degradation under anaerobic conditions.

The anaerobic degradation pathway is as follows:

PCE------> TCE------> DCE-----> vinyl chloride or chloroethane

The anaerobic biodegradation of TCE, which initially forms cis-1,2-DCE, occurs under reducing conditions where sulfide- and/or methane-producing conditions exist. Such conditions occur primarily in the presence of other natural or anthropogenic carbon sources. DCE is an indicator for this degradation pathway, because it is not used as a pure product but is found solely as a degradation product. 1,2-DCE may further degrade anaerobically to vinyl chloride, but the rate is slower and the process may require stronger reducing conditions than those required for reduction of PCE or TCE.

TCE generally would be expected to persist under aerobic or denitrifying conditions. Denitrifying conditions are indicated when nitrates are present in groundwater but no oxygen is present.

Aerobic biodegradation of TCE may occur under certain conditions. For example, specialized microorganisms have been identified that aerobically degrade some of these solvents in the presence of ammonia, methane, and toluene. Smaller chlorinated parameters, such as DCE, are harder to degrade anaerobically, but are easier to aerobically degrade than the more chlorinated solvents such as TCE.

1,1,1-TCA can degrade anaerobically to 1,1-DCA, which subsequently degrades to the relatively non-persistent chloroethane. In addition, 1,1-TCA can degrade chemically to 1,1-DCE. That abiotic rate depends only on temperature and allows some estimations of the residence time in groundwater. The half-life for the chemical transformation is approximately 8 months at 25° C, which is within 8 degrees of the temperature measured in groundwater. During this degradation process, approximately 75% of the TCA is transformed to acetic acid and only 25% to 1,1-DCE.

Ratios of TCE to DCE were calculated for Sector 4 (source) and Sector 6 (downgradient of primary TCE source). The average ratios for Sector 4 (400.27) and Sector 6 (1877.88) indicate unfavorable conditions for biodegradation. The lack of widespread daughter products also supports this conclusion (1 detection of vinyl chloride).

5.3.3 Metals

Inorganic chemicals released to unsaturated soil become dissolved in soil moisture or adsorbed onto soil particles. Dissolved inorganic analytes detected at WAG 6 include the metals presented in Table 5.2. These dissolved metals are subject to movement by vadose zone water. Aqueous transport mechanics may result in metal migration through the vadose zone to groundwater. Metals, unlike organic compounds, cannot be degraded. However, metals migration can be attenuated by retarding reactions such as adsorption, surface complexation, and ion-exchange reactions with the soils with which they come into contact. Such reactions are affected by pH; oxidation-reduction conditions; and the type and amount of organic matter, clay, and hydrous oxides present. These reactions are typically reversible, resulting in dynamic metal solubility in immature or poorly developed soils. Some metals, such as arsenic and chromium, can be transformed to other oxidation states in soil. Such transformations can reduce the metals' toxicities and/or affect their mobilities by affecting the way in which they react with soil particles or other solid surfaces by ion exchange, adsorption, precipitation, or complexation.

The oxidation state and chemical speciation of inorganic chemicals control solubility and thus, to a great extent, mobility in the environment. Chemical speciation may be an important process in determining the chemical form present in the soil. However, speciation is very complex and difficult to distinguish in routine laboratory analysis; therefore, its impact may not be measurable or predictable. In soil, metals are typically found in the following depositional pools in the soil:

- Dissolved in soil solution
- Occupying exchange sites on inorganic soil constituents
- Adsorbed on inorganic soil constituents
- Associated with insoluble soil organic matter
- Precipitated as pure or mixed solids
- Present in the structure of secondary minerals
- Present in the structure of primary minerals

In situations where metals have been introduced into the environment through human activities, metals are typically associated with the first five pools. The dissolved aqueous fraction and its equilibrium solid fraction are of primary importance when considering the migration potential of metals associated with soils. The unfilterable inorganics represent the dissolved fraction, which is the more mobile fraction. Of the compounds that are most likely to form in soils, chlorides, nitrates, and nitrites are the most soluble. Sulfates, carbonates, and hydroxides have low to moderate solubility. In general, soluble compounds are transported in aqueous forms that are subject to retardation, whereas insoluble compounds remain as precipitates and limit the overall dissolution of metals.

Adsorption depends on the surface charge, the dissolved ion and its charge, and the pH of the soils. Positively charged metal ions (such as trivalent chromium, cadmium, lead, iron, manganese, and zinc) tend to be adsorbed, and the transport of these species is slower than the groundwater or pore water velocity. The retardation factor (RF) describes numerically the extent to which the velocity of the contaminant migration is decreased and is largely derived from the partition coefficient (K_d).

Table 5.2 presents the range of K_d values for metals for the loam-type soils prevalent at WAG 6. The K_d values of metals vary widely in the same soil type and may vary by orders of magnitude among samples from the same site. However, for purposes of conducting transport analyses in the vertical direction through the UCRS (i.e., migration from the site sources to the RGA), only the average K_d values for loam soil were used. For lateral transport in the RGA, average K_d values for sandy soil were used.

Contaminant persistence is a function of physical, chemical, and biological processes that affect the chemical as it moves through air, soil, and water. Some inorganic contaminants may undergo chemical species transformation after being released to the environment. An important example of one such transformation is the change of the charge state from Cr^{+6} to Cr^{+3}. Organometallic compounds can undergo a variety of chemical reactions that may transform one compound into another, change the state of the compound, or cause a compound to combine with other chemicals; however, the metallic portion of the organometallic compounds only changes oxidation states. With the exception of changing oxidation states or possibly exchanging metallic species, inorganic contaminants are much more stable than organic contaminants.

The mobility of metals is directly related to their solubility in water or other fluids and to pH and redox conditions. In the absence of fluids to mobilize and transport metals, virtually no transport is possible. Even if fluids are present, metals become more mobile only under favorable pH and redox conditions. Movement of metals also is controlled by the solubility (pH- and Eh-dependent), adsorption, and redox state of the metal. With the exceptions of hexavalent chromium, barium, and selenium, the solubility of other metals of concern is inversely proportional to pH. However, iron, manganese, and aluminum oxides, plus carbonates, hydroxides, and organic materials, cause metals to precipitate or be adsorbed onto soil particles.

Abundant Metals

A recurring issue in the WAG 6 RI is the ubiquitous presence of abundant metals identified in all media. The most common of these are aluminum and iron. It is important to distinguish evidence for release and transport from the natural variability at the site or secondary factors that may alter the solubility. A review of the patterns of these constituents at all sectors confirms that they are not primary constituents in the industrial processes performed at the C-400 Building based on the following:

- With the exception of antimony, cadmium, chromium, and thallium, no specific use or source of metals exists at the C-400 Building.
- Aluminum and iron in particular are the second and third most abundant metals in the earth's crust. These were present in the soil and sediment samples analyzed.
- The concentrations in soils were sometimes above the screening value calculated from available background data. The background values for soils identified in this study are lower than generally reported literature values for these constituents.
- These metals were also commonly reported in groundwater at elevated concentrations.
- There is no "plume" (pattern of high to lower concentrations) of these metals. Dissolved concentrations were generally low.
- Elevated dissolved iron is also frequently related to anaerobic conditions in the groundwater, increasing the solubility of iron in its reduced form (Fe^{+2}).

There are two major fate and transport implications for metals when particulates are present: First, there may be several biases in the determination of other related metals concentrations. In addition, the potential for facilitated transport of metals may be considered.

The fate and transport of metals were frequently estimated based on the dissolved concentrations, which are typically low across WAG 6. Colloids may migrate in aquifer systems if the particle size is much smaller than the pore size. Mobile colloids are commonly smaller than 0.45 micron. The samples were filtered with a 0.45-micron filter to limit removal of the non-mobile colloids. A comparison of filtered versus unfiltered metals data for the monitoring wells was evaluated against the filtered versus unfiltered metals data for the borehole water samples. The results indicate that average concentrations in borehole water samples for aluminum and iron were 41 and 72 times higher, respectively, than aluminum and iron reported in the monitoring well samples. A comparison of other metals would yield similar results.

This condition is a result of the high volume of particulate matter introduced into the samples during collection. Although turbidity was not measured on the borehole water samples, the chemists have indicated that the borehole water samples in many cases were visually turbid. It can be concluded that the concentrations of metals in the borehole water samples are not representative of the groundwater in the RGA and the evaluation indicated anomalously high metals concentrations in these samples.

Only the metals data from the monitoring wells are of sufficient quality to be used to prepare a BRA.

Trace Metals

The potential release and migration of metals in the subsurface environment is a complex process. The migration of metals depends on factors such as the overall groundwater composition, pH, presence of dissolved organic matter that may complex with the metals, the valence state of the metal, and the cation exchange capacity. Metals may be removed from the water phase through mechanisms such as precipitation and irreversible sorption.

In addition to the abundant metals (aluminum and iron), other metals were sometimes reported above background levels in the various environmental media.

In groundwater, interpretation of the unfiltered metals is complicated by turbid samples. In these cases, low-mobility constituents (such as lead) that do not represent a dissolved plume are typically detected at significant levels.

5.3.4 Radionuclides

Radionuclides represent a special case of inorganic species. Radioactive nuclides undergo spontaneous transformations that involve the emission of particles and radiant energy. Most important for WAG 6 are the emission of alpha and beta particles and the emission of gamma energy. The resulting daughters (i.e., product nuclides) may be either radioactive themselves (in which case they too will undergo spontaneous decay), or they may be stable nuclides. The decay process can occur by various spontaneous mechanisms. Two of the more important decay modes are alpha decay and beta decay; the latter is differentiated into negatron and positron decay. As with inorganic and organic chemical species that do not undergo nuclear transformations, the persistence of radionuclide contaminants at WAG 6 is related largely to their geochemical mobility in the environment. Table 5.3 presents the half-lives ($t_{1/2}$), radioactive decay constants, and K_d values for the site-related radionuclides. The K_d values for uranium in Table 5.3 are the most conservative site-specific value reported.

Natural uranium consists of three primary isotopes: ^{234}U, ^{235}U, and ^{238}U. The natural abundance of these isotopes, as well as their abundance in enriched (typical power reactor grade) and depleted uranium, are listed in Table 5.3. The decay products of uranium isotopes are also radioactive and form decay chains. The decay products of ^{238}U and ^{235}U (^{234}U is a member of the ^{238}U decay chain), along with the half-lives of each nuclide, are presented in Table 5.3.

Because DOE facilities do not routinely process uranium ore concentrates, the only non-uranium members of these decay chains that are present in virgin feed materials are those that have developed since the chemical extraction of the uranium. The nuclides that occur in sufficient abundance to have an impact on radiological controls are ^{234}Th, ^{234}Pa, and ^{231}Th. The long half-lives of ^{230}Th in the ^{238}U chain and the ^{231}Pa in the ^{235}U chain effectively prevent the accumulation of significant quantities of other decay products. Still, some ^{230}Th and ^{226}Ra may be found in the process wastewater. Thus, it is prudent to include those radionuclides in effluent and/or environmental monitoring programs.

Some of the uranium feed material that was handled at PGDP has been reclaimed or recycled from reprocessed, spent reactor fuel. The chemical processes by which recycled uranium is purified leave trace amounts of transuranic (TRU) elements (neptunium and plutonium) and fission products (mainly ^{99}Tc). Recycled uranium also contains trace amounts of uranium isotopes not found in nature, such as ^{236}U.

All of the primary isotopes of uranium are long-lived alpha emitters. However, several other radionuclides can be radiologically significant at PGDP, given its history of uranium processing. During the roughly 40 years of operations at PGDP, thousands of tons of uranium were processed through the diffusion cascades. The vast majority of the uranium has been extracted and purified from ore, but some was recycled material obtained from spent reactor fuel. Processing of recycled uranium has been conducted during 3 periods: 1952-1964, 1969-1974, and 1976-1977. Virtually all of the recycled uranium came from plutonium production reactors at the Hanford and Savannah River sites, with very little coming from power or demonstration reactors.

Unlike virgin feed material, the material recycled from reprocessed reactor fuels contained trace quantities of fission products and TRU elements formed during the irradiation of the fuels. Most of these impurities were removed during chemical processing of the fuels. Because the fluorinated compounds of the elements in question have limited volatility, much of the impurity activity initially present remained in the feed cylinders or was deposited in the cascade equipment very close to the feed point. However, trace quantities passed through both of these chemical and physical separations and contaminated the diffusion cascades.

On an activity basis, the principal radionuclides expected to pass through chemical processing and contaminate the recycled uranium are the TRU radionuclides produced in highest abundance and with moderate half-lives: ^{237}Np, ^{238}Pu, ^{239}Pu, ^{240}Pu, and ^{241}Am. However, characterization studies have generally shown that these radioisotopes are usually present in activities that are <1% of the uranium activity unless treatment processes have collected and concentrated them in sludges or trap material. Of the TRU radionuclides, neptunium fluoride is believed to have been the most mobile in the gaseous phase and traveled further in the process before being deposited. The others are believed to have been present in the feed in lower concentrations and to have been more persistent in the heel of the feed cylinders.

In addition, certain fission and activation products may form volatile compounds in the fluorination process: ^{95}Zr, ^{95}Nb, ^{99}Tc, ^{106}Ru, ^{134}Cs, and ^{137}Cs. However, ^{95}Zr, ^{95}Nb, ^{106}Ru, and ^{134}Cs have short half-lives (65 days, 55 days, 368 days, and 2.1 years, respectively) compared to the 15-plus years since recycled uranium was last introduced; as a result, they are unlikely to be present in significant quantities today. Because ^{137}Cs has a half-life of 30 years, it is the most likely fission product (except for ^{99}Tc) to still be present at the site.

Radionuclides such as ^{230}Th, ^{226}Ra, and ^{222}Rn are probably a result of the long-term decay of terrestrial uranium in soil and/or groundwater. It should also be noted that before total uranium data (expressed in mg/kg or mg/L) can be compared with the total isotopic uranium activity (expressed in pCi/L), additional calculations must be performed.

5.3.4.1 Buildup of Uranium Daughter Products

Radioisotopes such as ^{235}U and ^{238}U decay over relatively long time periods and produce daughter products. However, because the presence of any daughter product is a function of the half-life of the progeny, the parent and progeny can approach equilibrium within a few half-lives of the progeny. Table 5.3 lists daughter activities for several radionuclides for time periods of up to 10,000 years. The radionuclides ^{238}U, ^{234}Th, and ^{234}Pa are in radioactive equilibrium and show essentially no decrease in activity, even after 10,000 years (SAIC 1996).

5.4 CHEMICAL MIGRATION RATES

Chemicals in soil or groundwater migrate at a velocity slower than that of the water, which is the transport medium. The retardation factor, RF, is the relative chemical migration velocity, which is calculated as follows:

$$RF = 1 + (K_d \rho) / \eta$$

where

RF = chemical-specific retardation factor (dimensionless)

ρ = bulk mass density of dry aquifer system skeleton (g/cc)
{1.67 g/cc (based on soil samples collected during this RI)}

η = total porosity (dimensionless)
{0.37 value from literature}

K_d = chemical-specific distribution coefficient (cc/g)

The distribution coefficient K_d for organic constituents is estimated as follows:

$$K_d = K_{oc} * foc$$

where

K_{oc} = chemical-specific organic carbon partition coefficient
foc = fraction of organic carbon
{0.00509 (based on soil samples collected during this RI)}

In general, metals are persistent in the environment. Metals are not typically volatile, so any emissions to ambient air would be in the form of particulate emissions. The chemical migration rates for site-related COCs are presented in Table 5.5.

5.4.1 Migration Pathways

5.4.1.1 Soil to Groundwater Pathway—UCRS

Contaminants present in surface and subsurface soils may leach to the underlying aquifer. Several factors influence the dissolution of COPCs in soils and the rate of contaminant movement through soils. These include the physical/chemical properties of the contaminants (e.g., solubility, density, viscosity, K_d) and the physical/chemical properties of the environment (e.g., rainfall, percolation rate, soil permeability, porosity, particle size, and amount of organic carbon). Contaminants migrate to groundwater through infiltration, leaching, and the movement of subsurface water within the capillary fringe.

Generally, the groundwater is relatively deep at WAG 6, and many of the potential source areas have been present for a long time. Therefore, leaching potential is indicated by the observed groundwater concentrations. The amount of available water for infiltration is based on an average rainfall recharge rate of 7 in. per year. The interstitial groundwater velocity (in./year) is estimated by the recharge rate divided by the volumetric moisture content of the unsaturated zone. Assuming a water-filled porosity of 0.37, the velocity of the infiltrating water is about 19 in. per year. The depth to the water table in many areas is approximately 50 ft, suggesting a 32-year travel time from the surface to the water table. In areas beneath pavement or other low-permeability zones, less infiltration would occur. Adjacent to paved areas, higher rates of recharge may occur as runoff increases the infiltration in localized areas. It is obvious that vertical migration has occurred at a much higher rate than indicated by advection/leaching, primarily because of diffusion. Diffusion can significantly increase the rate of contaminant migration as the chemical moves to counteract concentration gradients, which are estimated to be quite significant at WAG 6. It appears that the dominant driving force for chemical migration in the UCRS is diffusion.

Chemicals can attenuate in the vadose zone. Chemicals that strongly sorb to soils, including most PAH compounds, tend to remain in or near the point of release. The RFs for these constituents indicate that they would be expected to migrate much more slowly than water in some instances. In addition to their strong tendency to adsorb, these compounds biodegrade during the slow transport, limiting the impacted area. Other constituents such as VOAs tend to volatilize in the unsaturated zone, decreasing their persistence in that medium.

5.4.1.2 Groundwater Migration—RGA

The COCs reported in RGA groundwater include arsenic, beryllium, iron, chromium, lead, manganese, thallium, silver, TCE, cis-1,2-DCE, trans-1,2-DCE, vinyl chloride, 1,1-DCE, 1,1,1-TCA, 1,1,2-TCA, and several radionuclides. VOAs are the most widespread of the COCs. The highest concentrations of VOAs were reported in Sector 4. TCE was present in all sectors and at concentrations ranging from 1.5 μg/L to 701,000 μg/L. DCE was reported in all sectors except 3 and 9, but at much lower concentrations. DCE is formed from anaerobic biodegradation of TCE or the DCE intermediates. It subsequently degrades to ethene and/or ethane. The current data indicate that anaerobic biodegradation (e.g., TCE to DCE) is not a major process in the hydrogeological/geochemical environment at WAG 6.

Once in the groundwater, the COCs generally move through the RGA via advection. Using the hydraulic properties of the RGA as a conservative estimate of advective transport, the seepage velocity (advection velocity) at the site was estimated at 2.4 ft/day. [The advection (seepage) velocity, $v = ki/n$, where k is the hydraulic conductivity, i is the hydraulic gradient, and n is the effective porosity.] Therefore, based on advection alone, it was estimated that contaminants from the site could migrate 876 ft each year.

COCs spread both horizontally and vertically due to the process of dispersion, while adsorption retards the movement of chemicals in groundwater. Dispersion generally causes chemicals to migrate from 10 to 20% farther than migration caused by advection alone. Adsorption, which retards the movement of chemicals, counteracts the advection and dispersion processes. Adsorption is generally described by a chemical's distribution coefficient (K_d). The migration potential for 1 year is calculated for COCs, in accordance with the groundwater flow velocities at that location. These calculations were based on the following equation:

$$V_c = V / R_d$$

where

V_c = chemical horizontal migration velocity in feet per year (ft/yr)
V = site-specific groundwater flow velocity (ft/yr)
R_d = chemical-specific retardation factor (dimensionless)

Calculated horizontal migration velocities are based on advection, retardation, and dispersion, but not on the effects of biodegradation. In accordance with the COCs identified in Table 5.5, the most mobile constituents include the chlorinated VOAs. Other constituents, including PAHs and metals (such as lead and vanadium), are not readily transported in groundwater. Consistent with these properties, PAHs were not detected in the groundwater. The widespread occurrence of unfiltered metals such as iron is the result of highly turbid groundwater samples and is not a result of migration or site-related activities.

The maximum extent of contamination confirmed in the RGA is due to TCE. Considering that the site began operations approximately 46 years ago, the current horizontal migration potential of TCE due to advection, retardation, and dispersion is estimated to be 16,568 ft. This distance is consistent with fate and transport modeling of TCE contamination in the RGA that is reported in Section 5.5.

5.5 FATE AND TRANSPORT MODELING

As part of the RI, contaminant fate and transport modeling was performed that is specific to each WAG 6 sector's conceptual model. Soil and groundwater are the primary media for contaminant migration at this site. Therefore, the RI focused on fate and transport modeling of the groundwater pathway. Air and surface water are not considered important pathways for contaminant transport from WAG 6 for reasons described in the following two paragraphs.

As an operating facility, the C-400 Building has been subject to a continuing industrial hygiene program that includes monitoring the breathing zone and facility emissions for compliance with health-based standards. None of the monitoring results required a change in building operations. The Health and Safety Program of the WAG 6 RI provides further evidence of the lack of an air pathway for WAG 6 contaminants. Health and Safety Officers performed air monitoring prior to and during sampling of hundreds of boreholes around and within the C-400 Building. Although monitoring detected VOAs in the breathing zone at some locations, no occurrences of significantly elevated levels, requiring an upgrade of PPE above a modified level D, were encountered. The impact of air emissions to an off-site receptor from WAG 6 source areas is insignificant.

The C-400 Building, as well as the entire plant, is engineered to control stormwater runoff. All runoff from the C-400 Area, with the possible exception of rainfall on the concrete aprons at the north and south ends of the building, flows to stormwater sewer intakes of KPDES Outfall 008. Annual site environmental reports summarize the results of compliance monitoring at KPDES Outfall 008. The monitoring record for Outfall 008 demonstrates the lack of a significant surface-water pathway from the C-400 Area.

Groundwater contaminant transport near the WAG 6 area occurs principally by dissolution of sources present in the UCRS soils and transport by advective and dispersive mechanisms to the RGA. This occurs as rainwater infiltrates from the surface and percolates through the source of contamination and its surrounding soil into the saturated zone. Lateral transport pathways follow groundwater flow paths established by the regional groundwater gradient. Figure 5.2 illustrates the conceptual model for vertical transport through the unsaturated and saturated zones of the UCRS to the RGA, as well as horizontal transport through the RGA to downgradient locations.

Lower levels of contamination, decreasing with depth, are found in the underlying McNairy Formation. This contamination is attributed, in part, to limited advective transport across the RGA/McNairy boundary. Dispersion, particularly diffusion, may also be an important transport mechanism.

An additional source release mechanism present beneath the WAG 6 area is DNAPL dissolution. WAG 6 is the site of several distinct releases of TCE, a DNAPL. Because of the chemical's greater density and high interfacial tension with water, DNAPL movement is gravity-driven, largely independent of groundwater flow, and is often directed by subtle textural changes in the soils. Where spill volumes are sufficiently large, DNAPLs penetrate to significant depths. As dissolution removes residual DNAPL ganglia left along the DNAPL flow path, secondary sources of contamination result where the DNAPL is pooled above zones of lower permeability.

The C-400 Building is the source of a large DNAPL zone in the RGA. This DNAPL zone is the principal source of one large dissolved-phase plume of TCE known as the Northwest Plume and a contributor to another large dissolved-phase plume of TCE known as the Northeast Plume. Monitoring results are available for the previous 10 years that define the contaminant levels and trends resulting from the DNAPL zone. Over the period of monitoring, the annual average TCE level has remained constant. Furthermore, the extent of the Northwest Plume over 2.5 miles suggests that the Northwest Plume has been developed fully for decades. Thus, transport modeling is not required for assessing current or future levels of contaminant exposure originating from the DNAPL zone.

The Northwest Plume also contains a zone of high ^{99}Tc activity that originates from the WAG 6 vicinity. Soil and groundwater samples from the RI show the ^{99}Tc source to be downgradient of the primary TCE DNAPL zone, but the exact location of the ^{99}Tc source remains undefined. Figure 5.3 shows that, over the 10-plus-year record of contaminant levels in the Northwest Plume, ^{99}Tc activity has declined from 3000 pCi/L to approximately 1000 pCi/L in well MW66, located in the core of the plume at the PGDP security fence. This trend of declining ^{99}Tc levels is well defined and reflects the loss of source mass. As with the DNAPL zone, modeling is unnecessary for assessing current or future levels of contaminant exposure originating from the ^{99}Tc source.

Although empirical data are sufficient to show the need for a remedial action in the RGA, fate and transport modeling is required to assess the impact of contaminant levels in each sector of WAG 6. The Multimedia Environmental Pollutant Assessment System (MEPAS) (Battelle 1995) was used in this analysis to simulate fate and transport of contaminants at WAG 6. The MEPAS model is a fate and transport and risk computation code that combines source term, transport, and exposure type models. For purposes of this analysis, only the groundwater pollutant transport portion of the model was run to calculate predicted contaminant concentrations in groundwater at receptor points within the RGA (Whelan et al. 1992). The

MEPAS code calculates groundwater concentrations using the one-dimensional advective and three-dimensional dispersive equations for solute flow, accounting for degradation and decay:

$$\left(\frac{\partial c}{\partial t}\right) + \left(\frac{u}{R_f}\right)\left(\frac{\partial c}{\partial x}\right) = \left(\frac{D_x}{R_f}\right)\left(\frac{\partial^2 c}{\partial x^2}\right) + \left(\frac{D_y}{R_f}\right)\left(\frac{\partial^2 c}{\partial y^2}\right) + \left(\frac{D_z}{R_f}\right)\left(\frac{\partial^2 c}{\partial z^2}\right) - \lambda c$$

in which

$$R_f = 1 + \frac{\beta K_d}{n_e} \text{ (saturated zone)}$$

$$R_f = 1 + \frac{\beta K_d}{\theta} \text{ (vadose zone)}$$

$$\theta = n\left[\frac{(K(\theta))}{K_s}\right]^b$$

C = dissolved concentration (g/mL or Ci/mL)
u = pore-water velocity (cm/sec)
D_x,D_y,D_z = the dispersion coefficients in the X, Y, and Z directions, respectively (cm^2/sec)

λ = degradation/decay rate (L/sec)
β = bulk density of soil (g/cm^3)
K_d = distribution coefficient (mL/g)
n_e = effective porosity (dimensionless)
n = total porosity (dimensionless)
Θ = moisture content of the soil (dimensionless)
K(Θ) = hydraulic conductivity (cm/sec)
K_s = saturated hydraulic conductivity (cm/sec)
b = empirically based value that is a function of the soil property

Because the MEPAS algorithm does account for degradation/decay, the model is especially useful for such screening level groundwater modeling. A full discussion of the mathematical formulations utilized in the source-term release and groundwater modules of MEPAS (Version 3.2) can be found in Volumes I and III of the report, *MEPAS® - Multimedia Environmental Pollutant Assessment System Formulations* (Battelle 1997).

The MEPAS model allows flexibility in how sources are modeled. In this analysis, all sources were modeled as depleting over time and degrading within the environment (groundwater). The MEPAS degradation function is based on the amount of carbon present in soils. Very little carbon is present in soils at PGDP, so MEPAS modeling resulted in little degradation of organics in the groundwater. Several site-specific source terms were represented within the model for each WAG 6 sector. Contaminant source concentrations were assessed from sampling results. Simulated sources are further distinguished between surface soil and subsurface soil to accommodate the remedial action decision process.

This analysis defines source terms for eight of the nine WAG 6 sectors. No source term was modeled for Sector 9, which was intended only for assessing the presence and location of a dissolved contaminant plume originating from Sector 2. Table 5.6 presents the soil and aquifer transport parameters that were input into the MEPAS model. Although a thin zone of saturation may exist within the UCRS across the WAG 6area, the sector source terms treat the entire interval above the RGA as an unsaturated zone, partly because MEPAS can only accommodate one saturated zone at a time (RGA), and because the zone of saturation above the aquifer is so thin across the WAG 6area that its cumulative effect on contaminant transport is minimal.

The decision flow chart shown in Figure 5.4 defines the screening process by which contaminants to be modeled for assessment of fate and transport were identified for each WAG 6 sector. For those soil sample analytes with an established preliminary remediation goal (PRG) defined by DOE (1996) or background level as defined by DOE (1995a), modelers compared all detections in a sector against the larger of the PRG or twice the background. If no detection of the analyte was above the reference level, then that analyte was screened out as a sector-related contaminant. Note, screening against twice background was applied only to reduce the number of contaminants for fate and transport modeling to a manageable level. This is not the screening process used in the RI risk assessment.

Next, laboratory-related contaminants, decontamination solvents, and essential human nutrients were excluded from the list of potential sector-related contaminants. Laboratory-related contaminants in the WAG 6 RI database included acetone, carbon disulfide, methylene chloride, and all phthalate esters. Detections of the solvents 2-propanol and 2-hexanone appeared to be geographically unrelated, other than common to discrete borings. These chemicals typically are used as decontamination solvents and are not thought to be sector-related contaminants. The essential human nutrients screened from consideration as sector-related contaminants are calcium, chloride, iodine, magnesium, potassium, sodium, and phosphorus. Additional analytes were screened out of the list of sector-related contaminants where very few detections (typically one) of the analyte were present in the database for the sector and the analyte concentrations did not greatly exceed a screening level. These analyte concentrations that did not greatly exceed a screening level were determined by site experts based on the range of observed contaminant levels and the closeness of the screening level to the sample quantification level. Analyte concentrations that did not greatly exceed a screening level were determined by site experts based on the range of observed contaminant levels and the closeness of the screening level to the sample quantification level.

In general, the full distance to adjacent boreholes where a contaminant could be documented to be below detection level and the full depth to where a contaminant could be assessed to be below detection level defined the extent of the modeled source terms. As a consequence, many source terms incorporate the entire volume of the unsaturated soil in a sector. However, in a few instances where source delineation was not so clearly derived, some professional judgment was necessary to assess source zones. In all instances, modelers applied conservatism (worst case) in the definition of the extent of the source zones. Table 5.7 presents the final list of contaminants resulting from the screening process that were modeled with MEPAS for each sector.

The MEPAS model requires a discrete volume and contaminant level for each sector source zone. In some instances, the conceptual model of the sector source zones includes areas of different contaminant levels for a given contaminant. Where the conceptual model includes multiple volumes of discrete contaminant levels, the contaminant inventory for the sector was normalized to facilitate the transport model process. Depending on the distribution of data, the procedures used to characterize the contaminant levels for each source term vary. The source term definitions are detailed in Table 5.8 (Sector 1), Table 5.11 (Sector 2), Table 5.14 (Sector 3), Table 5.17 (Sector 4), Table 5.20 (Sector 5), Table 5.23 (Sector 6), Table 5.26 (Sector 7), and Table 5.29 (Sector 8).

For each defined sector within WAG 6, constituents were modeled for both surface and subsurface sources. The source terms for "Surface" and "Subsurface," respectively, apply to topsoil and the UCD (host formation of the UCRS). Modelers identified sources of undissolved contaminants within the lower Continental Deposits (host formation of the RGA) for two sectors: 5 and 7. These source terms are identified as "RGA" in Tables 5.21 and 5.27. Concentrations were modeled at two receptor points: the plant fence, approximately 3300 ft from source areas and the plant property boundary, 5500 ft from the source areas. Output tables report the maximum concentrations and their corresponding times. Modelers noted some instances where a maximum concentration could not be modeled within a 10,000-year time frame. Modelers also identified whether constituents were source term inputs or whether they resulted from the degradation or decay of a sector contaminant (daughter product). The following sections document source term development and present MEPAS modeled concentrations for these contaminants for each WAG 6 sector.

5.5.1 Sector 1

Sector 1 does not include any SWMUs of WAG 6. It includes subsurface soils beneath the C-400 Building. Three concerns limited the number of boreholes drilled in Sector 1: (1) health and safety risks from drilling through the building floor (primarily risk of contact with energized electrical utilities), (2) risk of impacting current operations (disrupted electrical, steam, and water utilities), and (3) nuclear criticality. Single borehole locations were completed near the main degreaser unit, in the building's southeast quadrant, and near the spray booth complex.

Tables 5.8 and 5.9 present the source terms and contaminant inventories for Sector 1. Screening eliminated from concern all metal and organic analytes of the samples with the exception of TCE. For purposes of this assessment, the TCE detected in Sector 1 was assumed to be related to the main spill zone of Sector 4. The Sector 4 TCE source zone was expanded to include the contaminated area beneath Sector 1. Therefore, TCE was not modeled as a surface source term for Sector 1. The C-400 Building contained many TCE-related processes. Other sources may account for the present distribution of TCE in Sector 1, but the contaminant inventory will likely be similar to the modeled source term.

Both ^{137}Cs and ^{237}Np subsurface soil source terms were defined for Sector 1. The source term volume was defined conservatively by the total area of the C-400 Building footprint multiplied by the depth of the unsaturated zone less the 10-ft depth of the building backfill. Table 5.10 lists the results of MEPAS modeling for Sector 1.

5.5.2 Sector 2 (SWMU 40)

MEPAS source terms were developed for two surface soil contaminants and seven subsurface soil contaminants in this sector. The surface soil contaminants, phenanthrene and ^{238}U, were assumed to be present at their maximum detected concentrations across the entire sector from 0 to 1 ft bgs. The source terms and contaminant inventories for Sector 2 are presented in Tables 5.11 and 5.12. The distribution of contaminants in the subsurface soils in Sector 2 suggests that SWMU 40 (the C-403 Neutralization Tank) is not the only source of contamination in the sector.

Phenanthrene, chromium, N-Nitroso-di-n-propylamine, and thallium were detected in areas outside the general vicinity of SWMU 40, indicating that at least one additional release location south of SWMU 40 and adjacent to the C-400 Building is likely. No shared pattern of contaminant distribution could be discerned that would enable grouping of any of the subsurface contaminants into common source areas, so discrete subsurface source areas were defined for each contaminant. Chromium was detected in samples from a boring near the southern edge of the sector (400-008), so the source term for this contaminant was assumed to consist of a rectangular box centered on this boring and extending from 1 ft bgs to the top of the RGA (50 ft bgs). The dimensions of the source area for phenanthrene were based on its detection only in shallow soil samples (above 7 ft) from two borings in the southwestern part of the sector. The source area for N-Nitroso-di-n-propylamine is located from 4 to 50 ft bgs in an area that extends from the southern boundary of the sector to the northeast corner of the C-400 Building to encompass the two borings (040-003 and 400-008) containing detectable concentrations. A small source area was defined for thallium, which was detected in one (0- to 2-ft) sample from Boring 400-003 in the northwestern portion of the sector.

Because ^{238}U appeared to be detected throughout the UCRS in several borings in the sector, it was modeled over the entire sector at its maximum detected concentration. Uranium-234 and ^{235}U were not detected below 38 ft and appeared to be confined to two smaller areas, one in the general vicinity of SWMU 40 and the other in the southwestern portion of the sector. Two additional sector contaminants, 2,6-DNT and dibenzofuran, were identified but could not be modeled because they were absent from the MEPAS database. Trichloroethene was not modeled for this sector because it was detected in only one soil sample and this detect was below the PRG level. Table 5.13 lists the results of MEPAS modeling for Sector 2.

5.5.3 Sector 3

There are no identified SWMUs in Sector 3. One surface source area and three subsurface source areas have been defined in the sector on the basis of surface and subsurface soil sampling data. The source terms and contaminant inventories for Sector 3 are presented in Tables 5.14 and 5.15. The source areas were assumed to be cubic for input into the MEPAS model.

Nine constituents were identified as present above screening levels in surface soils. They include phenanthrene, thallium, and PCBs (total and Aroclor-1260), as well as the radionuclides ^{237}Np, ^{230}Th, ^{234}U, ^{235}U, and ^{238}U. It was assumed conservatively that these contaminants were distributed homogeneously at their maximum detected concentrations across the entire sector in the surface soils.

The three subsurface source areas defined in Sector 3 are associated with elevated levels of phenanthrene, Trichloroethene, and ^{237}Np.

Source areas are confined to the western portion of the sector immediately adjacent to the C-400 Building in areas around those borings with detectable concentrations (Borings 400-011, 011-001, and 011-002). This supports the view that the sources of these contaminants are probably past releases from the storm sewer lines or the acid sewer lines located near the eastern edge of the C-400 Building. The source area for TCE extends across the entire sector and also includes soils directly beneath the eastern portion of the C-400 Building in Sector 1. TCE was assumed to be distributed homogeneously throughout the UCRS soils (1 to 50 ft bgs) at a concentration of 1502 µg/kg, which is the average concentration calculated from 23 detected values. The results of MEPAS modeling of the contaminant sources in Sector 3 are presented in Table 5.16.

5.5.4 Sector 4 (SWMU 11)

Tables 5.17 and 5.18 present the MEPAS source terms and contaminant inventories for Sector 4. The primary contaminant associated with Sector 4 is TCE. However, the RI data reveal several contaminants to be modeled as distributed across the entire sector, less the area of the sector that is covered by a concrete apron on the south side of the C-400 Building. These contaminants include the PCB Aroclor-1262 and phenanthrene in surface soils and ^{237}Np in subsurface soils.

Both the distribution of TCE and the location of potential sources of TCE suggest at least two distinct release points. In the conceptual model of the TCE sources, TCE is distributed along the length of the storm sewer in Sector 4 that includes the known release site, SWMU 11. In addition, the RI sample analyses define a distinct TCE source associated with a TCE off-loading pump station and associated transfer lines (tank trailer to day holding tank). The MEPAS source term for TCE is a combined volume of both sources normalized to the highest TCE levels observed in Sector 4 (approximately 10% DNAPL saturation). The TCE degradation products cis-1,2-dichloroethene, trans-1,2-dichloroethene, and vinyl chloride are included in the same source term, as well as ^{239}Pu. Although cis-1,2-DCE and trans-1,2-DCE were identified as contaminants, distribution coefficients (K_d) were not included in the MEPAS database. Thus these contaminants could not be modeled for fate and transport.

Table 5.19 presents the results of the MEPAS model for Sector 4 in terms of time until a maximum contaminant level is achieved at the PGDP security fence and the DOE property boundary. Model results indicate that the existing TCE in subsurface soils in Sector 4, alone, will result in dissolved TCE concentrations offsite of 50,000 µg/L, reaching a maximum level 105 years into the future.

Plutonium is typically restricted to surface soils because it readily binds to soil particles. Sector 4 analyses document that ^{239}Pu extends throughout the depth of the unsaturated zone in Sector 4, but is restricted to the area of the TCE source zone. It is suspected that the TCE or TCE degradation products have facilitated the transport of the plutonium through the subsurface soils. Boring 400-200 provided the only Sector 4 subsurface soil samples with elevated levels of other organic chemicals (1,1,1-trichloroethane; trichlorofluoromethane; 1,1,2-trichloroethane; 1,1-dichloroethene; carbon tetrachloride; phenanthrene; and tetrachloroethene) and chromium.

The source term volume for these contaminants was defined by the total distance to adjacent borings where the analytes were not detected. The MEPAS model results are reported in Table 5.19.

5.5.5 Sector 5

No sources of contamination (SWMUs) had been identified for Sector 5 previous to this RI. Sample analyses of the RI define many sector-related contaminants. The MEPAS source terms and contaminant inventories for Sector 5 are documented in Tables 5.20 and 5.21. All surface soil contaminant source terms were defined by the entire area of Sector 5 less the area covered by the concrete apron on the south side of the C-400 Building. Surface soil contaminants include the semivolatile compounds acenaphthylene, benz(a)anthracene, benz(a)pyrene, benz(b)fluoranthene, benz(k)fluoranthene, dibenzofuran, and phenanthrene; the metals chromium and thallium; and the radionuclides ^{237}Np, ^{239}Pu, ^{99}Tc, ^{234}U, ^{235}U, and ^{238}U. Although dibenzofuran was identified as a sector contaminant, it is not included in the MEPAS database and could not be modeled.

Subsurface soil source terms for thallium, ^{241}Am, ^{137}Cs, and ^{235}U were defined conservatively by the homogeneous distribution of the contaminants throughout the volume of the entire Sector 5 subsurface soils. Several organic contaminants appeared to be associated with the storm sewers exiting the south side of the C-400 Building. Boring 400-015 defined the locus for the subsurface soil source term for iodomethane and TCE. The remaining areas adjacent to the storm sewers are included in the subsurface soil source term for cis-1,2-dichloroethene, trans-1,2-dichloroethene, and vinyl chloride. Although trans-1,2-DCE and cis-1,2-DCE were identified as sector contaminants, they are not included in the MEPAS database and could not be modeled.

One contaminant source, ^{237}Np, was modeled for the RGA. The area modeled was 300 ft x 100 ft, including areas where ^{237}Np was detected and extending until there were no ^{237}Np detections in the RGA. A conservative depth of 50 to 95 ft was used. Because the highest observed detection (0.2 pCi/g) was also equivalent to the average concentration, 0.2 pCi/g was used as the contamination level for the model. Table 5.22 lists the results of MEPAS modeling for Sector 5.

5.5.6 Sector 6 (SWMU 47)

A bermed area measuring 20 ft x 20 ft defines the location of SWMU 47, the former position of the Technetium Storage Tank. The berm is used to define the dimensions of the source term for a number of radionuclides in surface soils: ^{241}Am, ^{137}Cs, ^{237}Np, ^{99}Tc, ^{230}Th, ^{234}U, ^{235}U, and ^{238}U; and in subsurface soils: ^{237}Np, ^{99}Tc, ^{234}U, ^{235}U, and ^{238}U.

The area of the entire sector defines the source term for three semivolatile compounds in surface soil: 2-methylnaphthalene, dibenz(a,h)anthracene, and dibenzofuran; and for ^{241}Am and ^{230}Th in subsurface soil. Both TCE and trans-1,2-dichloroethene are present at elevated levels in samples from Boring 047-002, located adjacent to the C-400 Building. By assuming that the VOAs uniformly contaminate soils along the west side of the C-400 Building, Boring 400-041 of Sector 5 defines the western extent of the source term. A collection line for the C-400 Building floor drain system parallels the west side of the C-400 Building and is a potential source for the contaminants. Tables 5.23 and 5.24 present the MEPAS source terms and contaminant inventories for Sector 6. The MEPAS modeling results are reported in Table 5.25.

5.5.7 Sector 7 (SWMU 203)

Sector 7 contains SWMU 203 (the Waste Discard Sump), which is located approximately 20 ft north of the northwest corner of the C-400 Building. Some of the Sector 7 contaminants were detected in samples collected in proximity to the northwest corner of the C-400 Building and are probably associated with releases from SWMU 203. The source terms and contaminant inventories for Sector 7 are presented in Tables 5.26 and 5.27.

Two constituents, chromium and ^{238}U, were identified as present above screening levels in surface soils. It was assumed that these contaminants were distributed homogeneously at their maximum detected concentrations across the entire sector from 0 to 1 ft bgs. Ten contaminants were present above the screening levels in subsurface soils. Two of these contaminants, antimony and ^{230}Th, had scattered detections throughout the sector in the UCRS and were assumed to be distributed across the entire sector from 1 to 50 ft bgs at their average detected concentrations. Four other contaminants, mercury and the radionuclides ^{99}Tc, ^{234}U, and ^{238}U, were also detected in numerous borings in Sector 7 but were not detected below a depth of 35 ft bgs. These four contaminants were assumed to be present throughout the entire sector but were confined to the 1- to 35-ft interval. Uranium-235 was detected above screening levels in the sector, but was confined to the shallow soils (0- to 2-ft sampling interval) in two borings (400-001 and 203-003). Its source area was assumed to center on these two borings but not to extend beyond other borings in the sector that had no detects. Two other sector contaminants, ^{241}Am and ^{237}Np, were detected in three and four samples, respectively, and these detects were from borings in the general area of SWMU 203. The source areas for these two contaminants were assumed to be confined to the northern portion of the sector. TCE was detected in four samples from four borings in the sector. Its source area was assumed to include a portion of the Sector 1 soils under the northwest corner of the C-400 Building, as well as the majority of Sector 7 subsurface soils above 22 ft.

Four contaminant sources for the RGA were also modeled for this sector: chromium, cobalt, iron, and manganese. These contaminants all were detected in the same boring at levels that exceeded two times background. Although these contaminants were not found in adjacent borings above two times background, a conservative area of 40 ft x 40 ft was used. A conservative depth from 50 ft to 95 ft bgs was modeled, although contamination was not found over this entire depth range. For chromium and cobalt, the highest observed detections (56 mg/kg and 71 mg/kg, respectively) were used as the concentrations for the model. Average concentrations of 358,000 mg/kg and 4200 mg/kg were used for iron and manganese, respectively.

Table 5.28 lists the results of MEPAS modeling for Sector 7.

5.5.8 Sector 8

Several radionuclide contaminants were detected along the route of the C-401 Transfer Line (SWMU 26) in surface soil samples. Boring 400-43, located across the street from the northeast corner of the C-400 Building, had detectable concentrations of the contaminants phenanthrene,

^{99}Tc, ^{239}Pu, and ^{238}U. Another boring to the east (Boring 400-034) also had detectable concentrations of ^{99}Tc, ^{238}U, ^{239}Pu, and ^{237}Np in its surface soil sample. On the basis of these detections, a surface source area extending 700 ft from east to west along the pipeline and with a width of 150 ft, from north to south, was defined to encompass these borings.

Fourteen contaminants (^{241}Am, ^{239}Pu, ^{235}U, ^{137}Cs, nickel, chromium, ^{99}Tc, copper, phenanthrene, ^{230}Th ^{237}Np, 2,4-DNT, ^{234}U, and ^{238}U) were detected above screening levels in subsurface soils at several locations within this sector. Sample locations along the pipeline route included Borings 400-208, 40-010, 026-009, 026-008, 026-007, 026-006, 026-005, 026-004, 026-003, and 026-001. Three additional samples were collected from an excavation associated with the pipeline. Those samples included 026-018 (pipeline water sample for VOAs only due to volume), 026-020 (sediment sample in the pipe), and 026-025 (from the soil below the invert of the pipe). The fact that the area in question follows the pipeline route was considered in assessing the potentially affected areas. Contaminants that may have been released from the pipe typically would follow the pipeline route itself, due to the presence of sand or gravel as typical bedding material for buried pipelines. Little lateral movement would be expected out of the bedding material, away from the pipeline. The source terms, however, have included large areas adjacent to the pipeline, due to the limited amount of lateral data available.

Phenanthrene, copper, chromium, nickel, ^{234}U, ^{237}Np, ^{238}U, ^{239}Pu ^{137}Cs, ^{99}Tc, ^{230}Th, and ^{241}Am were grouped into a common source area extending 375 ft along the eastern portion of the pipeline and extending 150 ft north and south of the pipeline for a width of 300 ft. The western edge of this area is bounded by two borings, 026-017 and 400-123, because no detectable concentrations were reported there. Two borings, 026-009 and 040-010, in this area had detectable concentrations, in addition to the excavation soil sample 026-025. The maximum concentrations from each boring were used in the MEPAS modeling. Samples exceeded the screening levels at 33 ft bgs. Therefore, the maximum 50-ft depth was assumed for the source area.

A second source area, which includes the majority of the pipeline area, contains detectable concentrations of ^{230}Th, ^{237}Np, and 2,4-DNT. The source area was extended 50 ft beyond the two northernmost sampling locations along the pipeline, due to the limited amount of data present. This source area encompasses Borings 026-007, 026-006, and 026-004 and measures 1125 ft along the X-axis (east-west). The area is assumed to be 175 ft wide, which is 50 ft beyond the sampling boundary, to include any potential contamination that may have left the pipeline. Samples exceeded the screening levels at 33 ft bgs along the pipeline here; therefore, 50 ft was the assumed depth of the source area. As noted above, ^{237}Np and ^{230}Th were also detected above screening levels in the eastern portion of the pipeline, so their modeled source areas include both the eastern and central portions of the pipeline area.

Based on the data from Boring 026-003, the radionuclides ^{234}U and ^{238}U are present along the western end of the pipeline. A source area measuring 300 ft in the east-west direction and 100 ft in the north-south direction was used for the western source area of ^{234}U and ^{238}U. This allows for 150 ft to the east and west of the sampling point 026-003 and 50 ft to the north and south of the sampling point. Sampling depths at this location were only 8 ft bgs. Based on the limited data at depth, the lower limit was assessed to be 50 ft, or the maximum depth of the UCRS. Because ^{234}U and ^{238}U were also detected in the excavation sampling location 026-025, their modeled source areas include both the eastern and western portions of the pipeline area.

Tables 5.29, 5.30, and 5.31 provide the source terms, contaminant inventories, and results of MEPAS modeling for Sector 8.

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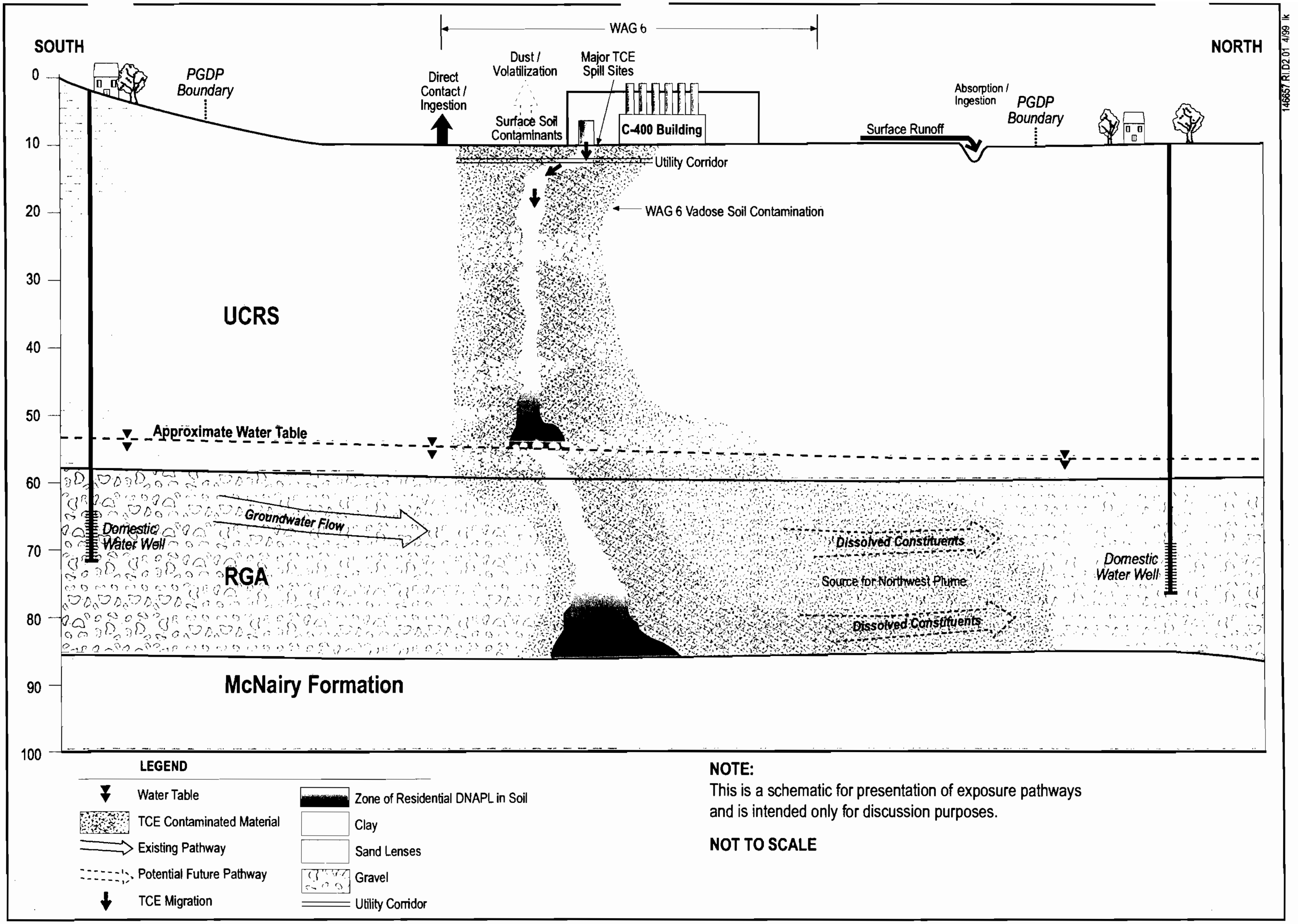
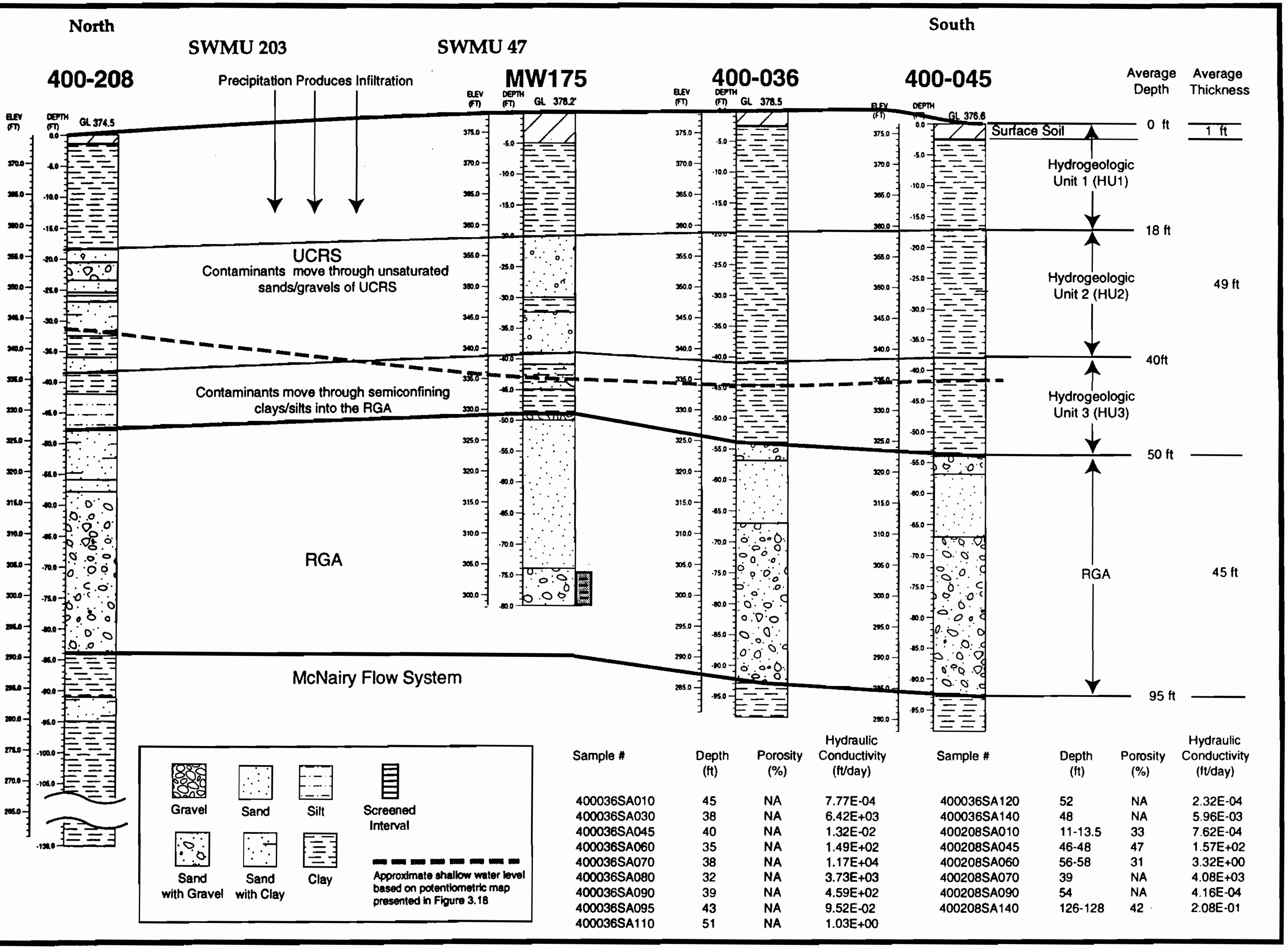


NOTE:
This is a schematic for presentation of exposure pathways and is intended only for discussion purposes.

NOT TO SCALE

Fig. 5.1. Schematic conceptual model.



Sample #	Depth (ft)	Porosity (%)	Hydraulic Conductivity (ft/day)
400036SA010	45	NA	7.77E-04
400036SA030	38	NA	6.42E+03
400036SA045	40	NA	1.32E-02
400036SA060	35	NA	1.49E+02
400036SA070	38	NA	1.17E+04
400036SA080	32	NA	3.73E+03
400036SA090	39	NA	4.59E+02
400036SA095	43	NA	9.52E-02
400036SA110	51	NA	1.03E+00

Sample #	Depth (ft)	Porosity (%)	Hydraulic Conductivity (ft/day)
400036SA120	52	NA	2.32E-04
400036SA140	48	NA	5.96E-03
400208SA010	11-13.5	33	7.62E-04
400208SA045	46-48	47	1.57E+02
400208SA060	56-58	31	3.32E+00
400208SA070	39	NA	4.08E+03
400208SA090	54	NA	4.16E-04
400208SA140	126-128	42	2.08E-01

Fig. 5.2. Conceptual model of site conditions at Waste Area Group 6.

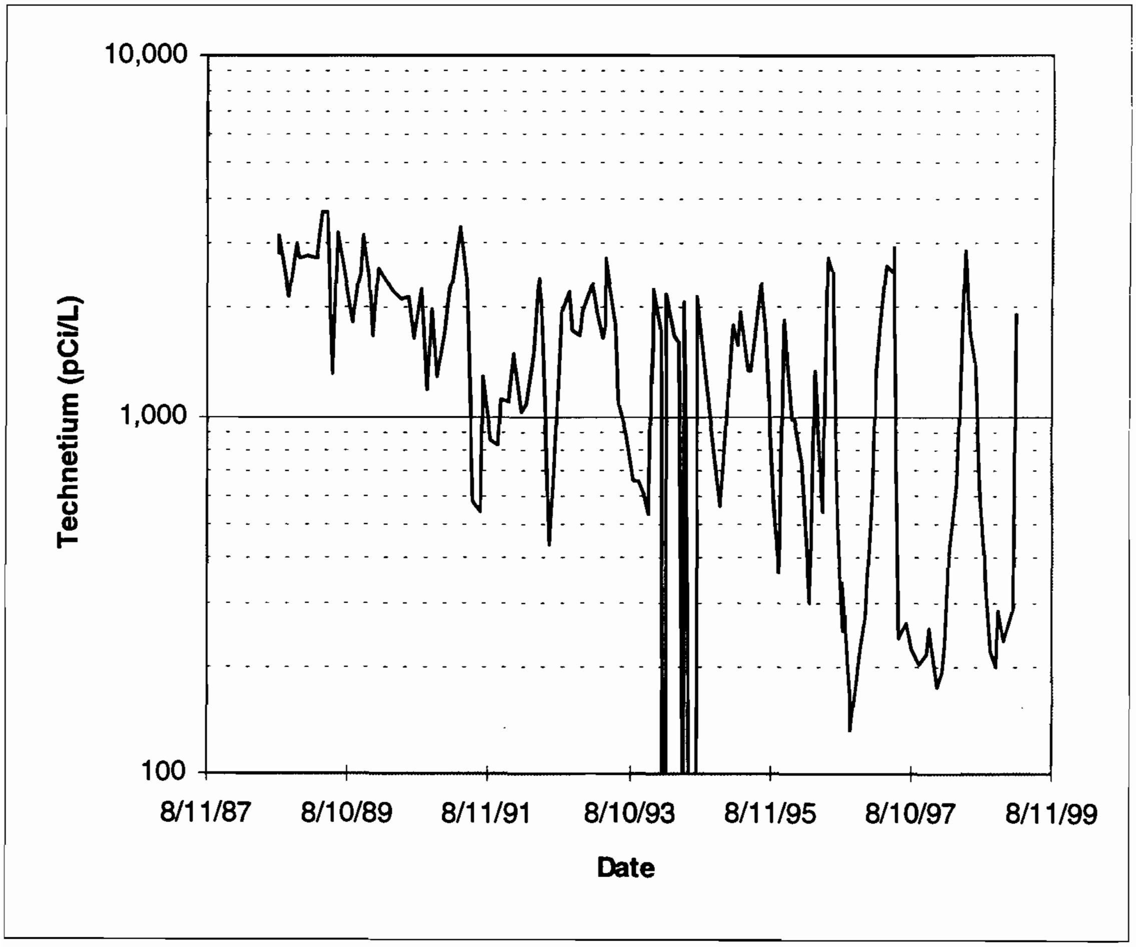
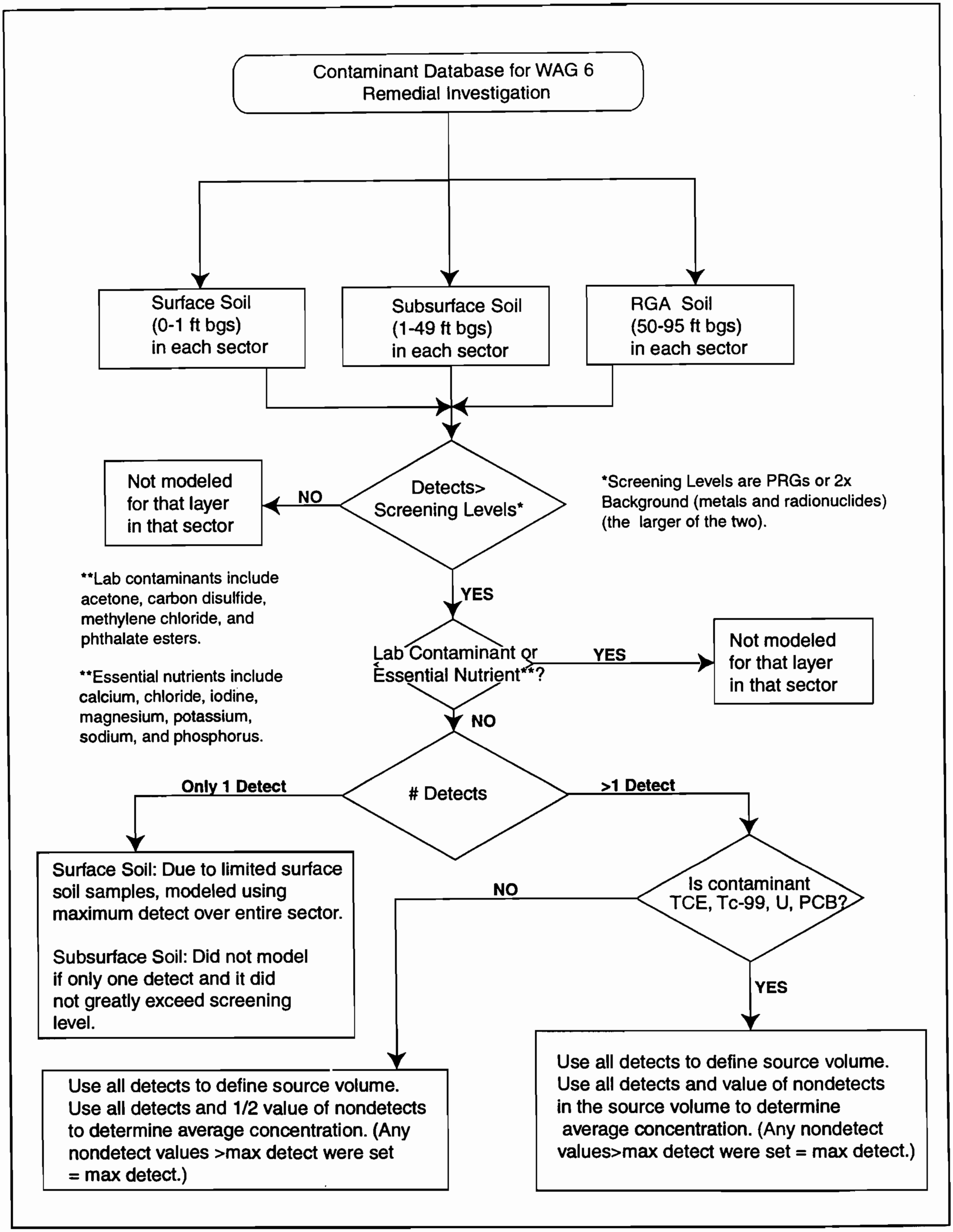


Figure 5-3. ^{99}Tc Activity in MW 66



*Screening Levels are PRGs or 2x Background (metals and radionuclides) (the larger of the two).

**Lab contaminants include acetone, carbon disulfide, methylene chloride, and phthalate esters.

**Essential nutrients include calcium, chloride, iodine, magnesium, potassium, sodium, and phosphorus.

Fig. 5.4. Contaminant screening and development of source terms.

Table 5.1. Physical and chemical properties of COPCs at WAG 6

Constituents	Media			Mol. wt. (g/mol)	Solubility S_w (mg/L)	S_w @ temp. (°C)	K_{ow} (ml/ml)	Vapor pressure (torr @ °C)	Henry's constant (K_h) (atm.m^3/mol)	K_h @ temp. (°C)	Air Diff. coeff. (cm^2/s)	K_{oc} (ml/g)	Biodeg. rate, l (1/d)	Biodeg. half-life (day)	Log (K_{ow})	CAS No.	Biodeg. half-life (hr)
	SS	SB	GW														
VOA																	
1,1 Dichloroethene		x	x	96.9	2.10E+02	25	3.02E+01	591@ 25	1.49E-02	25	0.114	6.50E+01	3.85E-03	180	1.48	75-35-4	4.32E+03
1,1,1 Trichloroethane		x	x	133.4	4.40E+03	20	2.95E+02	100 @ 20	4.08E-03	25	0.019	1.35E+02	6.35E-04	1092	2.47	71-55-6	2.62E+04
1,1,2 Trichloroethane		x		133.4	4.50E+03	20	1.48E+02	30@25	2.94E-05	25	0.079	7.50E+01	4.75E-04		2.17	79-00-5	3.50E+04
1,2-Dichloroethane		x		99.0	8.52E+03		2.81E+01	85.6@20-25	1.10E-03		0.091	3.80E+01	9.63E-04		1.45	107-06-2	
1,2 Dichloroethene		x	x	96.9	8.00E+02		1.23E+02	200 @ 20 -25	6.60E-03		0.114	7.75E+01	2.41E-04	2875	2.09	540-59-0	6.90E+04
cis-1,2-Dichloroethene		x	x	96.9	3.50E+03		7.24E+01		4.08E-03		0.074	3.55E+01			1.86		
trans-1,2-Dichloroethene		x	x	96.9	6.30E+03		1.17E+02	324@20-25	9.38E-03		0.071	3.80E+01		-	2.07	156-60-5	
2-Butanone		x		72.1	2.75E+05		1.82E+00	100 @ 25	6.61E-07	25	0.092	1.15E+00	2.48E-02	28	0.26	78-93-3	6.72E+02
2-Hexanone		x		100.2	3.50E+04	20	2.40E+01	2 @ 20	7.53E-06	20	0.078	1.51E+01			1.38	591-78-6	
2-Proponal		x															
Acetone		x	x	58.1	1.00E+06		5.75E-01	270 @ 30	5.14E-07	25	0.110	3.63E-01	2.48E-02	28	-0.24	67-64-1	6.72E+02
Benzene		x		78.1	1.78E+03	20	1.35E+02	95 @ 25	5.55E-03	25	0.093	6.20E+01	9.63E-04	720	2.13	71-43-2	1.73E+04
Bromodichloromethane		x	x	164.0	5.00E+01	20-25	1.74E+02	59.4@20-25	2.56E-01		0.090	1.07E+02			2.24	75-7-4	
Carbon disulfide		x		76.1	2.90E+03	20	1.45E+02	298 @ 20	2.94E-04	25	0.105	9.11E+01			2.16	75-15-0	
Carbon Tetrachloride		x	x	153.8	8.00E+02	20	5.37E+02	113 @ 25	2.93E-02	25	0.082	1.52E+02	1.93E-03	360	2.73	56-23-5	8.64E+03
Chloroform		x	x	119.4	9.30E+03	25	9.33E+01	160 @ 20	3.39E-03	25	0.091	5.30E+01	3.85E-04	1800	1.97	67-66-3	4.32E+04
Chloromethane		x		50.5	6.36E+03	20	8.13E+00	3800 @ 20	8.82E-03	25	0.110	5.12E+00	6.19E-03	112	0.91	74-87-3	2.69E+03
Methylene chloride	x	x		84.9	1.67E+04	25	1.78E+01	429 @ 25	3.19E-03	25	0.104	1.00E+01	6.19E-03	112	1.25	75-09-2	2.69E+03
Tetrachloroethene		x	x	165.8	1.50E+02	25	3.39E+02	19 @ 25	2.87E-02	25	0.077	2.65E+02	4.19E-04	1653	2.53	127-18-4	3.97E+04
Toluene	x	x	x	92.1	5.15E+02	20	4.90E+02	28 @ 25	5.92E-03	25	0.087	1.40E+02	3.30E-03	210	2.69	108-88-3	5.04E+03
Trichloroethene		x	x	131.4	1.10E+03	25	3.39E+02	77 @ 25	1.17E-02	25	0.088	9.40E+01	4.19E-04	1653	2.53	79-01-6	3.97E+04
Trichloroflouromethane		x		137.0	1.10E+03	20-25	3.39E+02	667@20-25	5.83E-02		0.093	1.59E+02			2.53	75-69-4	
Vinyl Acetate		x		86.1	2.00E+04		2.54E+01	83@20-25	5.66E-04		0.085	1.60E+01			1.40	108-05-4	1.40E+00
Vinyl Chloride		x	x	62.5	1.10E+00	25	3.98E+00	760@20-25	2.78E-02	25	0.106	2.51E+00	2.41E-04	6.90E+04	0.60	75-01-4	6.90E+04
SVOA																	
2-Methylnaphthalene	x			142.2	2.60E+01	25	7.24E+03	10 @ 105	2.20E-02		0.056	4.56E+03			3.86	91-57-6	
2,6-Dinitrotoluene	x	x		186.0	2.06E+02	20-25	7.76E+01	5.67E-04@20-25	4.86E-07		0.061	7.76E+01			1.89	606-20-2	
Acenaphthene		x		154.2	3.42E+00	25	8.32E+03	2.15E-03@20-25	2.41E-04	25	0.062	5.24E+03	1.70E-03	9.79E+03	3.92	83-32-9	9.79E+03
Acenaphthylene	x			152.2	3.93E+00	25	1.17E+04	6.7E-03@20-25	1.14E-04	25	0.062	7.40E+03	2.92E-03	5.70E+03	4.07	208-96-8	5.70E+03
Anthracene	x	x		178.2	1.29E+00	25	2.82E+04	1.95E-04	8.60E-05	25	0.042	2.35E+04	3.77E-04		4.45	120-12-7	
Benzo (a) anthracene	x	x		228.3	1.00E-02	24	4.07E+05	5E-9 @ 20	2.94E-08	25	0.051	3.58E+05	2.55E-04	2720	5.61	56-55-3	6.53E+04
Benzo (a) pyrene	x	x		252.3	3.80E-03	25	9.55E+05	5E-9 @ 21	4.90E-07	25	0.043	9.69E+05	3.27E-04	2120	5.98	50-32-8	5.09E+04
Benzo (b) fluoranthene	x	x		252.3	1.00E-03		3.72E+06	5.00E-07	2.94E-07	25	0.044	2.34E+06	2.84E-04	2440	6.57	205-99-2	5.86E+04
Benzo(g,h,i)perylene	x	x		276.3	2.60E-04	25	1.70E+07	1E-10 @ 20	1.40E-07		0.042	1.07E+07	2.67E-04	2600	7.23	191-24-2	6.24E+04
Benzo (k) fluoranthene	x	x		252.3	3.00E-04		6.92E+06	1E-11 @ 20	2.54E-05	25	0.044	4.36E+06	8.10E-05	8560	6.84	207-08-9	2.05E+05
Benzoic Acid			x	122.1	2.90E+03	20	7.41E+01	10 @ 132	5.54E-04		0.074	4.67E+01			1.87	65-85-0	
Bis-(2-Ethylhexyl)phthalate	x	x	x	390.6	1.30E+00	25	2.00E+05	1.2 @ 200	3.00E-07	20	0.032	1.11E+05	1.78E-03	389	5.30	117-81-7	9.34E+03
Bromide			x														
Butylbenzylphthalate	x	x		312.4	2.90E+00		6.03E+04	8.6E-6 @ 20	3.18E-08	25	0.040	1.37E+04	3.85E-03	180	4.78	85-68-7	4.32E+03
Chrysene	x	x		228.3	6.00E-03	25	4.07E+05	6.3E-9 @25	1.05E-06	25	0.046	2.57E+05	1.73E-04	4000	5.61	218-01-9	9.60E+04
Dibenzo(a,h)anthracene	x	x		278.4	5.00E-04	25	9.33E+05	1.00E-10	7.30E-08	25	0.042	1.79E+06	1.84E-04	3758	5.97	53-70-3	9.02E+04
Dibenzofuran	x	x		168.2	1.00E+01		1.32E+04	3.37E-05@20-25	7.45E-07		0.068	8.31E+03	6.19E-03	112	4.12	132-64-9	2.69E+03

Table 5.1. (continued)

Constituents	Media SS	SB	GW	Mol. wt. (g/mol)	Solubility S_w (mg/L)	S_w @ temp. (°C)	K_{OW} (ml/ml)	Vapor pressure (torr @ °C)	Henry's constant (K_h) (atm.m^3/mol)	K_h @ temp. (°C)	Air Diff. coeff. (cm^2/s)	K_{OC} (ml/g)	Biodeg. rate, l (1/d)	Biodeg. half-life (day)	Log (K_{OW})	CAS No.	Biodeg. half-life (hr)
Diethylphthalate		x		222.2	2.10E-02		9.12E+02	0.05 @ 70	1.17E-08	25	0.053	8.20E+01	3.09E-03	224	2.96	84-66-2	5.38E+03
Di-n-butylphthalate	x	x	x	278.4	4.00E+02	25	1.58E+05	0.1 @ 115	2.80E-07	25	0.042	1.57E+03	3.01E-02	23	5.20	84-74-2	5.52E+02
Fluoranthene	x	x		202.3	2.65E-01	25	2.14E+05	5.00E-06	6.50E-06	25	0.069	4.91E+04	3.94E-04	1760	5.33	206-44-0	4.22E+04
Fluorene		x		166.2	1.90E+00	25	1.51E+04	6.00E-04@20-25	1.17E-04	25	0.055	9.54E+03	2.89E-03	5.76E+03	4.18	86-73-7	5.76E+03
Hexachloroethane				236.7	5.00E+01		1.38E+04	0.40 @ 20	9.85E-03	25	0.056	8.70E+03	9.63E-04		4.14	67-72-1	1.73E+04
Indeno(1,2,3-c,d)pyrene	x	x		276.3	1.40E-04		4.57E+07	1.00E-10	6.95E-08	25	0.044	2.88E+07	2.37E-04	2921	7.66	193-39-5	7.01E+04
Iodomethene		x		142.0	1.40E+04	20-25	4.90E+01	400@20-25	5.34E-03		0.109	2.30E+01			1.69	77-88-4	
Isophorone				138.2	1.20E+04		5.01E+01	0.38 @20	5.76E-06	20		3.16E+01	6.23E-02		1.70	78-59-1	
Napthalene	x	x		128.2	3.00E+01	25	2.34E+03	0.082 @ 25	4.83E-04	25	0.059	1.19E+03	2.69E-03	258	3.37	91-20-3	6.19E+03
Pentachlorophenol				266.3	1.40E+01	20	1.02E+05	1.73E-03@20-25	2.80E-06	20	0.056	6.45E+04	4.56E-04	3.65E+04	5.01	87-86-5	3.65E+04
Pesticides/PCBS																	
Polychloronated biphenyl	x	x															
Aroclor-1016	x	x		257.9	4.90E-02	24	2.40E+04	9.00E-04@20-25 e	1.35E-02	25	0.046	1.51E+04			4.38	12674-11-2	
Aroclor-1248				299.5	5.40E-02		5.62E+05	1.80E-04@20-25	4.40E-04	25	0.043	3.54E+05			5.75	12672-29-6	
Aroclor-1254				328.4	5.70E-02	24	1.07E+06	4.30E-05@20-25	8.37E-03	25	0.041	6.75E+05	4.72E-03	147	6.03	11097-69-1	3528
Aroclor-1260				375.7	8.00E-02	24	1.29E+06	1.10E-05@20-25	3.36E-04	25	0.038	8.12E+05			6.11	11096-82-5	
Octachlorodibenzo-p-dioxin												0.00E+00					

Notes:

Solubilities, Henry's Constant, Log (K_{ow}), air diffusion coefficients, vapor pressure, and K_{oc} have been taken from EPA 1996 unless otherwise indicated.

Biodegrdation half-lives are taken from Hand Book of Environmental Degradation Rates (Howard et al. 1991) unless otherwise indicated.

K_h @ Henry's constant coefficient measurements made at temperatures ranging between 20 - 25 C°

S_w @ temp. - Solubility measurements made at temperatures ranging between 20 - 25 C°

SS = Surface soil

SB = Subsurface soil

GW = Groundwater

Table 5.2. List of distribution coefficients (K_d) used to describe the retardation factors (Rd) for the inorganic COPCs at WAG 6

Site Related Analytes	Media S	Media SB	Media GW	K_d[a] for Loam (mL/kg)	K_d[a] for Sand (mL/kg)
Aluminum	x	x	x	1500.0	1500.0
Antimony	x	x	x	185.0	45.0
Arsenic	x	x	x	200.0	25.0
Barium	x	x	x	50	0.5
Beryllium	x	x	x	800.0	650.0
Cadmium	x	x	x	190.0	80.0
Calcium	x	x	x	5.0	25.0
Chromium	x	x	x	418.0	35.0
Cobalt	x	x	x	1,300 (100 to 9700)	60.0
Copper	x	x	x	3.5E+01	22.0
Cyanide				9.9	10.0
Iron	x	x	x	351.0	220.0
Lead	x	x	x	16000 (100 to 59000)	270.0
Magnesium	x	x	x	13.0	1.6
Manganese	x	x	x	750 (40 to 77000)	50.0
Mercury	x	x	x	10 to 10,000	82.0
Molybdenum				125.0	10.0
Nickel	x	x	x	438.0	400.0
Potassium	x	x	x	40.0	15.0
Selenium	x	x	x	385.0	150.0
Silver	x	x	x	120 (28 to 333)	90.0
Sodium	x	x	x		
Thallium	x	x	x	1500	74.0
Tin				450.0	130.0
Vanadium	x	x	x	1.0E+03	1000.0
Zinc	x	x	x	200.0	200.0

[a] K_d values taken from EPA (1996) unless otherwise noted; the range is provided in parenthesis if available

Table 5.3. Radioactive half-lives, decay constants, and distribution coefficients (K$_d$) for the radionuclide COPCs at WAG 6

Site related radionuclides	Media			Half life (Year)	Decay constant (day^{-1})	K$_d$ in loam[a] (L/kg)	K$_d$ in sand[a] (L/kg)
	SS	SB	GW				
^{241}Am	x	x	x	4.33E+02	4.38E-06	9600 (400 to 48,309)	1900
^{137}Cs	x	x	x	3.00E+01	6.33E-05	4600 (560 to 61,287)	280
^{60}Co				5.26E+00	3.61E-04	1300 (100 to 9700)	60
^{237}Np	x	x	x	2.14E+06	8.87E-10	25 (1.3 to 79)	5
^{239}Np				6.43E-03	2.95E-01	25 (1.3 to 79)	5
$^{239/240}$Pu	x	x	x	6.58E+03	2.89E-07	1200 (100 to 5,933)	550
^{226}Ra				1.60E+03	1.19E-06	36,000 (1,262 to 530,000)	500
^{99}Tc	x	x	x	2.10E+05	9.04E-09	0.1 (0.01 to 0.4)	0.1
^{228}Th			x	1.91E+00	9.92E-04	24,000	5,800
^{230}Th	x	x	x	8.00E+04	2.37E-08	24,000	5,800
^{232}Th			x	1.41E+10	1.35E-13	24,000	5,800
$^{233/234}$U	x	x	x	1.62E+05	1.17E-08	421[b]	35
^{235}U	x	x	x	7.10E+08	2.67E-12	421[b]	35
^{238}U	x	x	x	4.51E+09	4.21E-13	421[b]	35

[a] K$_d$ values taken from EPA (1996) unless otherwise noted; the range is provided in parenthesis if available.

[b] K$_d$ values were obtained from site-specific uranium sorption analysis (SAIC 1996).

Table 5.4. Half-life estimates for PAH compounds

	Naphthalene	Anthracene	Benzo(a)pyrene
Soil (aerobic)	17	50	57
Groundwater	1	100	114
Aqueous (anaerobic)	25	200	228
Surface Water	<0.5 to 2		<0.5 to 5

Notes:

Biodegradation half-life estimates (for subsurface) are shown in days.

Surface water attenuation is primarily attributed to volatilization and photolysis in the water column and does not consider sediment-partitioning.

Table 5.5. Distribution coefficients, retardation factors, and chemical horizontal migration velocities for groundwater COCs

Chemical Name of Groundwater COC in Groundwater	Distribution Coefficient (cc/g)	Retardation Factor (FR)	Horizontal Migration Potential (ft/year)	Horizontal Migration Potential Due to Diffusion (ft/year)	Horizontal Migration Potential (Distance over 46 years) (ft/year)
Volatile Organic Analytes					
1,1 Dichloroethene	0.00	2.85	307.10	368.50	16954.60
1,1,1 Trichloroethane	0.00	3.01	290.75	348.90	16049.66
1,1,2 Trichloroethane	0.00	2.88	304.70	365.63	10819.16
cis-1,2-Dichloroethene	0.00	2.78	314.63	377.55	17367.35
trans-1,2-Dichloroethene	0.00	2.79	313.98	376.77	17331.59
Trichloroethene	0.00	2.92	300.14	360.16	16567.62
Vinyl Chloride	0.00	2.71	323.43	388.11	17853.36
Metals					
Arsenic	25.00	115.54	7.58	9.09	418.51
Beryllium	650.00	2936.49	0.30	0.35	16.46
Chromium	35.00	160.68	5.45	6.54	300.94
Iron	220.00	995.68	0.88	1.05	48.56
Lead	270.00	1221.35	0.72	0.86	39.59
Manganese	50.00	228.38	3.84	4.60	211.73
Nickel	400.00	1808.11	0.48	0.58	26.74
Silver	90.00	408.92	2.14	2.57	118.25
Thallium	74.00	336.70	2.60	3.10	143.61
Radionuclides					
^{241}Am	1900.00	8578.38	0.10	0.12	5.60
^{137}Cs	280.00	1266.49	0.69	0.83	38.18
^{60}Co	60.00	273.51	3.20	3.84	176.79
^{237}Np	5.00	25.27	34.67	41.59	1913.52
^{239}Np	5.00	25.27	34.67	41.59	1913.52
$^{239/240}$Pu	550.00	2485.14	0.35	0.42	19.45
^{226}Ra	500.00	2259.46	0.39	0.46	21.40
^{99}Tc	0.10	3.15	277.74	333.28	15331.13
^{228}Th	5800.00	26181.08	0.03	0.04	1.84
^{230}Th	5800.00	26181.08	0.03	0.04	1.84
^{232}Th	5800.00	26181.08	0.03	0.04	1.84
$^{233/234}$U	35.00	160.68	5.40	6.54	300.94
^{235}U	35.00	160.68	5.40	6.54	300.94

Table 5.6. MEPAS Transport Parameters

TOP SOIL PARAMETERS (WT)/PARTIALLY SATURATED ZONE (WP)/ SATURATED ZONE (WZ)

Textural classification	WT-CLASS	(WT) silt (McCracken Co. Soil Survey)
	WP-CLASS	(WP) silt loam (WAG 6 geotechnical data)
	WZ-CLASS	(WZ) sandy loam (WAG 6 geotechnical data)
Sand (%)	WT-SAND	(WT) 15 (conservative estimate - highest sand % reported in McCracken Co. Soil Survey)
	WP-SAND	(WP) 38 (WAG 6 geotechnical data)
	WZ-SAND	(WZ) 74 (WAG 6 geotechnical data)
Silt (%)	WT-SILT	(WT) 80 (maximum % silt for soil type)
	WP-SILT	(WP) 41 (WAG 6 geotechnical data, 1-50ft)
	WZ-SILT	(WZ) 17 (WAG 6 geotechnical data, 50-95 ft)
Clay (%)	WT-CLAY	(WT) 5 (100 % less 15 % sand and 80 % silt)
	WP-CLAY	(WP) 21 (WAG 6 geotechnical data)
	WZ-CLAY	(WZ) 9 (WAG 6 geotechnical data)
Organic matter (%)	WT-OMC	(WT) 0.05 (from Phase II, Table 5-1)
	WP-OMC	(WP) 0.05 (WAG 6 geotechnical data)
	WZ-OMC	(WZ) 0.02 (WAG 6 geotechnical data)
Iron and aluminum (%)	WT-IRON	(WT) 4 (DOE 1995b)
	WP-IRON	(WP) 4 (DOE 1995b)
	WZ-IRON	(WZ) 3 (average of WAG 6, 62 - 78 ft samples)
pH	WT-PH	(WT) 5.0 (Henry silt loam - McCracken Co. Soil Survey)
	WP-PH	(WP) 6.0 (DOE 1995b)
	WZ-PH	(WZ) 6.5
Vegetative cover of the site (%)	WT-VEGCOV	0 – WAG 6 area 95 - SWMU 26
Topsoil water capacity (inches)	WT-AVAILW	0 - WAG 6 (0% vegetative cover) 2.44-SWMU 26:(0.21 inches/inch water capacity x 12.2 inches root zone depth x 0.95 vegetative cover)
SCS curve number	WT-SCSN	86 – WAG 6 (AMC = II/normal moisture: silt loam; Group C hydro soil group; soil and condition = bare soil, hard surface) 71 - SWMU 26 (AMC = II/normal moisture: silt loam; Group C hydro soil group; soil and condition = well-vegetated surface)

PROPERTIES OF PARTIALLY SATURATED ZONE (WP)

Thickness (ft)	WP-THICK	49 ft (1 -49 ft bgs)
Bulk density (g/cm^3)	WP-BULKD	1.86 (2.65 g/cm^3 x 0.7)
Total porosity (%)	WP-TOTPOR	30 (WAG 6 geotechnical data)
Field capacity (%)	WP-FIELDC	14 (MEPAS guidance, based on soil texture)
Longitudinal dispersivity (ft)	WP-LDISP	0.4 [D_L = 0.01 (Th), D_L = 0.01 (40)] - C-400 0.1 [D_L = 0.01 (Th), D_L = 0.01 (14)] - SWMU 26
Saturated hydraulic conductivity (ft/day)	WP-CONDUC	0.3 (1.07x10^{-4} cm/sec): use of a vertical K is appropriate because groundwater flow is vertical in the UCRS

PROPERTIES OF SATURATED ZONE (WZ)

Total porosity (%)	WZ-TOTPOR	37 (WAG 6 geotechnical data)
Effective porosity (%)	WZ-EFFPOR	30 (conservative estimate)
Darcy velocity (ft/day)	WZ-PVELOC	0.6: conservative estimate, assumes conductivity of 1,500 ft/d and gradient of 0.0004
Thickness (ft)	WZ-THICK	45 (50 - 95 ft bgs)
Bulk density (g/cm^3)	WZ-BULKD	1.67 (2.65 g/cm^3 x 0.63)
Travel distance (ft)	WZ-DIST	3,300 to PGDP security fence 5,500 to DOE property boundary
Longitudinal dispersivity (ft)	WZ-LDISP	50.0 (EPA 1996)
Transverse dispersivity (ft)	WZ-TDISP	5.0 (EPA 1996)
Vertical dispersivity (ft)	WZ-VDISP	0.1 - near zero
Percent of total flux to aquifer (%)	WZ-FRACT	100
Perpendicular distance from groundwater flow to receptor (ft)	WZ-YDIST	0 (plume centerline concentrations)
Vertical distance below ground-water table (ft)	WZ-AQDEPTH	0 (most conservative result)

Table 5.6. MEPAS Transport Parameters (continued)

ADSORPTION COEFFICIENTS (K_ds) FOR MODELED CONTAMINANTS

	K_d for Surface Soils (WA-SURFKD)	K_d for Subsurface Soils (WA-SUBKD)	
		Partially Saturated Zone (PSZ)	Saturated Zone (SZ)
Americium-241	82	200	200
Antimony	2.0	6.0	6.0
Arsenic	5.86	19.4	19.4
Cesium-137	10	249	249
Chromium	1	56.5	56.5
Cobalt	0.2	8.81	8.81
Copper	4.19	92.2	92.2
Iron	10	15	15
Manganese	1.5	25.3	25.3
Neptunium-237	3	3	3
Nickel	1.2	58.6	58.6
PCBs	2740	3750	1610
Phenanthrene	62.9	86.1	36.9
Plutonium-239	4	100	100
Silver	0.4	4.0	4.0
Technetium-99	3	20	20
Thallium	0	0.2	0.2
Thorium-230	40	500	500
Trichloroethene	0.567	0.775	0.332
Uranium-234	0	50	50
Uranium-235	0	50	50
Uranium-238	0	50	50
Zinc	3	939	939

Notes:

Surface Soil = Top Soil
Subsurface Soil = Partially Saturated Zone
RGA = Saturated Zone

Table 5.7. Location of contaminants detected above screening levels

Contaminant	Surface Soil	Subsurface Soil	RGA Soil
1,1-Dichloroethene		Sector 4 (SE)	
1,1,1-Trichloroethane		Sector 4 (SE)	
1,1,2-Trichloroethane		Sector 4 (SE)	
2-Methylnaphthalene	Sector 6 (W)		
2,4-Dinitrotoluene		Sector 8 (Far N)	
2,6-Dinitrotoluene		Sector 2 (NE)	
Acenaphthylene	Sector 5 (SW)		
Americium-241	Sector 6 (W)	Sector 5 (SW) Sector 6 (W) Sector 7 (NW) Sector 8 (Far N)	
Antimony		Sector 7 (NW)	
Arochlor-1260	Sector 3 (E)		
Benz(a)anthracene	Sector 5 (SW)		
Benz(a)pyrene	Sector 5 (SW)		
Benzo(ghi)perylenene	All Sectors	Sector 3 (E) Sector 4 (SE) Sector 5 (SW) Sector 8 (Far N)	
Benz(b)fluoranthene	Sector 5 (SW)		
Benz(k)fluoranthene	Sector 5 (SW)		
Carbon Tetrachloride		Sector 4 (SE)	
Copper		Sector 8 (Far N)	
Cesium-137	Sector 6 (W)	Sector 5 (SW) Sector 8 (Far N)	
Chromium	Sector 5 (SW) Sector 7 (NW)	Sector 2 (NE) Sector 4 (SE) Sector 8 (Far N)	Groundwater Integrator Unit (Sector 2 - NE)
Cis-1,2-Dichloroethene		Sector 4 (SE) Sector 5 (SW)	
Cobalt			Groundwater Integrator Unit (Sector 2 - NE)
Dibenz(a,h)anthracene	Sector 6 (W)		
Dibenzofuran	Sector 5 (SW) Sector 6 (W)	Sector 2 (NE)	
Iodomethane		Sector 5 (SW)	
Iron			Groundwater Integrator Unit (Sector 2 - NE)
Manganese			Groundwater Integrator Unit (Sector 2 - NE)
Mercury		Sector 7 (NW)	
N-Nitroso-di-n-propylamine		Sector 2 (NE)	
Neptunium-237	Sector 3 (E) Sector 5 (SW) Sector 6 (W) Sector 8 (Far N)	Sector 1 (Central) Sector 3 (E) Sector 4 (SE) Sector 6 (W) Sector 7 (NW) Sector 8 (Far N)	Groundwater Integrator Unit (Sector 5 - SW)

Table 5.7. (continued)

Contaminant	Surface Soil	Subsurface Soil	RGA Soil
Nickel		Sector 8 (Far N)	
Polychlorinated Biphenyl (general)	Sector 3 (E)		
	Sector 4 (SE)		
Phenanthrene	Sector 2 (NE)	Sector 2 (NE)	
	Sector 3 (E)	Sector 3 (E)	
	Sector 4 (SE)	Sector 4 (SE)	
	Sector 5 (SW)	Sector 8 (Far N)	
	Sector 8 (Far N)		
Plutonium-239	Sector 5 (SW)	Sector 4 (SE)	
	Sector 8 (Far N)	Sector 8 (Far N)	
Technetium-99	Sector 5 (SW)	Sector 6 (W)	
	Sector 6 (W)	Sector 7 (NW)	
	Sector 8 (Far N)	Sector 8 (Far N)	
Tetrachloroethene		Sector 4 (SE)	
Thallium	Sector 3 (E)	Sector 2 (NE)	
	Sector 5 (SW)	Sector 5 (SW)	
Thorium-230	Sector 3 (E)	Sector 6 (W)	
	Sector 6 (W)	Sector 7 (NW)	
		Sector 8 (Far N)	
Trans-1,2-Dichloroethene		Sector 4 (SE)	
		Sector 5 (SW)	
		Sector 6 (W)	
Trichloroethene		Sector 3 (E)	
		Sector 4 (SE)	
		Sector 5 (SW)	
		Sector 6 (W)	
		Sector 7 (NW)	
Trichlorofluromethane		Sector 4 (SE)	
Uranium-234	Sector 3 (E)	Sector 2 (NE)	
	Sector 5 (SW)	Sector 6 (W)	
	Sector 6 (W)	Sector 7 (NW)	
		Sector 8 (Far N)	
Uranium-235	Sector 3 (E)	Sector 2 (NE)	
	Sector 5 (SW)	Sector 5 (SW)	
	Sector 6 (W)	Sector 6 (W)	
		Sector 7 (NW)	
		Sector 8 (Far N)	
Uranium-238	Sector 2 (NE)	Sector 2 (NE)	
	Sector 3 (E)	Sector 6 (W)	
	Sector 5 (SW)	Sector 7 (NW)	
	Sector 6 (W)	Sector 8 (Far N)	
	Sector 7 (NW)		
	Sector 8 (Far N)		
Vinyl Chloride		Sector 4 (SE)	
		Sector 5 (SW)	

Notes:

The following contaminants could not be modeled because they were absent from the MEPAS database: Benzo(ghi)perylene; Dibenzofuran; 2,6-Dinitrotoluene; Iodomethane; cis-1,2-Dichloroethene; trans-1,2-Dichloroethene; 1,1,1-Trichloroethane; 1,1,2-Trichloroethane; and Trichlorofluromethane.

Table 5.8. Sector 1 source terms

Contaminant	Level	X-Axis (ft)	Y-Axis (ft)	Z-Axis (ft)	Notes
		SUBSURFACE SOIL			
	y	235	498	39	
Neptunium-237	0.3 pCi/g	Modeled as distributed across sector. Z-axis assumes building backfill extends to 10 ft depth.			Maximum detection

Notes:

No source modeled for the following:

TCE: detections believed to be due to Sector 4 source. Sector 4 source dimensions include contaminated volume beneath Sector 1.

X-axis is east-west; Y-axis is north-south; Z-axis is vertical (thickness).

Table 5.9. Contaminant inventory for Sector 1

Source	Site Contaminant	Contaminant Concentration/Activity			WS-Length	WS-Width	z Thickness	Volume	Volume	Bulk Density	Inventory	Inventory
		mg/kg	g/g	pCi/g	ft	ft	ft	ft^3	cm^3	g/cm^3	g	Ci
Subsurface	Neptunium-237			0.3	498	235	39	4.56E+06	1.292E+11	1.86		7.21E-02

Note:

MEPAS uses WS-Length to denote length of source in direction of groundwater flow and WS-Width to denote width in direction perpendicular to groundwater flow.

Table 5.10. MEPAS results for Sector 1

Constituent	Plant Fence		Property Boundary	
	Max Conc. (mg/L)(pCi/L)	Time (yr)	Max Conc. (mg/L)(pCi/L)	Time (yr)
Source: Subsurface				
^{237}Np	3.77E-06	416	2.44E-06	478
^{233}Pa	3.77E-06	416	2.44E-06	478
^{233}U	7.11E-09	435	5.16E-09	497
^{229}Th	1.50E-10	455	1.19E-10	497
^{225}Ra	1.50E-10	455	1.19E-10	497
^{225}Ac	1.50E-10	455	1.19E-10	497

Notes:

Bold type denotes constituents which were run from screening.

Italic type denotes daughter product concentrations resulting from constituents listed in bold.

Table 5.11. Sector 2 source terms

Contaminant	Level	X-Axis (ft)	Y-Axis (ft)	Z-Axis (ft)	Notes
		SURFACE SOIL			
Phenanthrene	470 µg/kg	230	210	1	Modeled over entire sector.
Uranium-238	4.6 pCi/g				
		SUBSURFACE SOIL			
2,6-Dinitrotoluene	432 µg/kg	182	180	49	Maximum detect of 5 detects (in Borings 400-003, 400-005, 400-006, and 400-008). This contaminant could not be modeled because it was absent from the MEPAS database.
Chromium	54.3 mg/kg	101	41	49	Maximum detect. Area around Boring 400-008.
Dibenzofuran	576µg/kg	51	76	2	From 0-2 ft. This contaminant could not be modeled because it was absent from the MEPAS database.
N-Nitroso-di-n-propylamine	634 µg/kg	80	170	46	Maximum detect of 3 detects (in Borings 040-003 and 400-008).
Phenanthrene	487µg/kg	101	117	6	Average of 2 detects +1/2 of 62 non-detects. Detected in borings in southwestern portion of sector (400-005 and 400-008) in soil samples from 1-7 ft bgs.
Thallium	2.3 mg/kg	58	53	2	Maximum detect (Boring 400-003). Detected in 0-2 ft sample.
Uranium-234	20.1 pCi/g	53	129	38	Maximum detects.
Uranium-235	0.7 pCi/g				Detected in SWMU 40 area (Borings 40-005, 40-007, 40-008) and in southeastern portion of sector (Borings 400-058 and 400-061).
Uranium-238	20.2 pCi/g	210	230	49	Maximum detect.
		Modeled over entire sector			

Notes:

The following detects were excluded from consideration in the subsurface in Sector 2 because they only slightly exceeded the background levels:

- Chromium – detected concentration of 39 mg/kg in Boring 040-002 at 11-15 ft bgs just exceeds background of 38 mg/kg.
- Thallium – detected concentration of 0.9 mg/kg in Boring 400-007 at 1-2 ft bgs just exceeds background of 0.7 mg/kg.
- Thallium – detected concentration of 0.8 mg/kg in Boring 400-008 at 32-42 ft bgs just exceeds background of 0.7 mg/kg
- Thallium – detected concentration of 0.8 mg/kg in Boring 400-059 at 10-14 ft bgs just exceeds background of 0.7 mg/kg.

In addition, ^{237}Np was excluded from consideration because it had only one detect in 11 samples (0.3 pCi/g in Boring 040-005 at 7-11 ft bgs). There was a non-detect at 0.1 pCi/g in the same boring.

X-axis is east-west; Y-axis is north-south; Z-axis is vertical (thickness).

Table 5.12. Contaminant inventory for Sector 2

	Site	Contaminant Concentration/Activity			WS-Length	WS-Width	z Thickness	Volume	Volume	Bulk Density	Inventory	Inventory
Source	Contaminant	mg/kg	g/g	pCi/g	ft	ft	ft	ft^3	cm^3	g/cm^3	g	Ci
Surface	Phenanthrene	0.47	5E-07		210	230	1	4.83E+04	1367703855	1.6	1028.513299	
	Uranium-238			4.6	210	230	1	4.83E+04	1367703855	1.6		1.01E-02
Subsurface	2-6 Dinitrotoluene	0.432	4E-07		180	182	49	1.61E+06	45455340294	1.86	36524.27503	
	Chromium	54.3	5E-05		41	101	49	2.03E+05	5745743717	1.86	580308.6239	
	Dibenzofuran	576	0.0006		76	51	2	7.75E+03	219512221.2	1.86	235176.6133	
	N-Nitroso-di-n-propylamine	0.634	6E-07		170	80	46	6.26E+05	17715021360	1.86	20890.26179	
	Phenanthrene	0.487	5E-07		117	101	6	7.09E+04	2007721299	1.86	1818.634107	
	Thallium	2.3	2E-06		53	58	2	6.15E+03	174091993.8	1.6	640.6585372	
	Uranium-234			20.1	53	129	38	2.60E+05	7356887531	1.86		2.75E-01
	Uranium-235			0.7	53	129	38	2.60E+05	7356887531	1.86		9.58E-03
	Uranium-238			20.2	210	230	49	2.37E+06	67017488895	1.86		2.52E+00

Note:

MEPAS uses WS-Length to denote length of source in direction of groundwater flow and WS-Width to denote width in direction perpendicular to groundwater flow.

Table 5.13. MEPAS results for Sector 2

	Plant Fence		Property Boundary	
Constituent	Max Conc. (mg/L)(pCi/L)	Time (yr)	Max Conc. (mg/L)(pCi/L)	Time (yr)
Source: Surface				
^{238}U	7.22E-08	5,160	4.51E-08	5,950
^{234}Th	7.22E-08	5,160	4.51E-08	5,950
^{234}U	1.05E-09	5,160	7.55E-10	5,950
^{230}Th	2.41E-11	5,160	2.00E-11	5,950
^{226}Ra	1.12E-11	5,160	1.01E-11	5,950
^{222}Rn	1.12E-11	5,160	1.01E-11	5,950
^{210}Pb	1.12E-11	5,160	9.93E-12	6,180
^{210}Bi	1.12E-11	5,160	9.93E-12	6,180
^{210}Po	1.12E-11	5,160	9.92E-12	6,180
Phenanthrene	4.68E-06	7,560	3.00E-06	7,980
Source: Subsurface				
Chromium[1]	2.56E-53	10,000	0.00E+00	NA
N-Nitroso-di-propylamine	2.17E-02	24	1.37E-02	27
Phenanthrene	8.62E-06	7,810	5.41E-06	8,450
Thallium	8.45E-04	31	4.94E-04	37
^{238}U	6.62E-06	7,380	4.28E-06	8,050
^{234}Th	6.62E-06	7,380	4.28E-06	8,050
^{234}U	1.45E-07	7,870	1.03E-07	8,750
^{230}Th	5.17E-09	8,110	4.02E-09	8,980
^{226}Ra	3.05E-09	8,110	2.49E-09	8,980
^{222}Rn	3.05E-09	8,110	2.49E-09	8,980
^{210}Pb	3.02E-09	8,110	2.47E-09	8,980
^{210}Bi	3.02E-09	8,110	2.47E-09	8,980
^{210}Po	3.02E-09	8,110	2.47E-09	8,980
^{234}U	9.61E-07	6,460	6.08E-07	7,580
^{230}Th	5.93E-08	7,130	4.15E-08	7,820
^{226}Ra	4.13E-08	7,130	3.02E-08	8,050
^{235}U	3.41E-08	6,640	2.16E-08	7,580
^{231}Th	3.41E-08	6,640	2.16E-08	7,580
^{231}Pa	4.67E-09	7,130	3.26E-09	7,810
^{227}Ac	4.65E-09	7,130	3.25E-09	7,810
^{227}Th	4.65E-09	7,130	3.25E-09	7,810
^{223}Ra	4.65E-09	7,130	3.25E-09	7,810

[1] Did not reach maximum during model runs

Notes:

Bold type denote constituents which were run from screening.

Italic type denotes daughter products resulting from constituents listed in bold

Table 5.14. Sector 3 source terms

Contaminant	Level	X-Axis (ft)	Y-Axis (ft)	Z-Axis (ft)	Notes
Source: Surface Soil					
Arochlor-1260	3,300 µg/kg				Maximum detected values.
Neptunium-237	0.4 pCi/g				Only two surface soil sampling
PCBs	10,000 µg/kg				Locations in Sector 3, so
					Modeled as distributed across
Phenanthrene	1,200 µg/kg	122	234	1	Entire sector.
Thallium	1.2 mg/kg				
Thorium-230	4.2 pCi/g				
Uranium-234	7.1 pCi/g				
Uranium-235	0.4 pCi/g				
Uranium-238	9.1 pCi/g				
Source: Subsurface Soil					
Phenanthrene	706.3 µg/kg	70	135	4	Average of 3 detects.
Trichloroethene	1,502 µg/kg	152	234	49	Average of 23 detects. Area includes entire sector plus a small portion of the eastern side of Sector 1.
Neptunium-237	0.3 pCi/g	70	234	49	Average of 8 detects. The area is centered around the 2 borings (011-001 and 011-002) with the 8 detects.

Notes:

No sources were modeled for the following subsurface contaminants because they were detected in only one sample:

- Dibenzofuran (max detect = 50 µg/kg), 1 detect, 43 non-detects.
- N-Nitroso-di-n-propylamine (max detect = 331 µg/kg), 1 detect, 43 non-detects.
- Thallium (maximum detect = 0.8 mg/kg), 1 detect, 29 non-detects. The one detect value was only slightly above the PRG.
- Americium-241 (maximum detect = 0.2 pCi/g), 1 detect, 35 non-detects.

In addition, Uranium-238 was not modeled in a subsurface source because it was only detected once above the 2 times background value in 35 detects. This maximum detect value (2.5 pCi/g) only slightly exceeded 2 times background (2.4 pCi/g).

X-axis is east-west; Y-axis is north-south; Z-axis is vertical (thickness).

Table 5.15. Contaminant inventory for Sector 3

	Site	Contaminant Concentration/Activity			WS-Length	WS-Width	z Thickness	Volume	Volume	Bulk Density	Inventory	Inventory
Source	**Contaminant**	**mg/kg**	**g/g**	**pCi/g**	**ft**	**ft**	**ft**	**ft^3**	**cm^3**	**g/cm^3**	**g**	**Ci**
Surface	Aroclor 1260	3.3	3E-06		234	122.1	1	2.86E+04	809118309.5	1.6	4272.144674	
	PCB (General)	10	1E-05		234	122.1	1	2.86E+04	809118309.5	1.6	12945.89295	
	Phenanthrene	1.2	1E-06		234	122.1	1	2.86E+04	809118309.5	1.6	1553.507154	
	Neptunium-237			0.4	234	122.1	1	2.86E+04	809118309.5	1.6		5.18E-04
	Thallium	1.2	1E-06		234	122.1	1	2.86E+04	809118309.5	1.6	1553.507154	
	Thorium-230			4.2	234	122.1	1	2.86E+04	809118309.5	1.6		5.44E-03
	Uranium-234			7.1	234	122.1	1	2.86E+04	809118309.5	1.6		9.19E-03
	Uranium-235			0.4	234	122.1	1	2.86E+04	809118309.5	1.6		5.18E-04
	Uranium-238			9.1	234	122.1	1	2.86E+04	809118309.5	1.6		1.18E-02
Subsurface	Phenanthrene	0.7	7E-07		135	70	4	3.78E+04	1070376930	1.86	1393.630763	
	Neptunium-237			0.3	234	70	49	8.03E+05	22727670147	1.86		1.27E-02
	Trichloroethene	1.5	2E-06		234	152	49	1.74E+06	49351512319	1.86	137690.7194	

Note:

MEPAS uses WS-Length to denote length of source in direction of groundwater flow and WS-Width to denote width in direction perpendicular to groundwater flow.

Table 5.16. MEPAS results for Sector 3

	Plant Fence		Property Boundary	
Constituent	**Max Conc. (mg/L)(pCi/L)**	**Time (yr)**	**Max Conc. (mg/L)(pCi/L)**	**Time (yr)**
Source: Surface				
PCB	0.00E+00	10,000	0.00E+00	10,000
Aroclor-1260	0.00E+00	10,000	0.00E+00	10,000
Phenanthrene	7.73E-06	7,560	4.66E-06	7,980
^{235}U	4.06E-09	5,160	2.39E-09	5,950
^{231}*Th*	4.06E-09	5,160	2.39E-09	5,950
^{231}*Pa*	4.19E-10	5,160	2.82E-10	5,950
^{227}*Ac*	4.16E-10	5,160	2.80E-10	5,950
^{227}*Th*	4.16E-10	5,160	2.80E-10	5,950
^{223}*Ra*	4.16E-10	5,160	2.80E-10	5,950
^{238}U	9.25E-08	5,160	5.43E-08	5,950
^{234}*Th*	9.25E-08	5,160	5.43E-08	5,950
^{234}U	1.35E-09	5,160	9.10E-10	5,950
^{230}*Th*	3.09E-11	5,160	2.41E-11	5,950
^{226}*Ra*	1.44E-11	5,160	1.21E-11	5,950
^{222}*Rn*	1.44E-11	5,160	1.21E-11	5,950
^{210}*Pb*	1.42E-11	5,160	1.20E-11	5,950
^{210}*Bl*	1.42E-11	5,160	1.20E-11	5,950
^{210}*Po*	1.41E-11	5,160	1.20E-11	5,950
Thallium	2.09E-03	31	1.17E-03	37
^{230}Th (1)	3.29E-53	10,000	0.00E+00	10,000
^{226}*Ra (1)*	3.31E-50	10,000	0.00E+00	10,000
^{237}Np	6.55E-08	320	3.75E-08	359
^{233}*Pa*	6.55E-08	320	3.75E-08	359
^{233}*U*	9.12E-11	320	5.86E-11	359
^{229}*Th*	1.36E-12	320	1.07E-12	379
^{225}*Ra*	1.36E-12	320	1.07E-12	379
^{225}*Ac*	1.36E-12	320	1.07E-12	379
^{234}U	7.10E-08	5,160	4.16E-08	5,950
^{230}*Th*	3.25E-09	5,160	2.19E-09	5,950
^{226}*Ra*	1.97E-09	5,160	1.42E-09	5,950

Table 5.16. (continued)

	Plant Fence		Property Boundary	
Constituent	**Max Conc. (mg/L)(pCi/L)**	**Time (yr)**	**Max Conc. (mg/L)(pCi/L)**	**Time (yr)**
Source: Subsurface				
Phenanthrene	7.02E-06	7,560	4.21E-06	8,220
^{237}Np	5.77E-07	455	3.64E-07	497
^{233}*Pa*	5.77E-07	455	3.64E-07	497
^{233}*U*	1.21E-09	493	8.41E-10	537
^{229}*Th*	2.79E-11	512	2.15E-11	537
^{225}*Ra*	2.79E-11	512	2.15E-11	557
^{225}*Ac*	2.79E-11	512	2.15E-11	557
TCE	2.91E-02	105	1.85E-02	112

[1] Did not reach maximum during model runs.

Notes:

Bold type denote constituents which were run from screening.

Italic type denote daughter product concentrations resulting from constituents listed in bold.

Table 5.17. Sector 4 source terms

Contaminant	Level	X-Axis (ft)	Y-Axis (ft)	Z-Axis (ft)	Notes
Source: Surface Soil					
Arochlor-1262	38 µg/kg	196	221	1	Only one surface soil analysis available. Modeled as distributed across sector less area covered by concrete apron.
Phenanthrene	70 µg/kg				
Source: Subsurface Soil					
1,1,1-Trichloroethane	2,400 µg/kg				Detected in Boring 400-200 only.
Trichlorofluoromethane	1.7 µg/kg	65	65	9	Only at 5-9 ft bgs.
1,1,2-Trichloroethane	530 µg/kg				
1,1-Dichloroethene	950 µg/kg				
Carbon Tetrachloride	710 µg/kg	65	65	49	Detected in Boring 400-200 only.
Chromium	51.6 mg/kg				
Phenanthrene	250 µg/kg				
Tetrachloroethene	690 µg/kg				
Neptunium-237	0.29 pCi/g	196	221	49	Modeled as distributed across sector less area cover by concrete apron.
Cis-1,2-Dichloroethene	2,400 µg/kg				
Trichloroethene	11,000,000 µg/kg	130	63	49	1’-35’: 115’ X 34’
Trans-1,2-Dichloroethene	34,000 µg/kg				36’-50’: 147’ X 120’
Vinyl Chloride	130 µg/kg				
Plutonium-239	0.2 pCi/g				

Notes:
No source modeled for the following:

- Chloromethane (max detect = 270 µg/kg) and Iodomethane (max detect = 430 µg/kg): Boring 400-014. Only detected at 45’-49’ interval.
- Chromium detections in Boring 400-103 (at 9’-13’ interval): detection = 38.3 mg/kg, PRG = 38 mg/kg.
- Cobalt detections in Borings 400-068 (at 13’-17’ interval) (14.2 mg/kg)and 400-016 (at 16’-20f interval) (16.1 mg/kg): these detections are only slightly above background (13 mg/kg) and unrelated geographically.
- Cobalt (at 126 mg/kg) and lead (at 82.5 mg/kg) detections in Boring 011-006 (at 36’-40’ interval): only low levels of detections of cobalt and lead above and below interval - no local source known.
- Lead in Boring 400-138 (at 4’-8’ interval) (24.5 mg/kg): isolated detection only slightly above background (23 mg/kg).
- N-Nitroso-di-n-propylamine (447 µg/kg): singular detection in Boring 400-069 (at 13’-17’ interval).
- Thallium detections in Borings 400-066 (at 13’-17’ interval) (0.9 mg/kg) and 400-139 (at 4’-8’ interval) (1.1 mg/kg): detections only slightly above PRG (0.7 mg/kg) and geographically unrelated.
- Uranium-238: detected above background levels in only 3 of 139 analyses.
- Vinyl chloride in Boring 400-201 (at 4’-8’ interval): detection of 3,000 µg/kg is one order of magnitude above all other detections (10).

No water sources were modeled. All water contaminants (TCE and trans-1,2-DCE) are subsurface soil contaminants.

X-axis is east-west; Y-axis is north-south; Z-axis is vertical (thickness).

Table 5.18. Contaminant inventory for Sector 4

Source	Site Contaminant	Contaminant Concentration/Activity mg/kg	g/g	pCi/g	WS-Length ft	WS-Width ft	z Thickness ft	Volume ft^3	Volume cm^3	Bulk Density g/cm^3	Inventory g	Inventory Ci
Surface	Aroclor-1262	0.038	3.80E-08		221	196	1	4.E+04	1.E+09	1.6	7.46E+01	
	Phenanthrene	0.07	7.00E-08		221	196	1	4.E+04	1.E+09	1.6	1.37E+02	
Subsurface	1,1,1-Trichloroethane	2.4	2.40E-06		65	65	9	4.E+04	1.E+09	1.86	4.81E+03	
	Trichlorofluoromethane	0.0017	1.70E-09		65	65	9	4.E+04	1.E+09	1.86	3.40E+00	
	1,1,2-Trichloroethane	0.53	5.30E-07		65	65	49	2.E+05	6.E+09	1.86	5.78E+03	
	1,1-Dichloroethene	0.95	9.50E-07		65	65	49	2.E+05	6.E+09	1.86	1.04E+04	
	Carbon Tetrachloride	0.71	7.10E-07		65	65	49	2.E+05	6.E+09	1.86	7.74E+03	
	Chromium	51.6	5.16E-05		65	65	49	2.E+05	6.E+09	1.86	5.63E+05	
	Phenanthrene	0.25	2.50E-07		65	65	49	2.E+05	6.E+09	1.86	2.73E+03	
	Tetrachloroethene	0.69	6.90E-07		65	65	49	2.E+05	6.E+09	1.86	7.52E+03	
	Neptunium-237			0.29	221	196	49	2.E+06	6.E+10	1.86		3.24E-02
	Cis-1,2-Dichloroethene	2.4	2.40E-06		63	130	49	4.E+05	1.E+10	1.86	5.07E+04	
	Trichloroethene	11000	1.10E-02		63	130	49	4.E+05	1.E+10	1.86	2.33E+08	
	Trans-1,2-Dichloroethene	34	3.40E-05		63	130	49	4.E+05	1.E+10	1.86	7.19E+05	
	Vinyl Chloride	0.13	1.30E-07		63	130	49	4.E+05	1.E+10	1.86	2.75E+03	
	Plutonium-239			0.2	63	130	49	4.E+05	1.E+10	1.86		4.23E-03

Note:
MEPAS uses WS-Length to denote length of source in direction of groundwater flow and WS-Width to denote width in direction perpendicular to groundwater flow.

Table 5.19. MEPAS results for Sector 4

	Plant Fence		**Property Boundary**	
Constituent	**Max Conc. (mg/L)(pCi/L)**	**Time (yr)**	**Max Conc. (mg/L)(pCi/L)**	**Time (yr)**
Source: Surface				
PCB	0.00E+00	10,000	0.00E+00	10,000
Phenanthrene	6.34E-07	7,559	4.03E-07	7,979
Source: Subsurface				
1,1-Dichloroethene	4.14E-03	62	2.50E-03	67
Carbon Tetrachloride	4.87E-04	386	2.94E-04	406
Chromium[1]	2.69E-53	10,000	0.00E+00	10,000
Phenanthrene	6.36E-06	10,280	3.89E-06	10,830
^{237}Np	1.47E-06	455	9.08E-07	497
^{233}Pa	1.47E-06	455	9.08E-07	497
^{233}U	3.08E-09	493	2.09E-09	537
^{229}Th	7.07E-11	493	5.31E-11	557
^{225}Ra	7.07E-11	493	5.31E-11	557
^{225}Ac	7.07E-11	493	5.31E-11	557
^{239}Pu	1.22E-08	10,200	7.00E-09	11,960
Tetrachloroethene	6.44E-04	285	3.89E-04	298
TCE	5.00E+01	105	3.17E+01	112
Vinyl Chloride	1.14E-03	54	7.27E-04	61

Notes:

Bold type denotes constituents which were run from screening.

Italic type denotes daughter product concentrations resulting from constituents listed in bold.

[1] Did not reach maximum during model runs.

Table 5.20. Sector 5 source terms

Contaminant	Level	X-Axis (ft)	Y-Axis (ft)	Z-Axis (ft)	Notes
Source: Surface Soil					
Acenaphthylene	2924 µg/kg				Average of 1 detect and 1/2 of 4 non-detects
Benz(a)anthracene	7600 µg/kg				Average of 3 detects - no non-detects
Benz(a)pyrene	13,000 µg/kg				1 analysis
Benz(b)fluoranthene	9800 µg/kg				Average of 2 detects - no non-detects
Benz(k)fluoranthene	8751 µg/kg				1 analysis
Chromium	48 mg/kg	350	250	1	1 analysis
Dibenzofuran	429 µg/kg	Modeled as distributed across sector less area covered by concrete apron			Average of 3 detects and 2 non-detects (used max detect level)
Neptunium-237	0.13 pCi/g				Average of 1 detect and 2 non-detects
Phenanthrene	5197 µg/kg				Average of 5 detects
Plutonium-239	0.10 pCi/g				Average of 1 detect and 2 non-detects
Technetium-99	11.8 pCi/g				Average of 3 detects
Thallium	1.2 mg/kg				Average of 2 detects - no non-detects
Uranium-234	4.9 pCi/g				Average of 3 detects
Uranium-235	0.27 pCi/g				Average of 1 detect and 2 non-detects
Uranium-238	7.0 pCi/g				Average of 3 detects
Source: Subsurface Soil					
Cis-1,2-Dichloroethene	1000 µg/kg				Modeled as discrete source
Trans-1,2-Dichloroethene	15,300 µg/kg	250	85	49	Along storm sewer
Vinyl Chloride	35 µg/kg				
Iodomethane	700 µg/kg	55	45	18	Detected in Boring 400-015 only. Only at 8'-12'. 3 non-detects beginning at 19' depth.
Americium-241	1 pCi/g				Single analysis
Cesium-137	0.31 pCi/g	350	336	49	Average of 29 detects
Thallium	1.6 mg/kg	Modeled as distributed across entire sector			Maximum of 2 analyses
Uranium-235	0.4 pCi/g				Maximum of 2 analyses
Trichloroethene	168,200 µg/kg	59	45	49	Maximum detection
		Modeled as discrete source centered on Boring 400-015			

Notes:

No subsurface source modeled for the following:

- N-Nitroso-di-n-propylamine (582 µg/kg): singular analysis for Boring 400-088 (at 6'-10' interval).
- Tc-99: 2 of 56 detections above background (2.8 pCi/g). 3.1 pCi/g in 400-192 at 16'-20' only slightly above background. 7.3 pCi/g in 400-141 at 0'-4' attributed to surface soils.
- U-234: 1 detection (2.7 pCi/g in 400-141 at 0'-4') of 69 analyses only slightly above background (2.4 pCi/g). Higher activity attributed to surface soils.
- U-238: 2 of 69 detections above background (1.2 pCi/g). 1.4 pCi/g in 400-145 at 4'-8' only slightly above background. 4.6 pCi/g in 400-141 at 0'-4' attributed to surface soils.

No water sources were modeled. Unfiltered water samples yielded detections of the following at levels above the higher of background or PRG reference levels:

Boring 400-017 (at 33' - 43'):
metals: none
organics: TCE
radionuclides: none

Boring 400-018 (at 38' - 40'):
Metals: Al, As, Ba, Be, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Hg, Ni, K, Na, V, Zn
Organics: TCE
Radionuclides: Pb-212, K-40, Th-228, Th-230, Th-232, U-233/234, U-238

X-axis is east-west; Y-axis is north-south; Z-axis is vertical (thickness).

Table 5.21. Contaminant inventory for Sector 5

Source	Site Contaminant	Contaminant Concentration/Activity			WS-Length	WS-Width	z Thickness	Volume	Volume	Bulk Density	Inventory	Inventory
		mg/kg	g/g	pCi/g	ft	ft	ft	ft³	cm³	g/cm³	g	Ci
Surface	Acenaphythylene	2.924	2.92E-06		250	350	1	8.75E+04	2.478E+09	1.6	1.16E+04	
	Benz(a)anthracene	7.6	7.60E-06		250	350	1	8.75E+04	2.478E+09	1.6	3.01E+04	
	Benz(a)pyrene	13	1.30E-05		250	350	1	8.75E+04	2.478E+09	1.6	5.15E+04	
	Benz(b)fluoranthene	9.8	9.80E-06		250	350	1	8.75E+04	2.478E+09	1.6	3.89E+04	
	Benz(k)fluoranthene	8.751	8.75E-06		250	350	1	8.75E+04	2.478E+09	1.6	3.47E+04	
	Chromium	48	4.80E-05		250	350	1	8.75E+04	2.478E+09	1.6	1.90E+05	
	Dibenzofuran	0.429	4.29E-07		250	350	1	8.75E+04	2.478E+09	1.6	1.70E+03	
	Neptunium-237			1.30E-01	250	350	1	8.75E+04	2.478E+09	1.6		5.15E-04
	Phenanthrene	5.197	5.20E-06		250	350	1	8.75E+04	2.478E+09	1.6	2.06E+04	
	Plutonium-239			1.00E-01	250	350	1	8.75E+04	2.478E+09	1.6		3.96E-04
	Technetium-99			1.18E+01	250	350	1	8.75E+04	2.478E+09	1.6		4.68E-02
	Thallium	1.2	1.20E-06		250	350	1	8.75E+04	2.478E+09	1.6	4.76E+03	
	Uranium-234			4.90E+00	250	350	1	8.75E+04	2.478E+09	1.6		1.94E-02
	Uranium-235			2.70E-01	250	350	1	8.75E+04	2.478E+09	1.6		1.07E-03
	Uranium-238			7.00E+00	250	350	1	8.75E+04	2.478E+09	1.6		2.78E-02
Subsurface	Americium-241			1.00E+00	336	350	49	5.76E+06	1.632E+11	1.86		3.04E-01
	Cesium-137			3.10E-01	336	350	49	5.76E+06	1.632E+11	1.86		9.41E-02
	Cis-1,2-Dichloroethene	1	1.00E-06		85	250	49	1.04E+06	2.948E+10	1.86	5.48E+04	
	Iodomethane	0.7	7.00E-07		45	55	18	4.46E+04	1.262E+09	1.86	1.64E+03	
	Thallium	1.6	1.60E-06		336	350	49	5.76E+06	1.632E+11	1.86	4.86E+05	
	Trans-1,2-Dichloroethene	15.3	1.53E-05		85	250	49	1.04E+06	2.948E+10	1.86	8.39E+05	
	Trichloroethene	168.2	1.68E-04		45	59	49	1.30E+05	3.684E+09	1.86	1.15E+06	
	Uranium-235			4.00E-01	336	350	49	5.76E+06	1.632E+11	1.86		1.21E-01
	Vinyl Chloride	0.035	3.50E-08		85	250	49	1.04E+06	2.948E+10	1.86	1.92E+03	
RGA	Neptunium-237			0.2	300	100	45	1350000	3.823E+10	1.67		1.28E-02

Note:
MEPAS uses WS-Length to denote length of source in direction of groundwater flow and WS-Width to denote width in direction perpendicular to groundwater flow.

Table 5.22. MEPAS results for Sector 5

	Plant Fence		**Property Boundary**	
Constituent	**Max Conc. (mg/L)(pCi/L)**	**Time (yr)**	**Max Conc. (mg/L)(pCi/L)**	**Time (yr)**
Source: Surface				
Acenaphthylene	2.66E-04	1,336	1.71E-04	1,419
Benz(a)anthracene	0.00E+00	10,000	0.00E+00	10,000
Benz(a)pyrene	0.00E+00	10,000	0.00E+00	10,000
Benz(b)fluoranthene	0.00E+00	10,000	0.00E+00	10,000
Benz(k)fluoranthene	0.00E+00	10,000	0.00E+00	10,000
Chromium	0.00E+00	9,799	0.00E+00	10,000
^{237}Np	5.43E-08	320	3.41E-08	359
^{233}Pa	5.43E-08	320	3.41E-08	359
^{233}U	7.57E-11	320	5.50E-11	379
^{229}Th	1.13E-12	320	9.73E-13	379
^{225}Ra	1.13E-12	320	9.72E-13	379
^{225}Ac	1.13E-12	320	9.72E-13	379
Phenanthrene	8.57E-05	7,559	5.66E-05	7,979
^{239}Pu	9.91E-10	10,200	6.02E-10	11,750
^{99}Tc	7.44E-07	2,088	4.80E-07	2,335
Thallium	5.35E-03	31	3.29E-03	37
^{234}U	1.25E-07	5,162	8.04E-08	5,953
^{230}Th	5.73E-09	5,162	4.24E-09	5,953
^{226}Ra	3.47E-09	5,162	2.74E-09	5,953
^{235}U	7.00E-09	5,163	4.51E-09	5,951
^{231}Th	7.00E-09	5,163	4.51E-09	5,951
^{231}Pa	7.22E-10	5,163	5.31E-10	5,951
^{227}Ac	7.18E-10	5,163	5.29E-10	5,951
^{227}Th	7.18E-10	5,163	5.29E-10	5,951
^{223}Ra	7.18E-10	5,163	5.29E-10	5,951
^{238}U	1.82E-07	5,163	1.17E-07	5,951
^{234}Th	1.82E-07	5,163	1.17E-07	5,951
^{234}U	2.65E-09	5,163	1.96E-09	5,951
^{230}Th	6.08E-11	5,163	5.19E-11	5,951
^{226}Ra	2.83E-11	5,163	2.62E-11	5,951
^{227}Rn	2.83E-11	5,163	2.62E-11	5,951
^{210}Pb	2.78E-11	5,163	2.58E-11	5,951
^{210}Bi	2.78E-11	5,163	2.58E-11	5,951
^{210}Po	2.78E-11	5,163	2.58E-11	5,951

Notes:

Bold type denotes constituents which were run from screening.

Italic type denotes daughter product concentrations resulting from constituents listed in bold.

Table 5.22. (continued)

	Plant Fence		Property Boundary	
Constituent	**Max Conc. (mg/L)(pCi/L)**	**Time (yr)**	**Max Conc. (mg/L)(pCi/L)**	**Time (yr)**
Source: Subsurface				
^{241}Am	1.38E-21	10,000	5.82E-24	14,900
^{137}Cs	0.00E+00	10,000	0.00E+00	10,000
TH-230	1.94E-50	10,000	0.00E+00	10,000
RA-226	1.95E-50	10,000	0.00E+00	10,000
TCE	2.53E-01	105	1.59E-01	112
Thallium	4.74E-01	34	2.99E-01	39
^{235}U	7.95E-07	5,160	5.10E-07	5,950
^{231}Th	7.95E-07	5,160	5.10E-07	5,950
^{231}Pa	8.20E-08	5,160	6.01E-08	5,950
Source: RGA				
^{237}Np	6.17E-07	435	4.06E-07	478
^{233}Pa	6.17E-07	435	4.06E-07	478
^{233}U	1.20E-09	455	8.75E-10	517
^{229}Th	2.60E-11	474	2.10E-11	517
^{225}Ra	2.60E-11	474	2.10E-11	517
^{225}Ac	2.60E-11	474	2.10E-11	517

Notes:

Bold type denotes constituents which were run from screening.

Italic type denotes daughter product concentrations resulting from constituents listed in bold.

Table 5.23. Sector 6 source terms

Contaminant	Level	X-Axis (feet)	Y-Axis (feet)	Z-Axis (feet)	Notes
SURFACE SOIL					
2-Methylnaphthalene	44 ug/kg	225	200	1	Detected in boring 400-044 only.
Dibenz(a,h)anthracene	3,200 ug/kg				Detected in boring 047-002 only.
Dibenzofuran	942 ug/kg				Average of detect in boring 047-002 and 1/2 non-detect in boring 400-044.
Americium-241	0.2 pCi/g	20 Modeled as 20′ X 20′ bermed area. Non-detect and below background in Boring 400-044.	20	1	Detections in Boring 047-002
Cesium-137	1.5 pCi/g				
Neptunium-237	1 pCi/g				
Technetium-99	53 pCi/g				
Thorium-230	6.4 pCi/g				
Uranium-234	31.1 pCi/g				
Uranium-235	1.9 pCi/g				
Uranium-238	39.5 pCi/g	20	20	1	Activity in boring 047-002. Also detected at 3 pCi/g in 400-044.
SUBSURFACE SOIL					
Americium-241	0.2 pCi/g	225	200	49	Average of 1 detect and 2 non-detects.
Neptunium-237	0.2 pCi/g	20	20	25	Boring 047-002. Non-detect at 26′.
Technetium-99	8.1 pCi/g	20	20	7	Boring 047-002. Non-detects and background levels @ 8′.
Uranium-234	41.7 pCi/g				
Uranium-235	2.2 pCi/g				
Uranium-238	42.8 pCi/g				
trans-1,2-Dichloroethene	2,500 ug/kg	50 X-axis determined by < 5 detects in boring 400-041 of Sector 5.	200	49	Maximum detect.
Trichloroethene	1,700 ug/kg				Maximum detect.

No source modeled for:

- Chromium (49.3 mg/kg): single analysis in boring 400-076 @ 14′-18′ interval.
- Benz(a)anthracene (18,000 ug/kg), Benz(a)pyrene (16,000 ug/kg), Benz(b)fluoranthene (17,000 ug/kg), Benz(k)fluoranthene (11,000 ug/kg): single analysis for each contaminant (surface soil sample) in boring 047-002, not expected to be a site contaminant.

X-axis is east-west; Y-axis is north-south.

Table 5.24. Contaminant inventory for Sector 6

Source	Site Contaminant	Contaminant Concentration/Activity			WS-Length	WS-Width	z Thickness	Volume	Volume	Bulk Density	Inventory	Inventory
		mg/kg	g/g	pCi/g	ft	ft	ft	ft^3	cm^3	g/cm^3	g	Ci
Surface	2-Methylnaphthalene	0.044	4.40E-08		200	225	1	4.50E+04	1.27E+09	1.6	8.97E+01	
	Americium-241			0.2	20	20	1	4.00E+02	1.13E+07	1.6		3.62E-06
	Cesium-137			1.5	20	20	1	4.00E+02	1.13E+07	1.6		2.72E-05
	Dibenz(a,h)anthracene	3.2	3.20E-06		200	225	1	4.50E+04	1.27E+09	1.6	6.52E+03	
	Dibenzofuran	0.942	9.42E-07		200	225	1	4.50E+04	1.27E+09	1.6	1.92E+03	
	Neptunium-237			1	20	20	1	4.00E+02	1.13E+07	1.6		1.81E-05
	Technetium-99			53	20	20	1	4.00E+02	1.13E+07	1.6		9.61E-04
	Thorium-230			6.4	20	20	1	4.00E+02	1.13E+07	1.6		1.16E-04
	Uranium-234			31.1	20	20	1	4.00E+02	1.13E+07	1.6		5.64E-04
	Uranium-235			1.9	20	20	1	4.00E+02	1.13E+07	1.6		3.44E-05
	Uranium-238			39.5	20	20	1	4.00E+02	1.13E+07	1.6		7.16E-04
Subsurface	Americium-241			0.2	200	225	49	2.21E+06	6.24E+10	1.86		2.32E-02
	Neptunium-237			0.2	20	20	25	1.00E+04	2.83E+08	1.86		1.05E-04
	Technetium-99			8.1	20	20	7	2.80E+03	7.93E+07	1.86		1.19E-03
	Thorium-230			3.4	200	225	49	2.21E+06	6.24E+10	1.86		3.95E-01
	Trans-1,2-Dichloroethene	2.5	2.50E-06		200	50	49	4.90E+05	1.39E+10	1.86	6.45E+04	
	Trichloroethene	1.7	1.70E-06		200	50	49	4.90E+05	1.39E+10	1.86	4.39E+04	
	Uranium-234			41.7	20	20	7	2.80E+03	7.93E+07	1.86		6.15E-03
	Uranium-235			2.2	20	20	7	2.80E+03	7.93E+07	1.86		3.24E-04
	Uranium-238			42.8	20	20	7	2.80E+03	7.93E+07	1.86		6.31E-03

Note:
MEPAS uses WS-Length to denote length of source in direction of groundwater flow direction and WS-Width to denote width in direction perpendicular to groundwater flow.

Table 5.25. MEPAS results for Sector 6

	Plant Fence		Property Boundary	
Constituent	**Max Conc. (mg/L)(pCi/L)**	**Time (yr)**	**Max Conc. (mg/L)(pCi/L)**	**Time (yr)**
Source: Surface				
2-Methylnaphthalene	1.27E-06	2,390	7.90E-07	2,530
^{241}Am	1.54E-24	13,500	1.80E-27	14,900
^{137}Cs	0.00E+00	10,000	0.00E+00	10,000
Dibenz(a,h,)anthracene	0.00E+00	10,000	0.00E+00	10,000
^{237}Np	2.26E-09	320	1.34E-09	359
^{233}*Pa*	2.26E-09	320	1.34E-09	359
^{233}*U*	3.15E-12	320	2.16E-12	379
^{229}*Th*	4.71E-14	320	3.81E-14	379
^{225}*Ra*	4.71E-14	320	3.81E-14	379
^{225}*Ac*	4.70E-14	320	3.81E-14	379
^{99}Tc	1.81E-08	2,090	1.10E-08	2,340
^{230}Th	0.00E+00	10,000	0.00E+00	10,000
^{234}U	4.32E-09	5,160	2.61E-09	5,950
^{230}*Th*	1.97E-10	5,160	1.38E-10	5,950
^{226}*Ra*	1.19E-10	5,160	8.90E-11	5,950
^{235}U	2.67E-10	5,160	1.63E-10	5,950
^{231}*Th*	2.67E-10	5,160	1.63E-10	5,950
^{231}*Pa*	2.75E-11	5,160	1.92E-11	5,950
^{227}*Ac*	2.74E-11	5,160	1.91E-11	5,950
^{227}*Th*	2.74E-11	5,160	1.91E-11	5,950
^{223}*Ra*	2.74E-11	5,160	1.91E-11	5,950
^{238}U	5.54E-09	5,160	3.37E-09	5,950
^{234}*Th*	5.54E-09	5,160	3.37E-09	5,950
^{234}*U*	8.07E-11	5,160	5.64E-11	5,950
^{230}*Th*	1.85E-12	5,160	1.49E-12	5,950
^{226}*Ra*	8.61E-13	5,160	7.52E-13	5,950
^{227}*Rn*	8.61E-13	5,160	7.52E-13	5,950
^{210}*Pb*	8.48E-13	5,160	7.42E-13	5,950
^{210}*Bi*	8.48E-13	5,160	7.42E-13	5,950
^{210}*Po*	8.47E-13	5,160	7.41E-10	5,950

Notes:

Bold type denotes constituents which were run from screening.

Italic type denotes daughter products resulting from constituents listed in bold

Table 5.25. (continued)

	Plant Fence		Property Boundary	
Constituent	Max Conc. (mg/L)(pCi/L)	Time (yr)	Max Conc. (mg/L)(pCi/L)	Time (yr)
Source: Subsurface				
1,2-Dichloroethene	7.64E-02	21	4.78E-02	23
^{241}Am	4.51E-22	13,500	4.65E-25	14,900
^{237}Np	8.79E-09	378	5.41E-09	438
^{233}Pa	8.79E-09	378	5.41E-09	438
^{233}U	1.45E-11	397	1.03E-11	438
^{229}Th	2.68E-13	397	2.11E-13	438
^{225}Ra	2.68E-13	397	2.11E-13	438
^{225}Ac	2.68E-13	397	2.11E-13	438
^{99}Tc	2.24E-11	2,090	1.36E-08	2,340
^{230}Th^{1}	2.62E-50	10,000	0.00E+00	10,000
^{226}Ra^{1}	2.64E-50	10,000	0.00E+00	10,000
Trichloroethene	9.58E-03	105	6.03E-03	112
^{234}U	4.55E-08	5,410	2.74E-08	6,190
^{230}Th	2.18E-09	5,410	1.50E-09	6,190
^{226}Ra	1.35E-09	5,410	9.87E-10	6,190
^{235}U	2.43E-09	5,410	1.47E-09	6,190
^{231}Th	2.43E-09	5,410	1.47E-09	6,190
^{231}Pa	2.62E-10	5,410	1.80E-10	6,190
^{227}Ac	2.61E-10	5,410	1.79E-10	6,190
^{227}Th	2.61E-10	5,410	1.79E-10	6,190
^{223}Ra	2.61E-10	5,410	1.79E-10	6,190
^{238}U	5.54E-09	5,160	3.37E-09	5,950
^{234}Th	5.54E-09	5,160	3.37E-09	5,950
^{234}U	8.07E-11	5,160	5.64E-11	5,950
^{230}Th	1.85E-12	5,160	1.49E-12	5,950
^{226}Ra	8.61E-13	5,160	7.52E-13	5,950
^{227}Rn	8.61E-13	5,160	7.52E-13	5,950
^{210}Pb	8.48E-13	5,160	7.42E-13	5,950
^{210}Bi	8.48E-13	5,160	7.42E-13	5,950
^{210}Po	8.47E-13	5,160	7.41E-13	5,950

Notes:

Bold type denotes constituents which were run from screening.

Italic type denotes daughter products resulting from constituents listed in bold.

[1] Did not reach maximum during model runs.

Table 5.26. Sector 7 source terms

Contaminant	Level	X-Axis (ft)	Y-Axis (ft)	Z-Axis (ft)	Notes
Source: Surface Soil					
Chromium	66 mg/kg	290	195	1	Detected in both surface soil samples.
Uranium-238	3.2 pCi/g	Modeled as distributed over surface of entire sector.			Detected in one surface soil sample.
Source: Subsurface Soil					
Americium-241	0.4 pCi/g	200	70	21	Maximum detect. Detected in 3 borings in northern portion of sector.
Neptunium-237	0.8 pCi/g	90	110	34	Maximum detect.
Antimony	0.85 mg/kg	290	195	49	Average of 9 detects + 1/2 of 21 non-detects. (Higher value than average of detects.) Modeled over entire sector.
Mercury	0.29 mg/kg	290	195	34	Average of 17 detects + 1/2 of 13 non-detects (Higher value than average of detects.)
Technetium-99	3.16 pCi/g	290	195	34	Average of 17 detects. Modeled over entire sector. Not detected in samples below 32 ft.
Thorium-230	1.2 pCi/g	290	195	49	Average of 18 detects. Modeled over entire sector and entire thickness of UCRS.
Trichloroethene	562 µg/kg	130	160	15	Average of 4 detects + 44 non-detects. Area includes portion of central sector under the NW corner of C-400 Bldg. TCE source area centered around Boring 203-003.
Uranium-234	1.1 pCi/g	290	195	34	Average of 18 detects. Modeled over entire sector. Not detected in samples below 32 ft.
Uranium-235	0.4 pCi/g	150	70	2	Maximum detect. Area defined by two detects in northern portion of sector in shallow soil.
Uranium-238	1.6 pCi/g	290	195	34	Average of 18 detects. Modeled over entire sector. Not detected in samples below 32 ft.

Notes:

Sources were not modeled for the following contaminants because they were detected only once in the subsurface soils:

- N-Nitroso-di-n-propylamine
- Phenanthrene
- Plutonium-239

X-axis is east-west; Y-axis is north-south; Z-axis is vertical (thickness).

Table 5.27. Contaminant inventory for Sector 7

	Site	Contaminant Concentration/Activity			WS-Length	WS-Width	z Thickness	Volume	Volume	Bulk Density	Inventory	Inventory
Source	**Contaminant**	**mg/kg**	**g/g**	**pCi/g**	**ft**	**ft**	**ft**	**ft^3**	**cm^3**	**g/cm^3**	**g**	**Ci**
Surface	Chromium	66	6.60E-05		195	290	1	5.66E+04	1.601E+09	1.6	1.69E+05	
	Uranium-238			3.2	195	290	1	5.66E+04	1.601E+09	1.6		8.20E-03
Subsurface	Americium-241			0.4	70	200	21	2.94E+05	8.325E+09	1.86		6.19E-03
	Antimony	0.85	8.50E-07		195	290	49	2.77E+06	7.846E+10	1.86	1.24E+05	
	Mercury	0.29	2.90E-07		195	290	34	1.92E+06	5.444E+10	1.86	2.94E+04	
	Neptunium-237			0.8	110	90	32	3.17E+05	8.971E+09	1.86		1.33E-02
	Technetium-99			3.16	195	290	34	1.92E+06	5.444E+10	1.86		3.20E-01
	Thorium-230			1.2	195	290	49	2.77E+06	7.846E+10	1.86		1.75E-01
	Trichloroethene	0.562	5.62E-07		160	130	15	3.12E+05	8.835E+09	1.86	9.24E+03	
	Uranium-234			1.1	195	290	34	1.92E+06	5.444E+10	1.86		1.11E-01
	Uranium-235			0.4	70	150	2	2.10E+04	594653850	1.86		4.42E-04
	Uranium-238			1.6	195	290	34	1.92E+06	5.444E+10	1.86		1.62E-01

Note:
MEPAS uses WS-Length to denote length of source in direction of groundwater flow and WS-Width to denote width in direction perpendicular to groundwater flow.

Table 5.28. MEPAS results for Sector 7

	Plant Fence		Property Boundary	
Constituent	Max Conc. (mg/L)(pCi/L)	Time (yr)	Max Conc. (mg/L)(pCi/L)	Time (yr)
Source: Surface				
Chromium	0.00E+00	10,000	0.00E+00	10,000
^{238}U	5.65E-08	5,160	3.57E-08	5,950
^{234}Th	5.65E-08	5,160	3.57E-08	5,950
^{234}U	8.22E-10	5,160	5.99E-10	5,950
^{230}Th	1.89E-11	5,160	1.58E-11	5,950
^{226}Ra	8.77E-12	5,160	7.98E-12	5,950
^{227}Rn	8.77E-12	5,160	7.98E-12	5,950
^{210}Pb	8.63E-12	5,160	7.87E-12	5,950
^{210}Bi	8.63E-12	5,160	7.87E-12	5,950
^{210}Po	8.63E-12	5,160	7.87E-12	5,950
Source: Subsurface				
^{241}Am	2.85E-22	13,500	2.91E-25	14,900
Antimony	5.73E-03	707	3.58E-03	824
Mercury	0.00E+00	NA	0.00E+00	NA
^{237}Np	9.07E-07	397	5.69E-07	458
^{233}Pa	9.07E-07	397	1.13E-09	458
^{233}U	1.61E-09	416	2.49E-11	478
^{229}Th	3.13E-11	416	2.49E-11	478
^{225}Ra	3.12E-11	416	2.49E-11	478
^{225}Ac	3.12E-11	416	2.49E-11	478
^{99}Tc	5.35E-06	2,090	3.37E-06	2,460
^{230}Th	0.00E+00	10,000	0.00E+00	10,000
Trichloroethene	3.84E-03	84	2.10E-03	96
^{234}U	3.91E-07	6,640	2.55E-07	7,350
^{235}U	3.33E-09	5,160	2.01E-09	5,950
^{231}Th	3.33E-09	5,160	2.01E-09	5,950
^{231}Pa	3.44E-10	5,160	2.37E-10	5,950
^{227}Ac	3.42E-10	5,160	2.36E-10	5,950
^{227}Th	3.42E-10	5,160	2.36E-10	5,950
^{223}Ra	3.42E-10	5,160	2.36E-10	5,950
^{238}U	5.80E-07	6,640	3.79E-07	7,350
^{234}Th	5.80E-07	6,640	3.79E-07	7,350
^{234}U	1.10E-08	6,880	8.02E-09	7,580
^{230}Th	3.37E-10	7,130	2.75E-10	7,810
^{226}Ra	1.87E-10	7,130	1.60E-10	7,810
^{227}Rn	1.87E-10	7,130	1.60E-10	7,810
^{210}Pb	1.85E-10	7,130	1.58E-10	7,810
^{210}Bi	1.85E-10	7,130	1.58E-10	7,810
^{210}Po	1.85E-10	7,130	1.58E-10	7,810

Notes:

Bold type denote constituents which were run from screening.

Italic type denotes daughter products resulting from constituents listed in bold

Table 5.28. (continued)

Constituent	Plant Fence Max Conc. (mg/L)(pCi/L)	Time (yr)	Property Boundary Max Conc. (mg/L)(pCi/L)	Time (yr)
Source: RGA				
Chromium[1]	6.91E-05	10,000	1.71E-13	10,000
Cobalt	2.74E-02	224	1.33E-02	374
Iron	8.18E+01	377	3.96E+01	631
Manganese	5.71E-01	633	2.77E-01	1,060

Notes:

Bold type denotes constituents which were run from screening.

Italic type denotes daughter products resulting from constituents listed in bold

[1] Did not reach maximum during model runs

Table 5.29. Sector 8 source terms

Contaminant	Level	X-Axis (ft)	Y-Axis (ft)	Z-Axis (ft)	Notes
Source: Surface Soil					
Neptunium-237	0.6 pCi/g	700	150	1	Maximum Detects. Contaminated area is associated with pipeline near Borings 400-043 and 400-034.
Phenanthrene	700 µg/kg				
Plutonium-239	0.4 pCi/g				
Technetium-99	17.0 pCi/g				
Uranium-238	4.6 pCi/g				
Source: Subsurface Soil					
Americium-241	0.6 pCi/g	375	300	49	Maximum detects. Eastern part of pipeline only.
Cesium-137	11.1 pCi/g				
Chromium	140 mg/kg				
Copper	390 mg/kg				
Nickel	467 mg/kg				
Phenanthrene	110 µg/kg				
Plutonium-239	0.8 pCi/g				
Technetium-99	265 pCi/g				
Uranium-235	1.1 pCi/g				
Thorium-230	3 pCi/g	1,500	206	49	Maximum detects. Eastern and central portion of pipeline area.
Neptunium-237	2.6 pCi/g				
2,4-Dinitrotoluene	457 µg/kg	1,125	175	49	Maximum detect. Central portion of pipeline area.
Uranium-234	28.2 pCi/g	675	211	49	Maximum detects. Eastern and western ends of pipeline area.
Uranium-238	53.2 pCi/g				

Notes:

X-axis is east-west; Y-axis is north-south; Z-axis is vertical (thickness).

Table 5.30. Contaminant inventory for Sector 8

Source	Site Contaminant	Contaminant Concentration/Activity			WS-Length	WS-Width	z Thickness	Volume	Volume	Bulk Density	Inventory	Inventory
		mg/kg	g/g	pCi/g	ft	ft	ft	ft^3	cm^3	g/cm^3	g	Ci
Surface	Neptunium-237			0.6	150	700	1	1.05E+05	2.973E+09	1.6		2.85E-03
	Phenanthrene	0.7	7.00E-07		150	700	1	1.05E+05	2.973E+09	1.6	3.33E+03	
	Plutonium-239			0.4	150	700	1	1.05E+05	2.973E+09	1.6		1.90E-03
	Technetium-99			17	150	700	1	1.05E+05	2.973E+09	1.6		8.09E-02
	Uranium-238			4.6	150	700	1	1.05E+05	2.973E+09	1.6		2.19E-02
Subsurface	2,4-Dinitrotoluene	0.457	4.57E-07		175	1125	49	9.65E+06	2.732E+11	1.86	2.32E+05	
	Americium-241			0.6	300	375	49	5.51E+06	1.561E+11	1.86		1.74E-01
	Cesium-137			11.1	300	375	49	5.51E+06	1.561E+11	1.86		3.22E+00
	Chromium	140	1.40E-04		300	375	49	5.51E+06	1.561E+11	1.86	4.06E+07	
	Copper	390	3.90E-04		300	375	49	5.51E+06	1.561E+11	1.86	1.13E+08	
	Neptunium-237			2.6	206	1500	49	1.51E+07	4.287E+11	1.86		2.07E+00
	Nickel	467	4.67E-04		300	375	49	5.51E+06	1.561E+11	1.86	1.36E+08	
	Phenanthrene	0.11	1.10E-07		300	375	49	5.51E+06	1.561E+11	1.86	3.19E+04	
	Plutonium-239			0.8	300	375	49	5.51E+06	1.561E+11	1.86		2.32E-01
	Technetium-99			265	300	375	49	5.51E+06	1.561E+11	1.86		7.69E+01
	Thorium-230			3	206	1500	49	1.51E+07	4.287E+11	1.86		2.39E+00
	Uranium-234			28.2	211	675	49	6.98E+06	1.976E+11	1.86		1.04E+01
	Uranium-235			1.1	300	375	49	5.51E+06	1.561E+11	1.86		3.19E-01
	Uranium-238			53.2	211	675	49	6.98E+06	1.976E+11	1.86		1.96E+01

Note:
MEPAS uses WS-Length to denote length of source in direction of groundwater flow and WS-Width to denote width in direction perpendicular to groundwater flow.

Table 5.31. MEPAS results for Sector 8

Constituent	Plant Fence Max Conc. (mg/L)(pCi/L)	Plant Fence Time (yr)	Property Boundary Max Conc. (mg/L)(pCi/L)	Property Boundary Time (yr)
Source: Surface				
^{237}Np	2.16E-07	320	1.50E-07	359
^{233}Pa	7.99E-09	416	1.50E-07	359
^{233}U	3.00E-10	320	2.44E-10	379
^{229}Th	4.49E-12	320	4.31E-12	379
^{225}Ra	4.49E-12	320	4.31E-12	379
^{225}Ac	4.49E-12	320	4.31E-12	379
Phenanthrene	9.92E-06	7,560	7.29E-06	7,980
^{239}Pu	3.40E-09	10,200	2.30E-09	11,800
^{99}Tc	9.24E-07	2,090	6.61E-07	2,340
^{238}U	1.03E-07	5,160	7.37E-08	5,950
^{234}Th	1.03E-07	5,160	7.37E-08	5,950
^{234}U	1.50E-09	5,160	1.24E-09	5,950
^{230}Th	3.44E-11	5,160	3.26E-11	5,950
^{226}Ra	1.60E-11	5,160	1.65E-11	5,950
^{227}Rn	1.60E-11	5,160	1.65E-11	5,950
^{210}Pb	1.57E-11	5,160	1.63E-11	6,180
^{210}Bi	1.57E-11	5,160	1.63E-11	6,180
^{210}Po	1.57E-11	5,160	1.63E-11	6,180
Source: Subsurface				
2,4-Dinitrotolune	1.07E-01	47	3.73E-02	50
^{241}Am^{1}	2.97E-21	13,500	3.21E-24	14,900
^{137}Cs	0.00E+00	10,000	0.00E+00	10,000
Chromium^{1}	1.59E-26	10,000	0.00E+00	10,000
Copper	4.00E-01	9,505	2.56E-01	11,100
^{237}Np	9.41E-05	455	5.82E-05	497
^{233}Pa	9.41E-05	455	5.82E-05	497
^{233}U	1.97E-07	493	1.34E-07	537
^{229}Th	4.51E-09	493	3.40E-09	557
^{225}Ra	4.51E-09	493	3.40E-09	557
^{225}Ac	4.51E-09	493	3.40E-09	557
Nickel	1.25E-02	9,814	8.41E-03	10,840
Phenanthrene	5.40E-05	10,500	3.63E-05	10,800
^{239}Pu	5.67E-07	10,200	3.46E-07	11,960
^{99}Tc	1.14E-03	2,213	7.48E-04	2,463
^{230}Th^{1}	3.99E-50	10,000	0.00E+00	10,000
^{234}U	4.90E-05	5,162	3.48E-05	5,953
^{230}Th	2.08E-06	5,162	1.83E-06	5,953
^{226}Ra	1.36E-06	5,162	1.19E-06	5,953

Note:

BOLD type denotes constituents remaining after screening and run with MEPAS

Italic type denotes daughter products resulting from constituents listed in bold

Table 5.31. (continued)

	Plant Fence		Property Boundary	
Constituent	Max Conc. (mg/L)(pCi/L)	Time (yr)	Max Conc. (mg/L)(pCi/L)	Time (yr)
^{235}U	2.04E-06	5,163	1.32E-06	5,951
^{231}*Th*	2.04E-06	5,163	1.32E-06	5,951
^{231}*Pa*	2.10E-07	5,163	1.56E-07	5,951
^{227}*Ac*	2.09E-07	5,163	1.55E-07	5,951
^{227}*Th*	2.09E-07	5,163	1.55E-07	5,951
^{223}*Ra*	2.09E-07	5,163	1.55E-07	5,951
^{238}U	9.37E-05	5,163	6.67E-05	5,951
^{234}*Th*	9.37E-05	5,163	6.67E-05	5,951
^{234}*U*	1.36E-06	5,163	1.12E-06	5,951
^{230}*Th*	3.13E-08	5,163	2.96E-08	5,951
^{226}*Ra*	1.46E-08	5,163	1.49E-08	6,184
^{227}*Rn*	1.46E-08	5,163	1.49E-08	6,184
^{210}*Pb*	1.46E-08	5,163	1.47E-08	6,184
^{210}*Bi*	1.46E-08	5,163	1.47E-08	6,184
^{210}*Po*	1.46E-08	5,163	1.47E-08	6,184

BOLD type denotes constituents remaining after screening and run with MEPAS

Italic type denotes daughter products resulting from constituents listed in bold

[1] Did not reach maximum during model runs

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6. RESULTS OF BASELINE RISK ASSESSMENT

This section presents the results of the baseline risk assessment (BRA) conducted for WAG 6, which consisted of two parts as discussed in Vol. 3: the baseline human health risk assessment (BHHRA) and the baseline ecological risk assessment (BERA). In these assessments, information collected during the recently completed WAG 6 RI was used to characterize the baseline risks posed to human health and the environment from contact with contaminants in soil and groundwater at SWMUs 11, 26, 40, 47, and 203 and at areas surrounding the C-400 Building that are not part of any recognized SWMU. In addition, the results of fate and transport modeling (see Sect. 5) were used to estimate the baseline risks posed to human health and the environment through contact with media impacted by contaminants migrating from the various sources in WAG 6. (Note: "baseline" risks are those that may be present now or in the future in the absence of corrective or remedial actions.)

To facilitate data aggregation and to focus results on specific areas, risk estimates were derived for the nine sectors defined in Sect. 1. The sectors and their definitions are as follows:

- Sector 1–the area under the C-400 Building
- Sector 2–the area to the northeast of the C-400 Building; sector contains SWMU 40
- Sector 3–the area to the east of the C-400 Building; sector does not contain a SWMU associated with WAG 6
- Sector 4–the area to the southeast of the C-400 Building; sector contains SWMU 11
- Sector 5–the area to the southwest of the C-400 Building; sector does not contain a SWMU associated with WAG 6
- Sector 6–the area to the west of the C-400 Building; sector contains SWMU 47
- Sector 7–the area to the northwest of the C-400 Building; sector contains SWMU 203
- Sector 8–the area to the far north and far northwest of the C-400 Building; sector contains SWMU 26
- Sector 9–the area to the far east and far northeast of the C-400 Building; sector does not contain a SWMU associated with WAG 6

Consistent with regulatory requirements and agreements contained in the approved human health risk assessment methods document (DOE 1996), the BHHRA was used to evaluate scenarios that encompass current use and several hypothetical future uses of the WAG 6 area and areas to which contaminants from WAG 6 may migrate. The scenarios assessed in Vol. 3 are as follows.

- Current on-site industrial—direct contact with surface soil (soil found 0 to 1 ft bgs)
- Future on-site industrial—direct contact with surface soil at and use of groundwater drawn from aquifers below the WAG 6 area Future on-site excavation scenario—direct contact with surface and subsurface soil (soil found 0 to 16 ft bgs)
- Future on-site recreational user—consumption of game exposed to contaminated surface soil
- Future off-site recreational user—direct contact with surface water impacted by contaminants migrating from sources and consumption of game exposed to this surface water
- Future on-site rural resident—direct contact with surface soil at and use of groundwater drawn from aquifers below the WAG 6 area, including consumption of vegetables that were hypothesized to be raised in this area.
- Future off-site rural resident—use in the home of groundwater drawn from the RGA at the DOE property boundary

Also consistent with regulatory guidance and the strategy for the ecological risk assessment of source units (DOE 1993), the BERA was used to evaluate risks under both current and potential future conditions to several nonhuman receptors that may come into contact with contaminated media at or migrating from sources in the WAG 6 area. In the BERA, as with the BHHRA, information collected during the recently completed RI and from the fate and transport information in Sect. 5 was used. (Note: because the fate and transport information indicated that surface migration of contaminants from WAG 6 to creeks surrounding PGDP is not significant, a quantitative assessment of risks from surface migration to these creeks is not included in this discussion or in Vol. 3.)

6.1 CONCLUSIONS

For all nine sectors of the WAG 6 area, the cumulative human health excess lifetime cancer risk (ELCR) and systemic toxicity exceed the accepted standards of KDEP and EPA for one or more scenarios when assessed using default exposure parameters. The scenarios for which risk exceeds *de minimis* levels (i.e.; a cumulative ELCR of 1×10^{-6} or a cumulative hazard index of 1) are summarized in Table 6.1. This information is taken from the risk summary tables (Tables 6.2 through 6.11) located at the end of this section, which present the cumulative risk values for each scenario, the COCs, and the pathways of concern.

Because the WAG 6 area is located in the heavily industrialized portion of PGDP, the BERA project team concluded during problem formulation that it would not be appropriate to derive risk estimates for impacts to nonhuman receptors exposed to contamination in the WAG 6 area under current conditions. However, in an analysis to assess potential impacts to nonhuman receptors exposed to contaminants in surface soil in the future, if the industrial infrastructure were removed, and to estimate the potential impact of surface migration of contaminated media, several contaminants in surface soil were found to be at concentrations greater than those derived from ecological benchmarks for protection of nonhuman receptors. Table 6.12 summarizes these chemicals of potential ecological concern (COPECs).

6.2 OBSERVATIONS

Observations of the BHHRA and the BERA are presented here. Note: the observations from the BHHRA focus on the industrial use, the current and most plausible future land uses for the WAG 6 area, whereas the observations of the BERA focus on the potential risks to nonhuman receptors. Please see Vol. 3 for more extensive discussions of each of the observations presented below.

6.2.1 Observations of the Baseline Human Health Risk Assessment

- The use of the provisional lead reference doses (RfDs) provided by KDEP results in total hazard indices that exceed 1000 for those locations where the maximum detected concentration of lead in soil exceeded its background concentration and for the use of groundwater at the WAG 6 area. However, when this provisional value is not included in the risk characterization, total hazard indices are markedly reduced. (Note: because the risks calculated using the provisional lead RfDs are so uncertain, none of the observations presented in this section after this discussion or in Tables 6.2 through 6.11 take into account the quantitative contribution from lead. Therefore, the reader must carefully examine the individual uncertainties to determine if the reported results reflect or do not reflect the inclusion of lead as a chemical of potential concern.) Due to the uncertainty in the results using the provisional lead RfDs, a better understanding of the risks presented by lead may be gained by comparing the representative exposure concentrations of lead in soil and groundwater to screening levels from KDEP and EPA. In these comparisons (see Exhibit 1.44 in Vol. 3), the concentrations of lead in RGA and McNairy Formation groundwater are seen to exceed both the KDEP and EPA screening levels. However, the representative exposure concentrations of lead in surface and subsurface soil never exceed either screening level. Also, it should be noted that the results of EPA's Integrated Exposure Uptake Biokinetic lead model do indicate that the concentrations of lead in groundwater may be unacceptable (see App. G of Vol. 3).

- The dermal contact with soil exposure route poses considerable risk, primarily from contact with metals (predominantly beryllium) in soil. In fact, for all land use scenarios evaluated, the systemic toxicity and the ELCR posed through the soil dermal exposure route exceed those posed through the soil ingestion route. As illustrated in Sect. 1.6.2.4 of Vol. 3, this is a direct result of using dermal absorption factors (ABS values) that exceed gastrointestinal absorption values and may be too conservative. This observation indicates that the risk estimates from the dermal exposure route may be unrealistic and may overstate the real risk posed by this route of exposure. Although chemical-specific ABS values were used when available, default ABS values were used for most chemicals because chemical-specific values are lacking. Chemical-specific ABS values were available for PCBs, cadmium, and carbon disulfide and were used in this BHHRA. Remedial decisions based on the dermal contact with soil exposure route should be carefully considered in light of the uncertainty associated with risk from this exposure route.

- The current use scenario, industrial use, has risk that is unacceptable at each sector, except Sector 1 where contact with surface soil is not possible, and throughout the WAG 6 area when assessed using KDEP default exposure parameters. At each location, the pathway driving systemic toxicity and ELCR is dermal contact with soil. The primary contaminants driving systemic toxicity and ELCR within this pathway are metals, chiefly beryllium, and PAHs for all locations.

- The risk associated with the most plausible future land use scenario, industrial use, is unacceptable at each location, except Sector 1 where contact with surface soil is not possible. As discussed in the BHHRA, the future industrial land use scenario is identical to the current industrial land use scenario except that in the future scenario, use of RGA and McNairy Formation groundwater is also evaluated. The addition of groundwater as a medium of exposure adds significantly to the risk for this scenario. If groundwater contribution is removed from the risk totals, the pathway driving systemic toxicity and ELCR is dermal contact with soil. As with the current industrial user, the primary contaminants driving systemic toxicity and ELCR within this pathway are metals, chiefly beryllium, and PAHs for all locations.

- Risks from use of groundwater drawn from both the RGA and the McNairy Formation exceed *de minimis* levels for all scenarios. For the RGA (excluding lead as a metal), the contaminants driving the ELCR were TCE, vinyl chloride, and ^{210}Pb, and the contaminants driving systemic toxicity were iron and TCE. For the McNairy Formation (excluding lead as a metal), the contaminants driving the ELCR were arsenic and ^{210}Pb, and the contaminants driving systemic toxicity were arsenic and iron. (See Section 1.6.1.1 in Volume 3a for additional discussion of risk from ^{210}Pb.)

- Unlike other assessments that have been performed for PGDP, where the inhalation of VOAs and particulates emitted from the soil exposure route has not been a pathway of concern, in this assessment this exposure route is a pathway of concern for the excavation worker for Sectors 4 and 5 and the entire WAG 6 area. The contaminant driving risk within this pathway and scenario combination at these locations is vinyl chloride.

- Of the analytes migrating from sources in WAG 6 soil and groundwater, the COCs determined using risk estimates for future residential groundwater users are 1,1-dichloroethene; 1,2-dichloroethene; 2,4-dinitrotoluene; carbon tetrachloride; n-nitroso-di-n-propylamine; tetrachloroethene; *trans*-1,2-dichloroethene; trichloroethene; vinyl chloride; antimony; copper; iron; and manganese.. There are no radionuclide COCs migrating from the WAG 6 area based upon risk estimates derived from the fate and transport modeling discussed in Sect. 5. However, ^{99}Tc was not modeled and was assumed (without quantitation) to be a COC.

6.2.2 Observations of the Baseline Ecological Risk Assessment

- Ten non-radionuclide COPECs (9 inorganics and PCBs) exceeded benchmarks for at least one receptor group. The inorganics were aluminum, arsenic, cadmium, chromium, iron, thallium, uranium, vanadium, and zinc. Of these, aluminum, iron, vanadium, and zinc were near background levels. Aluminum is unlikely to be a concern in the WAG 6 area, as the maximum aluminum concentration in any of the sectors was only 1.4 times background. Similarly, iron, vanadium, and zinc were near background levels (maximums of 1.3 times, 1.1 times, and 1.7 times background, respectively). Cadmium was of concern only for plants in Sector 6 and may have been related to a hot spot rather than a sectorwide concern. Arsenic was a concern only for shrews and plants in Sector 6. Chromium was of potential concern in all sectors except Sector 1. (No COPECs were identified for Sector 1 because the location is covered by the C-400 Building.) Thallium resulted in low exceedances (maximum hazard quotient of 1.5) for plants in Sectors 3 and 5. Uranium resulted in plant exceedances in all sectors except 1 and 4. PCBs were a concern only for shrews and mice in Sector 3. While individuals in Sector 3 may be at risk from exposure to PCBs, population-level risks across a broader area appear unlikely given the lack of risk from PCBs in other sectors.

- Estimated doses from exposure to radionuclides in soil were below recommended dose rate limits for all receptors in all sectors. Therefore, no unacceptable risks are expected from exposure to radionuclides.

- Uncertainty concerning the future condition, the bioavailability of various metals (e.g., aluminum at all sites was only slightly elevated above background), and use of only one line of evidence [comparison of exposures to Lowest Observed Adverse Effects Levels (LOAELs)] may have led to an overestimate of potential future ecological risks.

- A summary of analytes of potential ecological concern and receptors potentially at risk, should future exposures occur, is presented in Table 6.12. Additional discussion of these results is presented in Sect. 2 of Vol. 3.

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Table 6.1. Scenarios for which human health risk exceeds *de minimis* levels

		Location (Sector Number)								
Scenairo	**WAG 6**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Results for ELCR										
Current Industrial Worker	X	–	X	X	X	X	X	X	X	X
Future Industrial Worker		–	X	X	X	X	X	X	X	X
Exposure to Soil	X									
Exposure to Water[a]	X									
Future Excavation Worker	X	X	X	X	X	X	X	X	X	X
Future Recreational User	X	–	–	X	–	X	X	–	X	–
Future On-site Resident		–	X	X	X	X	X	X	X	X
Exposure to Soil	X									
Exposure to Water[a]	X									
Results for systemic toxicity[b]										
Current Industrial Worker	X	–	–	–	–	X	X	X	–	X
Future Industrial Worker		–	–	–	–	X	X	X	–	X
Exposure to Soil	X									
Exposure to Water[a]	X									
Future Excavation Worker	X	X	X	–	X	X	X	X	X	X
Future Recreational User	–	–	–	–	–	–	–	–	–	–
Future On-site Resident		–	X	X	X	X	X	X	X	X
Exposure to Soil	X									
Exposure to Water[a]	X									

[a] In the BHHRA, the risk from exposure to water was assessed on a WAG 6 area basis; therefore, these risks are not summed with those from exposure to soil. Additionally, in the BHHRA, risks associated with use of water drawn from the RGA were assessed separately from risks associated with use of water drawn from the McNairy Formation. The value reported here is for use of water drawn from the RGA.

[b] For the future recreational user and the future on-site resident scenarios, the results for child exposure are presented.

Notes: Scenarios in which risk exceeded *de minimis* levels are marked with an "X". Scenarios in which risk did not exceed *de minimis* levels are marked with a "–".

Table 6.2. Summary of human health risk characterization for WAG 6 without lead as a COPC

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI[a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Current industrial worker at current concentrations (soil only)	3.3×10^{-4}	Arsenic	5	Ingestion of soil	3	1.8	Aluminum	7	Dermal contact with soil	98
		Beryllium	28	Dermal contact with soil	95		Antimony	17		
		PAHs	65	External exposure to soil	2		Arsenic	5		
		PCBs	<1				Chromium	14		
		Cesium-137	1				Iron	29		
		Neptunium-237	<1				Vanadium	23		
		Uranium-238	<1							
Future industrial worker at current concentrations (RGA groundwater only)	2.7×10^{-3}	Arsenic	6	Ingestion of groundwater	85	37.7	Aluminum	1	Ingestion of groundwater	82
		Beryllium	8	Dermal contact with groundwater	8		Antimony	1	Dermal contact with groundwater	16
		1,1-Dichloroethene	1				Arsenic	3		
		Carbon tetrachloride	2	Inhalation while showering	7		Chromium	<1	Inhalation while showering	2
		Chloroform	<1				Iron	34		
		N-nitroso-di-n-propylamine	<1				Manganese	2		
		Tetrachloroethene	<1				Nitrate	<1		
		Trichloroethene	20				Vanadium	<1		
		Vinyl chloride	37				Carbon tetrachloride	5		
		Americium-241	<1				Trichloroehtene	49		
		Cesium-137	<1				*cis*-1,2-Dichloroethene	1		
		Lead-210	24							
		Neptunium-237	<1							
		Technetium-99	<1							
		Thorium-228	<1							
		Uranium-238	<1							

[a] Total ELCR and total HI columns reflect values from Tables 1.68 to 1.77 of Appendix A in Volume 3 without lead included.

Notes:

NA = ELCR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.

NE = Land use scenario not of concern.

Table 6.2. (continued)

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI[a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future industrial worker at current concentrations (McNairy Formation groundwater only)	4.5×10^{-3}	Arsenic	31	Ingestion of groundwater	98	20.6	Aluminum	4	Ingestion of groundwater	94
		Beryllium	4	Dermal contact with groundwater	1		Arsenic	42	Dermal contact with groundwater	6
		1,1-Dichloroethene	<1				Chromium	3		
		Bromodichloromethane	<1	Inhalation while showering	<1		Iron	35		
		Chloroform	<1				Manganese	2		
		Dibromochloromethane	<1				Vanadium	9		
		Tetrachloroethene	<1				Zinc	1		
		Trichloroethene	<1				Di-N-octylphthalate	1		
		Vinyl chloride	2							
		Cesium-137	<1							
		Lead -210	59							
		Lead-212	<1							
		Neptunium-237	<1							
		Plutonium-239	<1							
		Potassium-40	<1							
		Technetium-99	<1							
		Thorium-228	<1							
		Thorium-234	2							
		Uranium-235	<1							
Future industrial worker at current concentrations (soil only)	3.3×10^{-4}	Arsenic	5	Ingestion of soil	3	1.84	Aluminum	7	Dermal contact with soil	98
		Beryllium	28	Dermal contact with soil	95		Antimony	17		
		PAHs	65	External exposure to soil	2		Arsenic	5		
		PCBs	<1				Chromium	14		
		Cesium-137	1				Iron	29		
		Neptunium-237	<1				Vanadium	23		
		Uranium-238	<1							

[a] Total ELCR and total HI columns reflect values from Tables 1.68 to 1.77 of Appendix A in Volume 3 without lead included.

Notes:

NA = ELCR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.

NE = Land use scenario not of concern.

Table 6.2. (continued)

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI[a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future child rural resident at current concentrations (McNairy Formation groundwater only)	NA	NA	NA	NA	NA	224	Aluminum	4	Ingestion of groundwater	58
							Arsenic	44	Dermal contact with groundwater	2
							Barium	<1		
							Beryllium	<1	Consumption of vegetables	40
							Cadmium	<1	Inhalation from household use	<1
							Chromium	3		
							Cobalt	<1		
							Iron	36		
							Manganese	1		
							Nickel	<1		
							Selenium	<1		
							Vanadium	8		
							Zinc	2		
							1,1-Dichloroethene	<1		
							1,2-Dchloroethane	<1		
							Chloroform	<1		
							Di-N-octylphthalate	<1		
							Tetrachloroethene	<1		
							Trichloroethene	<1		
							cis-1,2-Dichlroethene	<1		

[a] Total ELCR and total HI columns reflect values from Tables 1.68 to 1.77 of Appendix A in Volume 3 without lead included.

Notes:

NA = ELCR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.

NE = Land use scenario not of concern.

Table 6.2. (continued)

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI[a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future adult rural resident at current concentrations (McNairy Formation groundwater only)	3.5×10^{-2}	Arsenic	33	Ingestion of groundwater	57	84.4	Aluminum	4	Ingestion of groundwater	64
		Beryllium	3	Dermal contact with groundwater	<1		Arsenic	44	Dermal contact with groundwater	2
		1,1-Dichloroethene	3				Barium	<1		
		1,2-Dichloroethane	<1	Inhalation while showering	<1		Cadmium	<1	Consumption of vegetables	34
		Bis(2-ethylhexyl)phthalate	<1	Consumption of vegetables	40		Chromium	3		
		Bromodichloromethane	<1				Iron	36		
		Chloroform	<1				Manganese	1		
		Dibromochloromethane	<1				Nickel	<1		
		Tetrachloroethene	<1				Selenium	<1		
		Trichloroethene	<1				Vanadium	8		
		Vinyl chloride	6				Zinc	2		
		Actinium-228	<1				Di-N-octylphthalate	<1		
		Cesium-137	<1				Trichloroethene	<1		
		Lead-210	43							
		Lead-212	<1							
		Neptunium-237	<1							
		Plutonium-239	<1							
		Potassium-40	<1							
		Technetium-99	10							
		Thorium-228	<1							
		Thorium-230	<1							
		Thorium-234	1							
		Uranium-234	<1							
		Uranium-235	<1							
		Uranium-238	<1							

[a] Total ELCR and total HI columns reflect values from Tables 1.68 to 1.77 of Appendix A in Volume 3 without lead included.

Notes:

NA = ELCR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.

NE = Land use scenario not of concern.

Table 6.2. (continued)

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI[a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future child rural resident at current concentrations (RGA groundwater only)	NA	NA	NA	NA	NA	475	Aluminum	1	Ingestion of groundwater	44
							Antimony	<1	Dermal contact with groundwater	<1
							Arsenic	2		
							Barium	<1	Consumption of vegetables	41
							Beryllium	<1	Inhalation while showering	<1
							Cadmium	<1	Inhalation from household use	10
							Chromium	<1		
							Cobalt	<1		
							Copper	<1		
							Iron	30		
							Manganese	1		
							Nickel	<1		
							Nitrate	<1		
							Silver	<1		
							Uranium	<1		
							Vanadium	<1		
							Zinc	<1		
							1,1-Dichloroethene	<1		
							Carbon tetrachloride	14		
							Chloroform	<1		
							Di-N-octylphthalate	<1		
							Tetrachloroethene	<1		
							Toluene	<1		
							Trichloroethene	46		
							cis-1,2-Dichloroethene	1		
							trans-1,2-Dichloroethene	<1		

[a] Total ELCR and total HI columns reflect values from Tables 1.68 to 1.77 of Appendix A in Volume 3 without lead included.

Notes:

NA = ELCR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.

NE = Land use scenario not of concern.

Table 6.2. (continued)

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI[a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future adult rural resident at current concentrations (RGA groundwater only)	6.4×10^{-2}	Arsenic	2	Ingestion of groundwater	17	169	Aluminum	1	Ingestion of groundwater	52
		Beryllium	2	Dermal contact with groundwater	<1		Antimony	<1	Dermal contact with groundwater	5
		1,1-Dichloroethene	1	Inhalation while showering	1		Arsenic	2	Consumption of vegetables	37
		Bromodichloromethane	<1	Consumption of vegetables	69		Barium	<1	Inhalation while showering	<1
		Carbon tetrachloride	<1				Cadmium	<1	Inhalation from household use	6
		Chloroform	<1				Chromium	<1		
		N-nitroso-di-n-propylamine	<1				Copper	<1		
		Tetrachloroethene	<1				Iron	32		
		Trichloroethene	12				Manganese	1		
		Vinyl chloride	30				Nickel	<1		
		Americium-241	<1				Nitrate	<1		
		Cesium-137	<1				Silver	<1		
		Lead-210	6				Vanadium	<1		
		Neptunium-237	<1				Zinc	<1		
		Technetium-99	45				Carbon tetrachloride	10		
		Thorium-228	<1				Chloroform	<1		
		Thorium-230	<1				Tetrachloroethene	<1		
		Uranium-234	<1				Trichloroethene	48		
		Uranium-238	<1				*cis*-1,2-Dichloroethene	1		
							trans-1,2-Dichloroethene	<1		
Future child rural resident at current concentrations (soil only)	NA	NA	NA	NA	NA	89.6	Aluminum	7	Ingestion of surface soil	1
							Antimony	5	Dermal contact with soil	12
							Arsenic	19	Consumption of vegetables	87
							Beryllium	<1		
							Cadmium	<1		
							Chromium	4		
							Iron	40		
							Uranium	9		
							Vanadium	5		
							Zinc	<1		
							PAHs	<1		
							PCBs	9		

[a] Total ELCR and total HI columns reflect values from Tables 1.68 to 1.77 of Appendix A in Volume 3 without lead included.

Notes:

NA = ELCR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.

NE = Land use scenario not of concern.

Table 6.2. (continued)

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI[a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future adult rural resident at current concentrations (soil only)	3.3×10^{-4}	Arsenic	14	Ingestion of soil	<1	26.9	Aluminum	7	Ingestion of soil	<1
		Beryllium	4	Dermal contact with soil	7		Antimony	5	Dermal contact with soil	8
		PAHs	77	Consumption of vegetables	92		Arsenic	20	Consumption of vegetables	92
		PCBs	2	External exposure	<1		Cadmium	<1		
		Cesium-137	<1				Chromium	4		
		Neptunium-237	<1				Iron	41		
		Uranium-234	<1				Uranium	9		
		Uranium-235	<1				Vanadium	4		
		Uranium-238	<1				PCBs	9		
							PAHs	<1		
Future child recreational user at current concentrations (soil only)	NA	NA	NA	NA	NA	<0.1	NE	NE	NE	NE
Future teen recreational user at current concentrations (soil only)	NA	NA	NA	NA	NA	0.1	NE	NE	NE	NE
Future adult recreational user at current concentrations (soil only)	1.1×10^{-4}	PAHs	96	Ingestion of deer	69	<0.1	NE	NE	NE	NE
		PCBs	3	Ingestion of rabbit	22					
				Ingestion of quail	9					
Future excavation worker at current concentrations (soil only)	2.6×10^{-3}	Arsenic	<1	Ingestion of soil	2	3.25	Aluminum	3	Ingestion of soil	12
		Beryllium	3	Dermal contact with soil	7		Antimony	3	Dermal contact with soil	88
		1,1-Dichloroethene	<1	Inhalation of vapors and particulates	91		Chromium	5		
		PAHs	2				Iron	14		
		N-nitroso-di-n-propylamine	<1	External exposure to soil	<1		Manganese	6		
		PCBs	<1				Vanadium	10		
		Trichloroethene	2				Trichloroethene	50		
		Vinyl chloride	91							
		Cesium-137	<1							
		Neptunium-237	<1							
		Uranium-238	<1							

[a] Total ELCR and total HI columns reflect values from Tables 1.68 to 1.77 of Appendix A in Volume 3 without lead included.

Notes:

NA = ELCR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.

NE = Land use scenario not of concern.

Table 6.3. Summary of human health risk characterization for Sector 1 without lead as a COPC

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Current industrial worker at current concentrations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Future industrial worker at current concentrations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Future child rural resident at current concentrations	NA	NA	NA	NA	NA	NE	NE	NE	NE	NE
Future adult rural resident at current concentrations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	NE	NE	NE	NE	NE
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	NE	NE	NE	NE	NE
Future adult recreational user at current concentrations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Future excavation worker at current concentrations	2.0×10^{-6}	Cesium-137	83	External exposure	93	1.7	Antimony Chromium Iron	34 21 45	Ingestion of soil Dermal contact with soil	14 86

[a] Total ELCR and total HI columns reflect values from Tables 1.68 to 1.77 of Appendix A in Volume 3 without lead included. Also, values in this table do not include contributions from water ingestion or use because groundwater was evaluated on an area basis. For risks due to water use, see Table 6.2.

Notes:
NA = ELCR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.
NE = Land use scenario not of concern or land use not evaluated because contact with medium is not possible as long as C-400 Building exists.

Table 6.4. Summary of human health risk characterization for Sector 2 without lead as a COPC

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI[a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Current industrial worker at current concentrations	1.7×10^{-5}	PAHs Uranium-238	88 9	Dermal contact with soil External exposure	86 10	0.4	NE	NE	NE	NE
Future industrial worker at current concentrations	1.7×10^{-5}	PAHs Uranium-238	88 9	Dermal contact with soil External exposure	86 10	0.4	NE	NE	NE	NE
Future child rural resident at current concentrations	NA	NA	NA	NA	NA	10.6	Chromium Uranium Zinc	55 40 4	Ingestion of soil Dermal contact with soil Consumption of vegetables	1 23 76
Future adult rural resident at current concentrations	8.1×10^{-4}	PAHs PCBs Uranium-235 Uranium-238	84 5 <1 11	Ingestion of soil Dermal contact with soil External exposure	<1 5 93	3.0	Chromium Uranium Zinc	51 44 5	Dermal contact with soil Consumption of vegetables	16 84
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	<0.1	NE	NE	NE	NE
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	<0.1	NE	NE	NE	NE
Future adult recreational user at current concentrations	4.7×10^{-7}	NE	NE	NE	NE	<0.1	NE	NE	NE	NE
Future excavation worker at current concentrations	1.6×10^{-4}	Arsenic Beryllium PAHs N-nitroso-di-n-propylamine Uranium-234 Uranium-238	6 44 35 10 <1 3	Ingestion of soil Dermal contact with soil External exposure	17 81 2	1.2	Aluminum Antimony Chromium Manganese Vanadium	10 20 14 16 28	Ingestion of soil Dermal contact with soil	11 88

[a] Total ELCR and total HI columns reflect values from Tables 1.68 to 1.77 of Appendix A in Volume 3 without lead included. Also, values in this table do not include contributions from water ingestion or use because groundwater was evaluated on an area basis. For risks due to water use, see Table 6.2.

Notes:

NA = ELCR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.

NE = Land use scenario not of concern.

Table 6.5. Summary of human health risk characterization for Sector 3 without lead as a COC

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI [a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Current industrial worker at current concentrations	8.5×10^{-5}	PAHs	52	Ingestion of soil	8	0.3	NE	NE	NE	NE
		PCBs	37	Dermal contact with soil	82					
		Cesium-137	6	External exposure	10					
		Uranium-238	3							
Future industrial worker at current concentrations	8.5×10^{-5}	PAHs	52	Ingestion of soil	8	0.3	NE	NE	NE	NE
		PCBs	37	Dermal contact with soil	82					
		Cesium-137	6	External exposure	10					
		Uranium-238	3							
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	<0.1	NE	NE	NE	NE
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	<0.1	NE	NE	NE	NE
Future adult recreational user at current concentrations	5.9×10^{-6}	PAHs	16	Ingestion of rabbit	86	<0.1	NE	NE	NE	NE
		PCBs	84							
Future child rural resident at current concentrations	NA	NA	NA	NA	NA	13.3	Cadmium	5	Ingestion of soil	1
							Chromium	31	Dermal contact with soil	14
							Uranium	63	Ingestion of vegetables	84
Future adult rural resident at current concentrations	8.2×10^{-3}	PAHs	25	Ingestion of soil	<i	4.0	Cadmium	5	Dermal contact with soil	9
		PCBs	72	Dermal contact with soil	3		Chromium	28	Ingestion of vegetables	90
		Cesium-137	<1	Ingestion of vegetables	96		Uranium	66		
		Neptunium-237	<1	External exposure	<1					
		Uranium-235	<1							
		Uranium-238	2							
Future excavation worker at current concentrations	1.2×10^{-4}	Arsenic	12	Ingestion of soil	15	0.7	NE	NE	NE	NE
		Beryllium	61	Dermal contact with soil	83					
		PAHs	21	External exposure	2					
		PCBs	2							
		Cesium-137	1							

[a] Total ELCR and total HI columns reflect values from Tables 1.68 to 1.77 of Appendix A in Volume 3 without lead included. Also, the values in this table do not include contributions from water ingestion or use because groundwater was evaluated on an area basis. For risks due to water use, see Table 6.2.

Notes:

NA = ELCR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.

NE = Land use scenario not of concern.

Table 6.6. Summary of human health risk characterization for Sector 4 (including SWMU 11) without lead as a COC

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI[a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Current industrial worker at current concentrations	3.7×10^{-6}	PAHs	95	Dermal contact with soil	96	1.0	None	-	None	--
Future industrial worker at current concentrations	3.7×10^{-6}	PAHs	95	Dermal contact with soil	96	1.0	None	-	None	--
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	<0.1	NE	NE	NE	NE
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	<0.1	NE	NE	NE	NE
Future adult recreational user at current concentrations	1.5×10^{-7}	NE	NE	NE	NE	<0.1	NE	NE	NE	NE
Future child rural resident at current concentrations	NA	NA	NA	NA	NA	24.8	Aluminum	59	Ingestion of soil	1
							Antimony	9	Dermal contact with soil	23
							Cadmium	2	Ingestion of vegetables	76
							Chromium	29		
Future adult rural resident at current concentrations	1.9×10^{-4}	PAHs	83	Ingestion of soil	<1	7.1	Aluminum	62	Dermal contact with soil	16
		PCBs	17	Dermal contact with soil	5		Antimony	9	Ingestion of vegetables	84
				Ingestion of vegetables	94		Cadmium	2		
							Chromium	27		
Future excavation worker at current concentrations	3.6×10^{-4}	Arsenic	3	Ingestion of soil	6	1.6	Aluminum	7	Ingestion of soil	15
		Beryllium	22	Dermal contact with soil	32		Antimony	6	Dermal contact with soil	85
		1,1-Dichloroethene	1	Inhalation of vapors and particles	62		Chromium	10		
		PAHs	11				Iron	29		
		PCBs	<1	External exposure	<1		Manganese	12		
		Trichloroethene	<1				Vanadium	20		
		Vinyl chloride	61							
		Cesium-137	<1							

[a] Total ELCR and total HI columns reflect values from Tables 1.68 to 1.77 of Appendix A in Volume 3 without lead included. Also, the values in this table do not include contributions from water ingestion or use because groundwater was evaluated on an area basis. For risks due to water use, see Table 6.2.

Notes:
NA = ELCR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.
NE = Land use scenario not of concern.

Table 6.7. Summary of human health risk characterization for Sector 5 without lead as a COC

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI [a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Current industrial worker at current concentrations	4×10^{-4}	Beryllium	31	Ingestion of soil	3	1.8	Antimony	22	Dermal contact with soil	1.7
		PAHs	68	Dermal contact with soil	96		Chromium	26		
		Uranium-238	1	External exposure	2		Iron	47		
Future industrial worker at current concentrations	4×10^{-4}	Beryllium	31	Ingestion of soil	3	1.8	Antimony	22	Dermal contact with soil	1.7
		PAHs	68	Dermal contact with soil	96		Chromium	26		
		Uranium-238	1	External exposure	2		Iron	47		
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	<0.1	NE	NE	NE	NE
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	<0.1	NE	NE	NE	NE
Future adult recreational user at current concentrations	2.5×10^{-5}	PAHs	99	Ingestion of deer	9	<0.1	NE	NE	NE	NE
				Ingestion of rabbit	82					
				Ingestion of quail	9					
Future child rural resident at current concentrations	NA	NA	NA	NA	NA	85.5	Antimony	7	Ingestion of soil	1
							Beryllium	<1	Dermal contact with soil	11
							Cadmium	<1	Ingestion of vegetables	87
							Chromium	8		
							Iron	66		
							Uranium	18		
							Zinc	<1		
							PAHs	<1		
Future adult rural resident at current concentrations	1.4×10^{-2}	Beryllium	5	Ingestion of soil	<1	25.6	Antimony	6	Ingestion of soil	<1
		PAHs	92	Dermal contact with soil	8		Cadmium	<1	Dermal contact with soil	8
		PCBs	<1	Ingestion of vegetables	91		Chromium	7	Ingestion of vegetables	92
		Neptunium-237	<1	External exposure	<1		Iron	67		
		Uranium-235	<1				Uranium	19		
		Uranium-238	<1							
Future excavation worker at current concentrations	2.3×10^{-4}	Arsenic	6	Ingestion of soil	12	1.6	Aluminum	7	Ingestion of soil	15
		Beryllium	34	Dermal contact with soil	60		Antimony	15	Dermal contact with soil	86
		PAHs	21	Inhalation of particulates and vapors	27		Chromium	9		
		N-nitrosodi-n-propylamine	10				Iron	30		
		Vinyl chloride	27	External exposure	1		Manganese	12		
		Cesium-137	<1				Vanadium	18		

[a] Total ELCR and total HI columns reflect values from Tables 1.68 to 1.77 of Appendix A in Volume 3 without lead included. Also, the values in this table do not include contributions from water ingestion or use because groundwater was evaluated on an area basis. For risks due to water use, see Table 6.2

Notes:

NA = ELCR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.

NE = Land use scenario not of concern.

Table 6.8. Summary of human health risk characterization for Sector 6 (including SWMU 47) without lead as a COC

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI[a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Current industrial worker at current concentrations	1.1×10^{-3}	Arsenic	3	Ingestion of soil	3	1.2	Aluminum	13	Dermal contact with soil	95
		Beryllium	9	Dermal contact with soil	95		Antimony	22		
		PAHs	86	External exposure	1		Arsenic	20		
		PCBs	<1				Chromium	22		
		Cesium-137	<1				PCBs	13		
		Neptunium-237	<1							
		Uranium-238	<1							
Future industrial worker at current concentrations	1.1×10^{-3}	Arsenic	3	Ingestion of soil	3	1.2	Aluminum	13	Dermal contact with soil	95
		Beryllium	9	Dermal contact with soil	95		Antimony	22		
		PAHs	86	External exposure	1		Arsenic	20		
		PCBs	<1				Chromium	22		
		Cesium-137	<1				PCBs	13		
		Neptunium-237	<1							
		Uranium-238	<1							
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	<0.1	NE	NE	NE	NE
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	<0.1	NE	NE	NE	NE
Future adult recreational user at current concentrations	3.2×10^{-5}	PAHs	98	Ingestion of deer	9	<0.1	NE	NE	NE	NE
				Ingestion of rabbit	81					
				Ingestion of quail	10					
Future child rural resident at current concentrations	NA	NA	NA	NA	NA	119	Aluminum	6	Ingestion of soil	1
							Antimony	3	Dermal contact with soil	6
							Arsenic	36	Ingestion of vegetables	93
							Beryllium	<1		
							Cadmium	1		
							Chromium	3		
							Uranium	9		
							Zinc	<1		
							PAHs	2		
							PCBs	38		

[a] Total ELCR and total HI columns reflect values from Tables 1.68 to 1.77 of Appendix A in Volume 3 without lead included. Also, the values in this table do not include contributions from water ingestion or use because groundwater was evaluated on an area basis. For risks due to water use, see Table 6.2.

Notes:

NA = ELCR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.

NE = Land use scenario not of concern.

Table 6.8. (continued)

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI[a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future adult rural resident at current concentrations	5.0×10^{-2}	Arsenic	9	Ingestion of soil	<1	36.4	Aluminum	6	Ingestion of soil	<1
		Beryllium	1	Dermal contact with soil	6		Antimony	3	Dermal contact with soil	4
		PAHs	88	Ingestion of vegetables	93		Arsenic	36	Ingestion of vegetables	96
		PCBs	1	External exposure	<1		Cadmium	1		
		Cesium-137	<1				Chromium	3		
		Neptunium-237	<1				Uranium	10		
		Uranium-234	<1				PAHs	2		
		Uranium-235	<1				PCBs	38		
		Uranium-238	<1							
Future excavation worker at current concentrations	5.5×10^{-4}	Arsenic	31	Ingestion of soil	29	2.1	Aluminum	7	Ingestion of soil	31
		Beryllium	14	Dermal contact with soil	69		Antimony	8	Dermal contact with soil	69
		PAHs	52	External exposure	2		Arsenic	50		
		PCBs	<1				Chromium	9		
		Cesium-137	<1				Vanadium	16		
		Neptunium-237	<1							
		Uranium-234	<1							
		Uranium-238	1							

[a] Total ELCR and total HI columns reflect values from Tables 1.68 to 1.77 of Appendix A in Volume 3 without lead included. Also, the values in this table do not include contributions from water ingestion or use because groundwater was evaluated on an area basis. For risks due to water use, see Table 6.2.

Notes:

NA = ELCR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.

NE = Land use scenario not of concern.

Table 6.9. Summary of human health risk characterization for Sector 7 (including SWMU 203) without lead as a COC

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI[a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Current industrial worker at current concentrations	1.2×10^{-4}	Beryllium	85	Dermal contact with soil	98	1.64	Antimony	6	Dermal contact with soil	99
		PAHs	14				Chromium	26		
		Uranium-238	<1				Iron	36		
							Vanadium	30		
Future industrial worker at current concentrations	1.2×10^{-4}	Beryllium	85	Dermal contact with soil	98	1.64	Antimony	6	Dermal contact with soil	99
		PAHs	14				Chromium	26		
		Uranium-238	<1				Iron	36		
							Vanadium	30		
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	<0.1	NE	NE	NE	NE
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	<0.1	NE	NE	NE	NE
Future adult recreational user at current concentrations	5.1×10^{-7}	NE	NE	NE		<0.1	NE	NE	NE	NE
Future child rural resident at current concentrations	NA	NA	NA	NA	NA	53.6	Antimony	3	Ingestion of soil	1
							Beryllium	<1	Dermal contact with soil	18
							Cadmium	<1	Ingestion of vegetables	81
							Chromium	12		
							Iron	75		
							Vanadium	9		
Future adult rural resident at current concentrations	1.5×10^{-3}	Beryllium	41	Ingestion of soil	<1	15.7	Antimony	3	Dermal contact with soil	12
		PAHs	55	Dermal contact with soil	24		Chromium	10	Ingestion of vegetables	88
		Uranium-238	4	Ingestion of vegetables	75		Iron	78		
				External exposure	<1		Vanadium	8		
Future excavation worker at current concentrations	1.3×10^{-4}	Arsenic	8	Ingestion of soil	13	1.7	Aluminum	7	Ingestion of soil	14
		Beryllium	62	Dermal contact with soil	86		Antimony	12	Dermal contact with soil	86
		PAHs	12	External exposure	1		Chromium	11		
		n-nitroso-di-n-propylamine	14				Iron	29		
		PCBs	1				Manganese	12		
		Uranium-238	<1				Vanadium	22		

[a] Total ELCR and total HI columns reflect values from Tables 1.68 to 1.77 of Appendix A in Volume 3 without lead included. Also, the values in this table do not include contributions from water ingestion or use because groundwater was evaluated on an area basis. For risks due to water use, see Table 6.2.

Notes:

NA = ELCR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.

NE = Land use scenario not of concern.

Table 6.10. Summary of human health risk characterization for Sector 8 (including SWMU 26) without lead as a COC

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI [a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Current industrial worker at current concentrations	2.4×10^{-4}	Beryllium	93	Ingestion of soil	<1	1.0	NE	NE	NE	NE
		PAHs	5	Dermal contact with soil	98					
		Neptunium-237	<1	External exposure	1					
		Uranium-238	<1							
Future industrial worker at current concentrations	2.4×10^{-4}	Beryllium	93	Ingestion of soil	<1	1.0	NE	NE	NE	NE
		PAHs	5	Dermal contact with soil	98					
		Neptunium-237	<1	External exposure	1					
		Uranium-238	<1							
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	<0.1	NE	NE	NE	NE
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	<0.1	NE	NE	NE	NE
Future adult recreational user at current concentrations	1.3×10^{-6}	None	--	None	--	<0.1	NE	NE	NE	NE
Future child rural resident at current concentrations	NA	NA	NA	NA	NA	18.8	Antimony	29	Ingestion of soil	<1
							Beryllium	2	Dermal contact with soil	31
							Cadmium	3	Ingestion of vegetable	68
							Chromium	44		
							Uranium	23		
Future adult rural resident at current concentrations	2.1×10^{-3}	Beryllium	63	Ingestion of soil	<1	5.2	Antimony	28	Dermal contact with soil	22
		PAHs	29	Dermal contact with soil	34		Cadmium	3	Ingestion of vegetables	78
		Neptunium-237	3	Ingestion of vegetables	65		Chromium	42		
		Uranium-235	4	External exposure	<1		Uranium	25		
		Uranium-238	<1							
Future excavation worker at current concentrations	2.3×10^{-4}	Arsenic	8	Ingestion of soil	27	4.4	Aluminum	3	Ingestion of soil	32
		Beryllium	38	Dermal contact with soil	45		Antimony	6	Dermal contact with soil	68
		PAHs	6	External exposure	28		Arsenic	2		
		Cesium-137	11				Chromium	12		
		Neptunium-237	5				Copper	8		
		Plutonium-239	<1				Iron	15		
		Technetium-99	7				Manganese	7		
		Uranium-234	7				Nickel	30		
		Uranium-235	<1				Uranium	17		
		Uranium-238	22							

[a] Total ELCR and total HI columns reflect values from Tables 1.68 to 1.77 of Appendix A in Volume 3 without lead included. Also, the values in this table do not include contributions from water ingestion or use because groundwater was evaluated on an area basis. For risks due to water use, see Table 6.2.

Notes:

NA = ELCR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.

NE = Land use scenario not of concern.

None = No COCs or POCs selected because all chemical-specific or pathway-specific risk values were below the benchmarks used for selection.

Table 6.11. Summary of human health risk characterization for Sector 9 without lead as a COC

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI [a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Current industrial worker at current concentrations	5.2×10^{-6}	PAHs	34	Dermal contact with soil	33	1.3	Aluminum	23	Dermal contact with soil	99
		Uranium-238	53	External exposure	62		Antimony	59		
							Chromium	17		
Future industrial worker at current concentrations	5.2×10^{-6}	PAHs	34	Dermal contact with soil	33	1.3	Aluminum	23	Dermal contact with soil	99
		Uranium-238	53	External exposure	62		Antimony	59		
							Chromium	17		
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	<0.1	NE	NE	NE	NE
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	<0.1	NE	NE	NE	NE
Future adult recreational user at current concentrations	2.7×10^{-7}	NE	NE	NE	NE	<0.1	NE	NE	NE	NE
Future child rural resident at current concentrations	NA	NA	NA	NA	NA	36.8	Aluminum	39	Dermal contact with soil	21
							Antimony	31	Ingestion of vegetables	78
							Chromium	9		
							Uranium	22		
Future adult rural resident at current concentrations	2.7×10^{-4}	PAHs	31	Ingestion of soil	<1	10.7	Aluminum	40	Dermal contact with soil	14
		PCBs	<1	Dermal contact with soil	2		Antimony	28	Ingestion of vegetables	86
		Uranium-235	4	Ingestion of vegetables	89		Chromium	8		
		Uranium-238	63	External exposure	8		Uranium	24		
Future excavation worker at current concentrations	1.5×10^{-4}	Arsenic	18	Ingestion of soil	12	2.7	Aluminum	5	Ingestion of soil	14
		Beryllium	74	Dermal contact with soil	85		Antimony	19	Dermal contact with soil	86
		PAHs	4	External exposure	2		Arsenic	6		
		Cesium-137	1				Chromium	7		
		Uranium-238	1				Iron	24		
							Manganese	18		
							Vanadium	19		

[a] Total ELCR and total HI columns reflect values from Tables 1.68 to 1.77 of Appendix A in Volume 3 without lead included. Also, the values in this table do not include contributions from water ingestion or use because groundwater was evaluated on an area basis. For risks due to water use, see Table 6.2.

Notes:

NA = ELCR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.

NE = Land use scenario not of concern.

Table 6.12. Summary of chemicals[a] posing potential future risks[b] to nonhuman receptors

Location	Receptor	Aluminum	Arsenic	Cadmium	Chromium	Iron	Thallium	Uranium	Vanadium	Zinc	PCBs
		Chemicals of Potential Ecological Concern									
Sector 1	Not evaluated because all soil is under the C-400 Building.										
Sector 2	Microbe	-	-		1.9	-		nb	-	-	nb
	Plant	-	-		19.3	nb		2.8	-	1.4	-
	Worm	nb	-		48.3	nb		nb	nb	-	nb
	Shrew	-	-		3.4	nb		-	-	-	-
	Mouse	-	-		-	nb		-	-	-	-
	Deer	-	-		-	nb		-	-	-	-
Sector 3	Microbe	-	-	-	1.8	-	nb	nb	-	-	nb
	Plant	-	-	-	18.2	nb	1.2	5.5	-	-	-
	Worm	nb	-	-	45.5	nb	nb	nb	nb	-	nb
	Shrew	-	-	-	2.4	nb	-	-	-	-	37.1
	Mouse	-	-	-	-	nb	-	-	-	-	5.2
	Deer	-	-	-	-	nb	-	-	-	-	-
Sector 4	Microbe	23.7	-	-	2.4	-		nb	-	-	nb
	Plant	284.0	-	-	23.6	nb		-	-	-	-
	Worm	nb	-	-	59.0	nb		nb	nb	-	nb
	Shrew	92.1	-	-	4.2	nb		-	-	-	-
	Mouse	8.8	-	-	-	nb		-	-	-	-
	Deer	6.0	-	-	-	nb		-	-	-	-
Sector 5	Microbe	-	-	-	4.8	185.0	nb	nb	-	1.1	nb
	Plant	-	-	-	48.0	nb	1.5	10.0	-	2.2	-
	Worm	nb	-	-	120.0	nb	nb	nb	nb	-	nb
	Shrew	-	-	-	3.7	nb	-	-	-	-	-
	Mouse	-	-	-	-	nb	-	-	-	-	-
	Deer	-	-	-	-	nb	-	-	-	-	-
Sector 6	Microbe	29.5	-	-	4.6	-		nb	-	-	nb
	Plant	354.0	4.5	1.4	45.8	nb		23.8	-	1.5	-
	Worm	nb	-	-	115.0	nb		nb	nb	-	nb
	Shrew	47.2	5.0	-	2.2	nb		-	-	-	-
	Mouse	4.5	-	-	-	nb		-	-	-	-
	Deer	3.1	-	-	-	nb		-	-	-	-
Sector 7	Microbe	-	-	-	6.6	153.0		nb	2.1	-	
	Plant	-	-	-	66.0	nb		1.9	21.2	-	
	Worm	nb	-	-	165.0	nb		nb	nb	-	
	Shrew	-	-	-	3.6	nb		-	-	-	
	Mouse	-	-	-	-	nb		-	-	-	
	Deer	-	-	-	-	nb		-	-	-	
Sector 8	Microbe	-	-	-	2.7	-	nb	nb	-	-	
	Plant	-	-	-	27.2	nb	-	2.8	-	-	
	Worm	nb	-	-	68.0	nb	nb	nb	nb	-	
	Shrew	-	-	-	4.8	nb	-	-	-	-	
	Mouse	-	-	-	-	nb	-	-	-	-	
	Deer	-	-	-	-	nb	-	-	-	-	
Sector 9	Microbe	26.2	-		1.7	-		nb	-	-	nb
	Plant	314.0	-		16.8	-		5.2	-	-	-
	Worm	nb	-		42.0	-		nb	nb	-	nb
	Shrew	89.6	-		1.8	-		-	-	-	-
	Mouse	8.6	-		-	-		-	-	-	-
	Deer	5.8	-		-	-		-	-	-	-

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[a] The table includes values for those chemicals with a maximum concentration above background (or no background available) and a hazard quotient > 1.0. Analytes for which ecological benchmarks were not available are shown in Tables 2.1 and 2.2 of Appendix A in Volume 3.

[b] Values in this table are hazard quotients estimated by dividing the dose to the receptor by the benchmark dose.

Notes:

PCBs = polychlorinated biphenyls

"–" indicates that the hazard quotient for the chemical/receptor combination did not exceed 1 or the chemical was below background in that sector.

"nb" indicates no toxicological benchmark was available for the chemical/receptor combination.

A blank cell indicates that the analyte was not detected in surface soil in the sector.

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7. CONCLUSIONS

This section presents the conclusions of the WAG 6 RI. The significant findings for each sector are described below in the Contaminant Nature and Extent section for WAG 6 soils. Groundwater systems are treated as OUs, and the nature and extent of contaminants for each system are described on a WAG 6 sitewide basis. Estimates of risk derived from the baseline risk assessment are presented for individual sectors as well as for the whole of WAG 6.

7.1 CONTAMINANT NATURE AND EXTENT

Sector 1. Two discrete zones of high TCE concentration were discovered between 12 and 48 ft bgs near the base of the UCRS vadose zone. These contaminant zones may be related to a widespread zone of TCE contamination present at the southeast side of the building at SWMU 11 in Sector 4.

Sector 2. A small area of surface soil between the C-402 Building and the C-400 Building was found to be impacted with moderate concentrations of several common PAH compounds. The source of the identified PAHs is unknown. A second area of contamination is associated with the floor drain collection line on the outer perimeter of the C-400 Building. Low levels of several radionuclides were detected between 15 and 40 ft bgs along this line.

A third area of contamination is associated with the C-403 Neutralization Tank (SWMU 40) and the former storm sewer. Subsurface soil collected adjacent to the tank backfill at a depth of 30 ft bgs was found to be impacted by several radionuclides. Elevated radioactivity and metals levels were also detected at several locations along the former storm sewer utility line that connects the C-403 Neutralization Tank to the C-410 HF Lagoon.

Sector 3. Elevated TCE levels were detected from near the surface to the total depth of 41 ft. The high TCE concentrations appear to be associated with a point source release near the C-400 Building. Elevated concentrations of arsenic, SVOAs, and PCBs were found in the surface and shallow subsurface soil. The widespread occurrences of low concentrations of VOAs, SVOAs, PCBs, and radionuclides in the Sector 3 soil may represent minor surface spills, isolated releases from the buried utilities that pass through the sector, and/or the results of daily plantwide operations. Elevated levels of PCBs in surface soil may be due to the explosion of a transformer that was located on the southwest side of the C-410 Building.

Sector 4. This sector contains a widespread TCE-impacted area located primarily between the C-400 Building and 11th Street and north of Tennessee Avenue. In that area, a large zone of shallow soil contains greater than 225,000 µg/kg TCE, indicating that the chlorinated solvent is present as a DNAPL in the UCRS soil.

TCE and its degradation products were found in soils throughout the UCRS. The highest concentrations were found below the backfilled excavation at SWMU 11 (8,208,600 µg/kg) and adjacent to the TCE off-loading pumps (11,055,000 µg/kg). The off-loading pumps were used to transfer TCE between tank cars and the TCE day storage tank and probably represent the primary release source in Sector 4. The high TCE concentrations in the shallow zone of soil that extends south of the off-loading pumps are probably due to migration of TCE along the bedding material of the utility line that runs north-south through Sector 4.

Sector 5. A release of a considerable quantity of TCE in the immediate vicinity of Boring 400-015 on the southwest corner of the C-400 Building appears to have occurred. Several subsurface samples collected from the UCRS between 4 and 48 ft bgs contained low to high concentrations of TCE and its degradation products.

A second area of contamination is located in the northwestern portion of Sector 5 (west of the C-400 Building). This area has been impacted by numerous constituents, including VOAs, SVOAs, metals (antimony and arsenic), and radionuclides. The building perimeter drain collection line or a sewer line leading from the C-400 Building may have been the source of releases that resulted in this multi-contaminant impact.

Sector 6. A small area of surface soil located immediately below the end of a pipe that protrudes from the C-400 Building toward the berm where the Technetium Storage Tank (SWMU 47) previously stood was found to be impacted with high concentrations of several PAH compounds and radionuclides. The berm, which was formerly paved with asphalt, also contained elevated levels of PAHs and radionuclides in the surface soils. TCE was reported at high levels between 4.5 and 29.5 ft bgs adjacent to the berm.

Sector 7. Surface and subsurface soils of Sector 7 showed contamination from mercury and ^{99}Tc, which is probably related to spills and releases of C-400 Building effluent to the Waste Discard Sump. TCE also was detected at 4500 μg/kg at a depth of 28.5 to 32 ft bgs. A subsurface spill or release from the northwest corner of the C-400 Building may have been the source of the TCE contamination.

Sector 8. The pipeline (SWMU 26) sludge sample was found to contain high levels of copper, nickel, and chromium, and high activities of several isotopes: ^{99}Tc, ^{230}Th, ^{239}Pu, ^{137}Cs, ^{237}Np, ^{234}U, and ^{238}U. In soil samples collected directly beneath the pipeline, nickel, copper, and chromium were found in high concentrations, and high activities of ^{99}Tc, ^{234}U, and ^{238}U were also found.

Sector 9. Sector 9 exhibits no areas of target contaminant impacts.

7.1.1 Upper Continental Recharge System

The UCRS is not an aquifer in the vicinity of WAG 6. Locally, at WAG 6, the UCRS potentiometric surface slopes in toward the C-400 Building from all directions. This flow pattern is probably the result of two conditions: (1) the depression of the water table created by the large building and paved areas around the C-400 Building, which prevents surficial recharge and (2) a discontinuity below the C-400 Building in the semi-confining clay layer that separates the UCRS and RGA intervals. Groundwater percolates downward through contaminated UCRS soil and serves as an effective carrier for the migration of contaminants from shallow subsurface soils into the RGA.

TCE was the most commonly detected contaminant and was reported in all samples in which VOAs were detected. The highest TCE concentrations are found on the southeast side of the C-400 Building in close association with the Trichloroethene Leak Site (SWMU 11) in Sector 4. The slight increase in TCE content of the UCRS water documented north of the C-400 Building is probably due to the same source that impacted UCRS soils adjacent to the Waste Discard Sump (SWMU 203) in Sector 7.

Based on the observed TCE content in UCRS groundwater, DNAPL probably exists at the southeast corner of the C-400 Building beneath the Trichloroethene Leak Site (SWMU 11), the former location of the TCE off-loading pumps, and extends beneath the southeast corner of the C-400 Building.

7.1.2 Regional Gravel Aquifer

TCE distribution in the RGA indicates that one or more sources of the TCE are located in the C-400 Area. The axis of the TCE contaminant plume trends southeast-northwest across the WAG 6 site and is consistent with the location and orientation of the Northwest Plume. The concentrations of TCE decrease rapidly away from the C-400 Building to less than 1000 µg/L TCE to the west, south, and east. Based on the high concentration of TCE in the RGA, TCE is probably present as DNAPL in the RGA over a large portion of the WAG 6 area.

A second area of high TCE concentrations in the RGA is present at the northwest corner of the C-400 Building below Sector 7 near SWMU 203. The high TCE content in the RGA observed in this area could be due to the commingling of TCE that has migrated downgradient from Sectors 4 and 5 with TCE contamination derived from a separate smaller source located in the vicinity of Sector 7 (SWMU 203).

Thirteen metals were reported at concentrations that exceed the PGDP background screening levels. Elevated nickel levels occur along the northwest side of the C-400 Building. Barium and manganese each exceed background levels in 50 of the 161 samples analyzed for both metals. No trend in the metals distribution was observed that would suggest that the C-400 Building is a source of metals detected in the RGA.

Technetium-99 was the most commonly detected isotope. The highest reported activity was 17,000 pCi/L in the 85-ft grab water sample from Boring 400-034 located north of the C-400 Building and south of the North-South Diversion Ditch. A source for the observed ^{99}Tc in the RGA was probably located somewhere near the north end of the C-400 Building, perhaps near SWMU 40 in Sector 2 (the C-403 Neutralization Tank) or more likely the North-South Diversion Ditch. The lack of ^{99}Tc in upgradient RGA groundwater (e.g., around SWMU 11) decreases the possibility that the ^{99}Tc is derived from this upgradient TCE source.

7.1.3 McNairy Flow System

TCE was the most widely detected VOA in the McNairy groundwater samples. The TCE content of all McNairy groundwater samples collected more than 40 ft below the top of the formation was below 5 µg/L. The maximum ^{99}Tc activity of 1.82 pCi/L is significantly below the maximum ^{99}Tc activity (113 pCi/L) detected in the overlying RGA groundwater. Migration of TCE and ^{99}Tc into the McNairy Formation is limited only to porous zones on the upper McNairy that are in direct contact with overlying RGA sediments that contain high TCE content.

7.2 FATE AND TRANSPORT MODELING

Contaminant fate and transport modeling was performed that is specific to each WAG 6 sector's conceptual model. Soil and groundwater are the primary media for contaminant migration at this site. Therefore, the RI focused on fate and transport modeling of the groundwater pathway. Air and surface water are not considered important pathways for contaminant transport from WAG 6.

Groundwater contaminant transport near the C-400 Area occurs principally by dissolution of sources present in the UCRS soils and transport by advective and dispersive mechanisms to the RGA. This occurs as rainwater infiltrates from the surface and percolates through the source of contamination and surrounding soil into the saturated zone. Lateral transport pathways follow groundwater flow paths established by the regional groundwater gradient.

Lower levels of contamination, decreasing with depth, are found in the underlying McNairy Formation. This contamination is attributed, in part, to limited advective transport across the RGA/McNairy boundary. Dispersion, particularly diffusion, may also be an important transport mechanism.

Another source release mechanism present beneath the WAG 6 area is DNAPL dissolution. WAG 6 is the site of several distinct releases of TCE, a DNAPL. Because of the chemical's greater density and high interfacial tension with water, DNAPL movement is gravity-driven, largely independent of groundwater flow, and is often directed by subtle textural changes in the soils. Where spill volumes are sufficiently large, DNAPLs penetrate to significant depths. As dissolution removes residual DNAPL ganglia left along the DNAPL flow path, secondary sources of contamination result where the DNAPL is pooled above zones of lower permeability.

The C-400 Building is the source of a large DNAPL zone in the RGA. This zone is the principal source of a large dissolved-phase plume of TCE known as the Northwest Plume and is a contributor to another large dissolved-phase plume of TCE known as the Northeast Plume. Monitoring results from the previous 10 years define the contaminant levels and trends resulting from the DNAPL zone. Over the period of monitoring, the annual average TCE level has remained constant. Furthermore, the extent of the Northwest Plume (2.5 miles) suggests that the plume has been developed fully for decades. Thus, transport modeling is not required for assessing current or future levels of contaminant exposure originating from the DNAPL zone.

The Northwest Plume also contains a zone of high ^{99}Tc activity that originates from the WAG 6 vicinity. Soil and groundwater samples from the RI show the ^{99}Tc source to be downgradient of the primary TCE DNAPL zone, but the exact location of the ^{99}Tc source remains undefined. Over the 10-plus-year record of contaminant levels in the Northwest Plume, ^{99}Tc activity has declined from 3000 pCi/L to approximately 1000 pCi/L in the core of the plume at the PGDP security fence. This trend of declining ^{99}Tc levels is well defined. As with the DNAPL zone, modeling is unnecessary for assessing current or future levels of contaminant exposure originating from the ^{99}Tc source.

7.3 BASELINE RISK ASSESSMENT

For all nine sectors and the C-400 Area, the ELCR and systemic toxicity exceed the accepted standards of KDEP and EPA for one or more scenarios when assessed using default exposure parameters. The scenarios for which risk exceeds *de minimis* levels (i.e., a cumulative ELCR of 1×10^{-6} or a cumulative hazard index of 1) are summarized in Table 7.1.

Because the WAG 6 area is located in the heavily industrialized portion of PGDP, the BERA project team concluded during problem formulation that it would not be appropriate to derive risk estimates for impacts to nonhuman receptors exposed to contamination in the WAG 6 area under current conditions. However, in an analysis to assess potential impacts to nonhuman receptors exposed to contaminants in surface soil in the future, if the industrial infrastructure were removed, and to estimate the potential impact of surface migration of contaminated media, several contaminants in surface soil were found to be at concentrations greater than those derived from ecological benchmarks for protection of nonhuman receptors.

7.3.1 Observations of Baseline Human Health Risk Assessment

- The use of the provisional lead reference doses (RfDs) provided by KDEP results in total hazard indices that exceed 1000 for those locations where the maximum detected concentration of lead in soil exceeded its background concentration and for the use of groundwater at the WAG 6 area. However, when this provisional value is not included in the risk characterization, total hazard indices are markedly reduced. Due to the uncertainty in the results using the provisional lead RfDs, a better understanding of the risks presented by lead may be gained by comparing the representative exposure concentrations of lead in soil and groundwater to screening levels from KDEP and EPA. In these comparisons, the concentrations of lead in RGA and McNairy Formation groundwater are found to exceed both the KDEP and EPA screening levels. However, the representative exposure concentrations of lead in surface and subsurface soil never exceed either screening level. Also, it should be noted that the results of EPA's Integrated Exposure Uptake Biokinetic lead model do indicate that the concentrations of lead in groundwater may be unacceptable.

- The dermal contact with soil exposure route poses considerable risk, primarily from contact with metals (predominantly beryllium) in soil. In fact, for all land use scenarios evaluated, the systemic toxicity and the ELCR posed through the soil dermal exposure route exceed those posed through the soil ingestion route. This is a direct result of using dermal absorption factors (ABS values) that exceed gastrointestinal absorption values and may be too conservative. This observation indicates that the risk estimates from the dermal exposure route may be unrealistic and may overstate the real risk posed by this route of exposure. However, remedial decisions based on the dermal contact with soil exposure route should be carefully considered in light of the uncertainty associated with risk from this exposure route.

- The current use scenario, industrial use, has risk that is unacceptable at each sector, except Sector 1 where contact with surface soil is not possible, and throughout the WAG 6 area when assessed using KDEP default exposure parameters. At each location, the pathway driving systemic toxicity and ELCR is dermal contact with soil. The primary contaminants driving systemic toxicity and ELCR within this pathway are metals, chiefly beryllium, and PAHs for all locations.

- The risk associated with the most plausible future land use scenario, industrial use, is unacceptable at each location, except Sector 1 where contact with surface soil is not possible. The primary contaminants driving systemic toxicity and ELCR within this pathway are metals, chiefly beryllium, and PAHs for all locations.

- Risks from use of groundwater drawn from both the RGA and the McNairy Formation exceed *de minimis* levels for all scenarios. For the RGA (excluding lead as a metal), the contaminants driving the ELCR were TCE, vinyl chloride, and ^{210}Pb, and the contaminants driving systemic toxicity were iron and TCE. For the McNairy Formation (excluding lead as a metal), the contaminants driving the ELCR were arsenic and ^{210}Pb, and the contaminants driving systemic toxicity were arsenic and iron.

- Inhalation of VOAs and particulates emitted from the soil exposure route is a pathway of concern for the excavation worker for Sectors 4 and 5 and the entire WAG 6 area. The contaminant driving risk within this pathway and scenario combination at these locations is vinyl chloride.

- Of the analytes migrating from sources in WAG 6 soil and groundwater, the COCs determined using risk estimates for future residential groundwater users are 1,1-dichloroethene; 1,2-dichloroethene; 2,4-dinitrotoluene; carbon tetrachloride; n-nitroso-di-n-propylamine; tetrachloroethene; *trans*-1,2-dichloroethene; trichloroethene; vinyl chloride; antimony; copper; iron; and manganese. There are no radionuclide COCs migrating from the WAG 6 area based upon risk estimates derived from the fate and transport modeling. However, ^{99}Tc was not modeled and was assumed (without quantitation) to be a COC.

7.3.2 Observations of Baseline Ecological Risk Assessment

- Ten nonradionuclide COPECs (9 inorganics and PCBs) exceeded benchmarks for at least one receptor group. The inorganics were aluminum, arsenic, cadmium, chromium, iron, thallium, uranium, vanadium, and zinc. Of these, aluminum, iron, vanadium, and zinc were near background levels and unlikely to be a concern in the WAG 6 area. Cadmium was of concern only for plants in Sector 6 and may have been related to a "hot spot" rather than a sector-wide concern. Arsenic was a concern only for shrews and plants in Sector 6. Chromium was of potential concern in all sectors except Sector 1. (No COPECs were identified for Sector 1 because the location is covered by the C-400 Building.) Thallium resulted in low exceedances for plants in Sectors 3 and 5. Uranium resulted in plant exceedances in all sectors except 1 and 4. PCBs were a concern only for shrews and mice in Sector 3. While individuals in Sector 3 may be at risk from exposure to PCBs, population-level risks across a broader area appear unlikely given the lack of risk from PCBs in other sectors.

- Estimated doses from exposure to radionuclides in soil were below recommended dose rate limits for all receptors in all sectors. Therefore, no unacceptable risks are expected from exposure to radionuclides. Uncertainty concerning the future condition, the bioavailability of various metals, and use of only one line of evidence may have led to an overestimate of potential future ecological risks.

Table 7.1. Scenarios for which human health risk exceeds *de minimis* levels

	Location (Sector Number)									
Scenario	**WAG 6**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Results for ELCR:										
Current Industrial Worker	X	–	X	X	X	X	X	X	X	X
Future Industrial Worker		–	X	X	X	X	X	X	X	X
Exposure to Soil	X									
Exposure to Water	X									
Future Excavation Worker	X	X	X	X	X	X	X	X	X	X
Future Recreational User	X	–	–	X	–	X	X	–	X	–
Future On-site Resident		–	X	X	X	X	X	X	X	X
Exposure to Soil	X									
Exposure to Water	X									
Results for systemic toxicity:										
Current Industrial Worker	X	–	–	–	–	X	X	X	–	X
Future Industrial Worker		–	–	–	–	X	X	X	–	X
Exposure to Soil	X									
Exposure to Water	X									
Future Excavation Worker	X	X	X	–	X	X	X	X	X	X
Future Recreational User	–	–	–	–	–	–	–	–	–	–
Future On-site Resident		–	X	X	X	X	X	X	X	X
Exposure to Soil	X									
Exposure to Water	X									

Notes:
Scenarios for which risk exceeded *de minimis* levels are marked with an "X".
Scenarios for which risk did not exceed *de minimis* levels are marked with a "–".

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