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Department of Energy

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JUN 16 1998

DOE-0894 -98

Mr. James A. Saric, Remedial Project Manager
U.S. Environmental Protection Agency
Region V-SRF-5J
77 West Jackson Boulevard
Chicago, Illinois 60604-3590

Mr. Tom Schneider, Project Manager
Ohio Environmental Protection Agency
401 East 5th Street
Dayton, Ohio 45402-2911

Dear Mr. Saric and Mr. Schneider:

TRANSMITTAL OF DRAFT RESPONSES TO THE U.S. ENVIRONMENTAL PROTECTION AGENCY AND OHIO ENVIRONMENTAL PROTECTION AGENCY COMMENTS ON THE DRAFT FINAL SITEWIDE EXCAVATION PLAN

Reference: (1) Letter from Saric to Reising, "Draft Final Sitewide Excavation Plan," dated May 29, 1998.

(2) Letter from Schneider to Reising, "DOE-FEMP Comments: Sitewide Excavation Plan," dated June 9, 1998.

The purpose of this letter is to transmit, for your review and approval, draft responses to the U.S. Environmental Protection Agency (U.S. EPA) and Ohio Environmental Protection Agency (OEPA) comments (References (1) and (2)) on the draft final Sitewide Excavation Plan (SEP). The enclosed draft responses were also provided to the U.S. EPA and OEPA through electronic mail on Friday, June 12, 1998. Also, enclosed with this transmittal is the revised Appendix G, based on the U.S. EPA and OEPA comments and informal discussions.

As indicated in Reference (1), the major issues identified by the U.S. EPA during your review of the draft SEP were adequately addressed by the Fernald Environmental Management Project (FEMP) in the submittal of the draft final SEP. Similarly, the OEPA recommended, Reference (2), that detailed responses and changes be submitted in response to their comments in order for the OEPA to conditionally approve the document. Therefore, the purpose of this transmittal is to provide the requested additional clarification on the issues identified by the U.S. EPA and OPEA and, hopefully, obtain your conditional approval to (1) proceed with the initiation of excavation in the Southern Waste Units (pending U.S. EPA and OEPA approval of the other critical documents) and (2) initiate the process for issuing the final SEP, which should eliminate the need for multiple revisions of the SEP at this final stage.

If you have any questions regarding the path forward for the SEP discussed above and/or the enclosed responses, please contact Robert Janke at (513) 648-3124.

Sincerely,

Johnny Reising

FEMP:R.J. Janke

Johnny W. Reising
Fernald Remedial Action
Project Manager

Enclosures: As Stated

cc w/encs:

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RESPONSES TO OHIO EPA COMMENTS ON THE APRIL 1998 DRAFT OF THE "SITEWIDE EXCAVATION PLAN"

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

1) Commenting Organization: Ohio EPA Commentor: HSI GeoTrans, Inc.
Section #: Pg #: Line #: Code: G
Original Comment #:
Comment: Though the document has been substantially revised and is stated to be in draft final status, many grammatical and typographic errors were detected during this review.

Response: DOE concurs that there are several grammatical and typographical errors in several of the Appendices, many of which are attributed to word processing codes embedded in the Word Perfect April 1997 document converted from the July 1997 Microsoft Word version of the SEP. This problem will be resolved for the final version of the SEP.

Action: Eliminate the embedded Microsoft Word commands present in the Word Perfect files.

2) Commenting Organization: Ohio EPA Commentor: OFFO
Section #: 1.0 Pg #: 1-1 Line #: 26 Code: E
Original Comment #:
Comment: The sentence references nine remediation areas, whereas the rest of the document refers to ten remediation areas. Please revise to improve consistency.

Response: Agree. There are 10 Remediation Areas, the 10th being off-site areas.

Action: Line 26 on page 1-1 will be changed to read "... into ten remediation areas, as listed ..."

3) Commenting Organization: Ohio EPA Commentor: OFFO
Section #: 1.3.2.6 Pg #: Line #: Code: C
Original Comment #:
Comment: Ohio EPA does not concur with DOE's inserted text. Ohio EPA support of the CAMU was specifically aimed a(t) management of listed wastes in the OSDF. Specifically, Ohio EPA is opposed to any storage of RCRA characteristic waste in a manner other than containerized storage in an approved RCRA storage facility.

Response: Agree. New text will be added to explain that RCRA characteristic soils, identified and excavated to meet the OU2 and OU5 ROD requirements will be containerized and placed in storage on the Plant 1 Pad (or similarly approved RCRA storage facility). The RCRA characteristic soils will not be placed in any stockpile(s) designated for above-WAC materials to be sent off site via the Waste Pit Remedial Action Project. In the future, temporary bulk storage of RCRA characteristic soils (in an approved configuration that can be approved by the OEPA) may need to be evaluated if the volume of the waste exceeds available storage capacity using containers. Note that the need for a new temporary RCRA storage facility will also be evaluated as part of the Area 3 remedial design process, considering the existing capacity and remediation schedule of the Plant 1 Pad.

Action: The following text will be inserted after line 2 on page 1-20: "RCRA characteristic soils identified and excavated to meet the OU2 and OU5 ROD requirements will be containerized and placed on an approved RCRA storage facility (Plant 1 Pad). The RCRA characteristic soils will not be placed in stockpiles designated for above-WAC materials. The need for a new temporary RCRA storage facility will be evaluated as part of the Area 3 remedial design process to replace the Plant 1 Pad after its removal. The new temporary RCRA storage facility may be designed for bulk storage of RCRA characteristic soils if the volume of the waste exceeds available storage capacity using containers."

4) Commenting Organization: Ohio EPA Commentor: OFFO
Section #: Table 1-5 Pg #: Line #: Code: C
Original Comment #:
Comment: The table should have had all the dates which changed from the previous version redlined. In future submittals, DOE must ensure that all changed text is redlined.

Response: Acknowledged. It is always DOE's intention to ensure that changed text is redlined. Unfortunately, there will be occasional omissions due to the large number of documents produced at the site.

Action: None.

5) Commenting Organization: Ohio EPA Commentor: OFFO
Section #: 2.1.2.2 Pg #: 2-8 Line #: 31-32 Code: C
Original Comment #:
Comment: Pre-excavation sampling must be aimed at ascertaining both the vertical and horizontal extent of contamination at depth. Revise the document to include the horizontal component of contamination.

Response: It is the intent of pre-excavation activities to define both the horizontal and vertical contamination, as noted in Section 3.1.3.

Action: Lines 31 and 32 on page 2-8 will be changed as follows: "... to ascertain the horizontal and vertical extent of contamination during implementation ..."

6) Commenting Organization: Ohio EPA Commentor: OFFO
Section #: 2.2.4 Pg #: 2-21 Line #: 26-29 Code: C
Original Comment #:
Comment: Ohio EPA does not concur with the proposal to use bulk storage for RCRA wastes. Ohio EPA believes the appropriate storage is in containers on the Plant 1 Pad or similarly approved RCRA storage facility.

Response: Agree. Also see response to Comment 3.

Action: Lines 26 through 28 on page 2-21 will be changed as follows: "... are shown on Figure 3-5. Excavated RCRA material will be containerized and placed on the Plant 1 Pad or an equivalent, approved RCRA storage facility. If all samples ..."

7) Commenting Organization: Ohio EPA Commentor: OFFO
Section #: 3.1.1.2 Pg #: 3-5 Line #: 1-27 Code: C
Original Comment #:
Comment: Ohio EPA does not agree with DOE's proposal to use SP 5 or 7 for storage of RCRA wastes. All above-WAC, RCRA wastes should be containerized and stored on at an approved RCRA storage facility. The document should be revised to remove all references to use of SP 5 or 7 for storage of RCRA wastes.

Response: Agree. Also see response to Comment 3.

Action: Lines 27 through 31 on page 3-4 will be changed to read: "... Operable Unit 1 remediation. If soil in a RCRA area exhibits the toxicity characteristic and overlaps with the area delineated for technetium-99 excavation, the RCRA hazardous material will be containerized and moved to an approved RCRA storage area to await a decision ..."

Lines 11 through 13 on page 3-5 will be changed to read: "... from an identified RCRA area will be containerized and removed to an approved RCRA storage area. Decisions regarding off-site treatment ..."

8) Commenting Organization: Ohio EPA Commentor: OFFO
Section #: 3.3.1.2 Pg #: 3-13 Line #: 5-8 Code: C
Original Comment #:
Comment: Ohio EPA does not agree with DOE's proposal to use SP 5 or 7 for storage of RCRA wastes. All above-WAC, RCRA wastes should be containerized and stored at an approved RCRA storage facility. The document should be revised to remove all references to use of SP 5 or 7 for storage of RCRA wastes.

Response: Agree. Also see response to Comment 3.

Action: Lines 6 through 8 on page 3-13 will be changed to read: "... the excavated technetium-99 soil will be segregated into non-treatment and treatment containers, as needed, and stored at an approved RCRA storage facility. If on-site treatment ..."

Line 14 on page 3-13 will be changed to read: "... will be excavated and segregated in containers for storage at an approved RCRA storage facility. Stabilization of this material will be required ..."

9) Commenting Organization: Ohio EPA Commentor: OFFO
Section #: 3.4.2.4 Pg #: 3-24 Line #: Code: C
Original Comment #:
Comment: Some confusion remains regarding which of the remediation areas encompasses the length of the old outfall line going to the GMR. This section references the outfall area at the GMR but not the length of the pipe. Please clarify within the document which area will include the length of the outfall line.

Response: Agree. Clarification will be provided in the following action.

Action: Lines 29 and 30 on page 3-24 will be changed as follows: "... along portions of the eastern FEMP boundary, along the length of the outfall pipeline between the FEMP and Great Miami River, and in the vicinity of ..."

Lines 6 and 7 on page 3-25 will be changed as follows: "... Area 9, Phase III is defined as the soil along the length of the outfall pipeline between the FEMP and the Great Miami River and the soil along ..."

10) Commenting Organization: Ohio EPA Commentor: OFFO
Section #: 3.4.4 Pg #: 3-26 Line #: 28 Code: c
Original Comment #:
Comment: The text states that a 90% UCL of the mean will be compared to the respective FRL to make the certification decisions. Ohio EPA Division of Hazardous Waste Management closure guidance recommends using a 95% UCL of the mean as the statistical criteria. In order to achieve closure consistent with Ohio EPA guidance a 95% UCL of the mean must be used.

Response: Agree. Text will be changed to note 95 percent UCL of the mean.

Action: Change line 28, page 3-26 to read: "... the 95 percent UCL of the mean ..."

11) Commenting Organization: Ohio EPA Commentor: OFFO
Section #: 3.4.5 Pg #: 3-27 Line #: 1-24 Code: C
Original Comment #:
Comment: There appears to be some disagreement regarding the description of Condition 2. Line 4 refers to "widespread contamination" whereas line 14 refers to "widespread variability." Regardless of the description, Ohio EPA believes CUs failing this condition require re-excavation prior to sampling.

Response: Line 14 on page 3-27 will be changed to be consistent with widespread contamination. As noted in the text of lines 15 and 16 on page 3-27, Group 1 CUs failing this condition will require excavation prior to collecting another round of samples. Lines 17 through 24 describe the options for Group 2 CUs, which are to re-excavate or resample the newly formed Group 1 CUs. However, it is not necessarily the case that widespread contamination in a Group 2 CU means every Group 1 CU formed from the Group 2 CU will have widespread contamination. Therefore, flexibility has been maintained to allow resampling of the newly formed Group 1 CUs without performing re-excavation - although at least one or more of the new Group 1 CUs will require further excavation. Regardless of whether re-excavation occurs in each Group 1 CU formed from the Group 2 CU, each newly formed Group 1 CU will be resampled and must pass the certification criteria.

Action: Line 14 on page 3-27 has been changed to read "widespread contamination," which is in agreement with line 4.

12) Commenting Organization: Ohio EPA Commentor: HSI GeoTrans, Inc.
Section #: 3 Pg #: 3-28 Line #: 13 Code: C
Original Comment #:
Comment: A strategy to address secondary COC hot spots should be developed and detailed in the SEP. The strategy should be based on 2x and 3x exceedances of the FRL and should be analogous to that discussed for the primary COCs following certification sampling.

Response: Agree. Proposed text to be added appears in action below.

Action: Lines 12 through 14 on page 3-28 will be changed to read: "... activities using real-time measurements, field instruments, and laboratory analysis of physical samples for each CU-specific primary and secondary COCs."

Insert the following paragraph on page 29 after line 3. "Secondary COC hot spots will be evaluated based on physical samples collected during the certification process. When a secondary COC concentration exceeds 2 times its FRL (Condition 3 on Figure 3-11) the hot spot associated with the secondary COC will be further delineated using a combination of field techniques, sampling, and laboratory analysis. In agreement with the hot spot criteria for primary COCs, if the area of the secondary hot spot is less than 10 m^2, measurements of the COC corresponding to the hot spot must exceed a value of three times its FRL before excavation will take place. In general, a decision on the need for further excavation of secondary COCs will be made with regulatory concurrence on a case-by-case basis."

13) Commenting Organization: Ohio EPA | Commentor: OFFO
Section #: Figure 3-11 | Pg #: | Line #: | Code: c
Original Comment #:

Comment: This flow chart outlines the hot spot implementation strategy. The first two action boxes call for an RTRAK scan to look for primary rad COC's at three times the FRL in areas of 10 square meters or greater. According to Table 4-12 of the RTRAK Applicability Study, the Minimum Detectable Concentration for uranium-238 is never smaller than 47 pCi/g (roughly 141 ppm total uranium). We conclude from this that the RTRAK is capable of detecting 3X FRL hot spots only in areas where the FRL for total uranium is 80 ppm. In the production area (FRL is 20 ppm) and in the Southern Waste Units (FRL is 3.22 pCi/g), the RTRAK will not be able to perform as required by the flow chart.

Response: This issue was discussed and resolved at the June 8, 1998 meeting between OEPA and DOE. The RTRAK scan will look directly for uranium hot spots in areas that exceed 10 m^2 when the uranium FRL is 82 mg/kg. When the uranium FRL is less than 82 mg/kg, the RTRAK scan will acquire data as total gross activity and the areas of highest total gross activity will be measured with the HPGe to establish the total gross activity measurement that corresponds to three times the uranium FRL. Excavation of the hot spot area will then take place within the area bounded by the total gross activity reading corresponding to three times the FRL.

Action: Line 18 on page 3-28 will be changed as follows: "... make the hot-spot decision. When the uranium FRL is less than 82 mg/kg, the RTRAK scan will acquire data as total gross activity and the areas of highest total gross activity will be measured with the HPGe to establish the total gross activity measurement that corresponds to three times the uranium FRL. Areas that exceed three times the FRL or areas that are contoured based on total gross activity will be scanned with the HPGe to confirm ..."

14) Commenting Organization: Ohio EPA | Commentor: OFFO
Section #: Figure 3-11 | Pg #: | Line #: | Code:
Original Comment #:

Comment: The second activity box of the flow chart states "Calculate two point (10 square meter) averages" (underlining added). Figure 4.2-1 of the Users Manual shows that at a 1.0 mph operating speed and a 4 second acquisition time the field of view is 8.8 square meters.

From this we infer that only one RTRAK read corresponds to the desired field of view (10 square meter hot spot). This appears to contradict the flow chart which calls for a two point average, which corresponds to a 17.6 square meter area.

Response: This issue was discussed and resolved at the June 8, 1998 meeting between OEPA and DOE. At this meeting, it was noted that the two point average corresponds to an area of 13.1 m^2 but 10 m^2 was retained for use because there is no difference in the whole integer result when the square root of 100/13 is compared to 100/10 (i.e., 2.8 versus 3.2). Two point averages are required if the RTRAK is to achieve a detection limit below approximately three times the uranium FRL of 82 mg/kg.

Action: None.

15) Commenting Organization: Ohio EPA Commentor: HSI GeoTrans, Inc.
Section #: 4 Pg #: 4-18 Line #: 7 Code: E
Original Comment #:
Comment: The figure reference in the text should be changed from Figure 4-5 to Figure 4-4.

Response: Agree.

Action: Figure callout on line 7 of page 4-18 will be changed to Figure 4-4.

16) Commenting Organization: Ohio EPA Commentor: HSI GeoTrans, Inc.
Section #: 4 Pg #: 4-18 Line #: 13 Code: E
Original Comment #:
Comment: The sentence that begins on this line is not complete. The preceding sentence and the sentence beginning on this line lines should be combined as follows: "There are two potential RCRA areas (i.e., potential for soil to exhibit the toxicity characteristic) in areas covered by Excavation Approach B: in Remediation Area 7..."

Response: Agree.

Action: Change line 13 on page 4-18 to read: "... covered by Excavation Approach B: in Remediation Area 7 ..."

17) Commenting Organization: Ohio EPA Commentor: OFFO
Section #: 5.1.2.2 Pg #: 5-7 Line #: 17-19 Code: C
Original Comment #:
Comment: As stated in Ohio EPA March, 1998 comments on DOE's SEP Response Package, Ohio EPA does not concur with the definition of an unpaved road. This specific topic received much discussion through the BAT determination during which it was agreed that unpaved roads would be field defined by Ohio EPA and DOE. Ohio EPA does not expect that unpaved roads will require "improvements" as part of their definition.

Response: In DOE's initial response (provided to OEPA again on June 9), it was noted that the IRDP will identify all unpaved roads on the design drawings, which OEPA reviews. It was never the intention of DOE to exclude OEPA from this process. DOE and OEPA will work together to locate and designate unpaved roads in remediation areas.

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Action: Lines 17 through 19 on page 5-7 will be changed to read: "... A predetermined and delineated area selected by OEPA and DOE for the specific purpose of vehicle traffic. Unpaved roads will appear in the IRDP on the design drawings."

18) Commenting Organization: Ohio EPA Commentor: HSI GeoTrans, Inc.
Section #: 5 Pg #: 5-16 Line #: 15 Code: E
Original Comment #:
Comment: The figure reference (Figure 2-1) on this line appears incorrect. The appropriate reference is probably to Figure 5-3.

Response: As noted on lines 15 and 16 on page 5-16, Figure 2-1 refers to Figure 2-1 in the Storm Water Pollution Prevention Plan, and not the SEP.

Action: None.

19) Commenting Organization: Ohio EPA Commentor: HSI GeoTrans, Inc.
Section #: Appendix B Pg #: B-8 Line #: 3 Code: C
Original Comment #:
Comment: The sentence beginning on this line is inconsistent with Figure B-10. According to this figure, surface water drainage from Area 4A is directed to Area 4B. The text, however, states that surface water drainage will be directed to the storm drain in the active area (Area 4A).

Response: Agree.

Action: Line 4 on page B-8 will be changed to read: "... will be directed to the active storm drain within Area 4. Haul routes ..."

20) Commenting Organization: Ohio EPA Commentor: OFFO
Section #: Appendix C Pg #: C-21 Line #: 1-9 Code: C
Original Comment #:
Comment: Ohio EPA believes the lead soil in the trap range should be excavated to the BTV of 200 ppm and has made this comment on the A1P2 IRDP. Additionally, this section discusses taking BTV samples after the borrow activities. The appropriate time for evaluating BTVs is during certification which will immediately follow treatment/excavation of the lead soils and precede borrow activities. The text should be revised to state BTVs will be evaluated during the certification process for the trap range.

Response: Agree. As noted in the edits to the A1P2 IRDP, lead soil in the trap range will be excavated to the lead BTV of 200 mg/kg.

Action: Line 1 on page C-21 will be changed to read: "... toxicity characteristic. After excavation to the lead FRL of 400 mg/kg, the soil will be evaluated against the lead BTV of 200 mg/kg during the certification process prior to soil being removed ..."

The last two sentences contained in lines 3 through 6 of page C-21 will be removed.

21) Commenting Organization: Ohio EPA Commentor: OFFO
Section #: Appendix D Pg #: Table D-3 Line #: Code: C
Original Comment #:
Comment: The table references validation pending for the data. Given the document has been in revision for approximately half a year, Ohio EPA would expect that validation is complete. Please revise the table to include validation information. Additionally, this relates to Ohio EPA comments on the previous document regard(ing) Tc-99 concentrations in trees. If the data represent non-detect values as referenced in DOE's responses the table should be revised to reflect these as non-detects.

Response: Agree. Footnotes have been added to Table D-3 which address data validation and the inclusion of non-detects within the calculation of reported average values.

Action: Table D-3 will be edited to remove the footnote stating: "Preliminary data. Validation pending." The following footnotes will be added:

"[A]The radiological data was assigned an "R" qualifier based on a calibration deficiency of the gamma spectrometers. The calibration deficiency was based on the difference in density between tree tissue (0.2 g/cc) and the calibration standard (1.15 g/cc). If the density differences were compensated for, then the radionuclide concentrations would have been lower than those reported. Analytes were not detected and the sensitivity of the measurements was well below the final soil remediation levels (FRLs). Therefore, the data are useable for determining that wood chips from site trees can be used as cover material in excavated or disturbed areas with no concern for violating soil FRLs.

[B]average values are representative of all samples within each area. Non-detects reported were used to calculate average values."

22) Commenting Organization: Ohio EPA Commentor: OFFO
Section #: Appendix E Pg #: E-9 Line #: 19 Code: C
Original Comment #:
Comment: Please include OEPA in the sentence requiring approvals for changes to the SEP.

Response: Agree.

Action: Line 19 on page E-9 will be changed to read: "... getting DOE, EPA, and OEPA approvals for SEP ..."

23) Commenting Organization: Ohio EPA Commentor: OFFO
Section #: Appendix F Pg #: F-7 Line #: 24-25 Code: C
Original Comment #:
Comment: This is probably an appropriate location to state that wood chips from clearing will only be used on-site.

Response: Agree. The text has been revised to be consistent with DOE's June 4, 1998 responses to OEPA comments 26-35.

Action: Line 25 on page F-7 will be changed to read: "... stockpiled for later use as mulch. Wood chips derived from clearing trees and brush on site will only be used on site. The stumps ..."

24) Commenting Organization: Ohio EPA Commentor: OFFO
Section #: Appendix F, F.7.1 Pg #: F-28-31 Line #: Code: C
Original Comment #:
Comment: The section should be revised to be consistent with Ohio EPA's May 13, 1998 comments on the A2P1 IRDP (comment #'s 26-35) and DOE's June 4, 1998 Responses.

Response: Agree. Changed text noted below.

Action: Lines 31 and 32 on page F-28 will be changed to read: "... general stabilization of disturbed areas by seeding or use of a crusting agent shall be performed at completion of excavation or within seven calendar days of knowing a disturbed area will be idle for more than 45 days, whichever is sooner. However, the need ..."

Lines 5 and 6 on page F-29 will be changed to read: "... areas/soil piles scheduled to be disturbed significantly within 2 years, destined for the OSDF, and/or need effective erosion control immediately. Examples ..."

Line 8 on page F-30 will be changed to read: "... offensive odor. The crusting agent shall be reapplied to eroded and bare areas as necessary, and maintained in a condition to ensure proper erosion control."

Line 21 on page F-30 will be changed to read: "... then the application rate will increase to 15 lbs pls/acre of prairie grass mix and 25 lbs pls/acre of oats."

Line 25 on page F-30 will be changed to read: "... prior to planting. The planting of buckwheat during the summer season will be followed by either interim or permanent seeding during the next seeding window. The interim ..."

Text between "accesible areas." on line 29 and "Seeding" on line 32 will be deleted.

The following sentence will be added to the end of text on line 3, page F-31: "Straw/mulch application activities are exempt from the fugitive dust control requirements."

25) Commenting Organization: Ohio EPA Commentor: OFFO
Section #: Appendix F Pg #: Figure F(.5)-1 Line #: Code: C
Original Comment #:
Comment: Ohio EPA does not concur with the proposal to use bulk storage for RCRA wastes. Ohio EPA believes the appropriate storage is in containers on the Plant 1 Pad or similarly approved RCRA storage facility.

Response: DOE cannot identify the comment raised by OEPA on Figure F.5-1. However, this comment has been addressed in other sections of the SEP. See the responses to Comments 3, 6, 7, and 8.

Action: None.

26) Commenting Organization: Ohio EPA Commentor: OFFO
Section #: Appendix G Pg #: Line #: Code: C
Original Comment #:
Comment: A strategy to address secondary COC hot spots should be developed and detailed in the SEP. The strategy should be based on 2x and 3x exceedances of the FRL and should be analogous to that discussed for the primary COCs following certification sampling.

Response: See response to Comment 12.

Action: None.

27) Commenting Organization: Ohio EPA Commentor: OFFO
Section #: Appendix G Pg #: Line #: Code: C
Original Comment #:
Comment: Consistent with Ohio EPA's comments on the A1P2 certification report, the section should be revised to state that when duplicate samples are collected the higher of the two will be used in the statistical evaluation.

Response: Appendix G will be revised to state that when duplicate samples are collected the higher of the two will be used in the statistical evaluation.

Action: The discussion on the treatment of duplicates is in Section G.2.2.

28) Commenting Organization: Ohio EPA Commentor: OFFO
Section #: Appendix G Pg #: Line #: Code: C
Original Comment #:
Comment: As discussed during review of the A1P2 Certification Report, the text should be revised to include a statement that the resulting statistic (p) from the normality test will be reported in the data tables of the Certification Report.

Response: Agree.

Action: This text has been added to G.2.2.1.

29) Commenting Organization: Ohio EPA Commentor: HSI GeoTrans, Inc.
Section #: Appendix G Pg #: G-I Line #: Code: E
Original Comment #:
Comment: The table of contents for this appendix should be revised to include the heading "G.2.4 Determination of Number of Samples for Certification."

Response: Agree.

Action: The entire appendix and table of contents have been revised.

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30) Commenting Organization: Ohio EPA Commentor: HSI GeoTrans, Inc.
Section #: Appendix G Pg #: Line #: 3 Code: G
Original Comment #:
Comment: This appendix should be revised to include a list of figures.

Response: Agree.

Action: Appendix G will be revised to include a list of figures.

31) Commenting Organization: Ohio EPA Commentor: HSI GeoTrans, Inc.
Section #: Appendix G Pg #: G-5 Line #: 17 Code: E
Original Comment #:
Comment: Revise the text from "The actual certification sample size for proposed for each CU" to "The actual certification sample size proposed for each CU."

Response: Noted.

Action: Due to extensive text revisions, this comment no longer applies. Certification sample population size is discussed in G.2.1.5.

32) Commenting Organization: Ohio EPA Commentor: HSI GeoTrans, Inc.
Section #: Appendix G Pg #: G-8 Line #: 9 Code: C
Original Comment #:
Comment: Based on the precalculation of the value *p* discussed later in this section, the definition of *p* as provided in the referenced text appears to be incorrect. It appears that *p* represents the proportion of samples that are *less than* the FRL and hence is calculated as the number of below-FRL samples divided by the total number of samples.

Response: DOE agrees that the text contained this discrepancy. However, Appendix G is being revised and will delete the test for proportions. The test for proportions as specified ($p_0 = 0.5$) is equivalent to the Sign Test. The Sign Test will replace the test for proportion in Appendix G.

Action: The Sign Text is discussed in G.2.2.3, Step 4 of G.2.3, and G.2.5.3.

33) Commenting Organization: Ohio EPA Commentor: HSI GeoTrans, Inc.
Section #: Appendix G Pg #: G-8 Line #: 12 Code: C
Original Comment #:
Comment: The equation shown resembles the large sample approximation for the sign test and as such is applicable for sample sizes of 20 and greater. The application of the test statistic equation to the relevant sample sizes (n = 12 and 16) should be justified.

Response: Noted.

Action: Appendix G is being revised and will delete the test for proportions and substitute the Sign Test (see response to Comment 32). The equation mentioned is no longer relevant. The Sign Test has exact probability tables (percentiles for the binomial for p = 0.5) available for sample populations as large as 100, as discussed in Section G.2.2.3. The test is also available in most statistical software such as Statgraghics Plus (Manugistics, Inc.) and Systat. (SPSS, Inc.).

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34) Commenting Organization: Ohio EPA Commentor: HSI GeoTrans, Inc.
Section #: Appendix G Pg #: G-8 Line #: 22 Code: E
Original Comment #:
Comment: The text should be revised from "greater than or equal to the FRL, *p*, the value of p..." to "greater than or equal to the FRL, the value of *p*..."

Response: Noted.

Action: See comment responses to Comments 32 and 33.

35) Commenting Organization: Ohio EPA Commentor: HSI GeoTrans, Inc.
Section #: Appendix G Pg #: G-12 Line #: 17-28 Code: E
Original Comment #:
Comment: The referenced text appears to be a discussion related to the test of proportions and does not appear to be germane to the topic of this paragraph (e.g., Step 1 dealing with the proportion of non-detects). The text should either be deleted or re-written such that its relevance is justified.

Response: Agree.

Action: Section G.2.3 has been revised to reflect the process represented in Figure G-1, Selection Procedure for the Certification Statistical Analysis Method.

36) Commenting Organization: Ohio EPA Commentor: HSI GeoTrans, Inc.
Section #: Appendix G Pg #: G-12 Line #: 21 Code: C
Original Comment #:
Comment: If there are not a significant proportion of non-detects, the next step that is appropriate is Step 2, checking for normality of the data set.

Response: Agree.

Action: Section G.2.3 has been revised to reflect the process represented in Figure G-1, Selection Procedure for the Certification Statistical Analysis Method.

37) Commenting Organization: Ohio EPA Commentor: HSI GeoTrans, Inc.
Section #: Appendix G Pg #: G-15 Line #: 16 Code: E
Original Comment #:
Comment: Table G-12 is referenced out of sequence.

Response: Agree.

Action: Tables and text have been extensively revised. Callouts have been corrected.

38) Commenting Organization: Ohio EPA Commentor: HSI GeoTrans, Inc.
Section #: Appendix G Pg #: G-20 Line #: 12 Code: E
Original Comment #:
Comment: Revise "Primary COCs average observed standard deviation was actual down ..." to "Primary COCs observed standard deviation was actually down ..."

Response: Agree.

Action: This text is now located in G.2.6, Summary and Recommendations, and has been revised as suggested.

39) Commenting Organization: Ohio EPA Commentor: HSI GeoTrans, Inc.
Section #: Appendix G Pg #: G-21 Line #: 24 Code: E
Original Comment #:
Comment: It is unclear what is meant by the word "information" in this sentence.

Response: Agree.

Action: Information has been replaced with "the possibility of missing a hot spot.

40) Commenting Organization: Ohio EPA Commentor: HSI GeoTrans, Inc.
Section #: Appendix G Pg #: G-22 Line #: 9 Code: E
Original Comment #:
Comment: Revise "the uranium FRL at were ..." to "the uranium FRL were ..."

Response: Agree.

Action: Text has been revised.

41) Commenting Organization: Ohio EPA Commentor: HSI GeoTrans, Inc.
Section #: Appendix G Pg #: G-22 Line #: 15 Code: E
Original Comment #:
Comment: The text "by varying the area of the contaminated soil" is redundant and should be deleted.

Response: Agree. Text has been deleted.

Action: See attached revision of Appendix G.

42) Commenting Organization: Ohio EPA Commentor: HSI GeoTrans, Inc.
Section #: Appendix G Pg #: G-22 Line #: 18-20 Code: C
Original Comment #:
Comment: The sentence included in the referenced text is unclear and requires revision. It appears that the ratio of the risk associated with a given area (e.g., a CU) to the risk (not dose) associated with the same concentration applied over some smaller area is what is intended.

Response: Agree.

Action: The word "dose" has been replaced with the word "risk".

43) Commenting Organization: Ohio EPA Commentor: HSI GeoTrans, Inc.
Section #: Appendix G Pg #: G-22 Line #: 22 Code: E
Original Comment #:
Comment: Figure G-2 is missing.

Response: Agree.

Action: Figure G-2 has been reinserted at the end of Appendix G.

44) Commenting Organization: Ohio EPA Commentor: HSI GeoTrans, Inc.
Section #: Appendix G Pg #: G-22 Line #: 25 Code: E
Original Comment #:
Comment: Revise "both sets of areas factors" to "both sets of area factors."

Response: Agree.

Action: Text has been revised.

45) Commenting Organization: Ohio EPA Commentor: HSI GeoTrans, Inc.
Section #: Appendix G Pg #: G-23 Line #: 11 Code: E
Original Comment #:
Comment: Revise "for states that:" to "states that:"

Response: Agree.

Action: Text has been revised.

46) Commenting Organization: Ohio EPA Commentor: HSI GeoTrans, Inc.
Section #: Appendix G Pg #: G-23 Line #: 14 Code: E
Original Comment #:
Comment: Figure G-1 does not contain the information described by the text (it's a flow chart).

Response: Agree.

Action: The figure callout has been changed from G-1 to G-2.

DRAFT RESPONSES TO TECHNICAL REVIEW COMMENTS ON THE DRAFT FINAL "SITEWIDE EXCAVATION PLAN"

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

SPECIFIC COMMENTS

Commenting Organization: U.S. EPA — Commentor: Saric
Section #: 1.4.2 — Page #: 1-26 — Line #: 38
Original Specific Comment #: 1

Comment: The text states that the Aquifer Restoration and Wastewater Treatment Project Operation and Maintenance Plan is scheduled for submittal in July 1997. The text should be revised to discuss the current status of the cited plan.

Response: Agree.

Action: The text will be changed to note that the Aquifer Restoration and Wastewater Treatment Project Operation and Maintenance Plan was approved by the EPA in November of 1997.

Commenting Organization: U.S. EPA — Commentor: Saric
Section #: 2.1.3 — Page #: 2-11 — Line #: 32 and 33
Original Specific Comment #: 2

Comment: The text indicates that the lower uranium final remediation level (FRL) of 20 milligrams per kilogram will require "special consideration" during excavation control, precertification, and certification activities. It is not clear what the phrase "special consideration" means. The text should be revised to clarify this issue.

Response: Agree. The use of the phrase "special consideration" is ambiguous and does not reflect the intent of this discussion to note that a uranium FRL of 20 will require exclusive use of HPGe to scan for uranium, thorium, and radium during precertification activities.

Action: Lines 32 and 33 will be changed as follows: This low FRL will require the exclusive use of HPGe instruments for radiological field surveys conducted during precertification activities.

Commenting Organization: U.S. EPA — Commentor: Saric
Section #: 2.5.12 — Page #: 2-45 — Line #: Not Applicable (NA)
Original Specific Comment #: 3

Comment: The text describes general strategies regarding access to off-property areas. An important aspect of access to off-property areas is property owner cooperation. It is not clear whether off-property Sitewide Excavation Plan (SEP) activities will require the permission of property owners or nearby residents. The text should be revised to clarify this issue and discuss methods by which the U.S. Department of Energy (DOE) will maintain and improve relationships with property owners or nearby residents to avoid access problems.

Response: General strategies for accessing off-property areas are summarized in the SEP to provide initial guidance on activities that may be required as part of the certification routine. As noted in the above comment, permission of property owners is a necessary element of the certification strategy for off-property areas, and this will be added to the discussion in Section 2.5.12. However, the DOE is limited by regulatory and legal policies in developing, maintaining, and improving relationships with property owners. For example, property owners may desire their lands to be purchased by the DOE yet the DOE currently has no legal avenue for pursuing this option. The DOE is committed to working with property owners to improve relationships, but the strategy for the improvement must fall within the legal and regulatory framework available to the DOE.

Action: Since the release of the final draft of the SEP, the cited procedure that discusses construction and NEPA issues with off-property areas (i.e., CT-3.4.7; line 13 on page 2-46) has been canceled. Therefore, lines 13 through 28 will be changed as noted to reflect the desire to develop a general policy between DOE, EPA, and the property owners on the procedures to be followed for off-site certification.

"A procedure for access to off-property areas requiring certification will be developed by DOE and EPA in cooperation with the affected property owner. In general, this procedure should require that:

1) Proper permits be obtained through the FEMP Real Estate Department

2) NEPA requirements are reviewed by the FEMP Natural and Cultural Resource Program to ensure all areas designated for ground disturbing activities met the intent of the NEPA

3) The Advisory Council on Historic Preservation be notified if there will be adverse effects on historic properties

4) FEMP Construction, Engineering, Planning, and Bidding review all necessary documentation relevant to remedial actions

5) Permission is obtained from the off-property owner prior to performing any remedial action.

The DOE is committed to the development of a good relationship with the nearby property owners during the planning, design, and implementation of any remedial action. Therefore, the DOE will work with the EPA and the property owners to schedule information meetings during the design process that will keep the property owner cognizant of proposed remedial actions. The information meetings should discuss a quick decision making process for the off-site certification issues, ways to reduce off-site impacts from on-site activities, and regular updates of site activities by FEMP public relations personnel."

Commenting Organization: U.S. EPA — Commentor: Saric
Section #: 3.1.2.3 — Page #: 3-6 — Line #: 30 to 32
Original Specific Comment #: 4

Comment: The text states that in deep excavations with mild side slopes, a "reasonable application" of radiological scanning methods and instruments can provide monitoring sufficient to provide excavation control. The term "reasonable application" is unclear. The text should be revised to provide greater detail about how it will be determined that sufficient monitoring has been conducted in deep excavations.

Response: Agree. The term "reasonable application" is unclear and it adds no benefit to the discussion on scanning mild side slopes in deep excavations.

Action: Text in lines 30 to 32 will be changed as follows: "In deep excavations containing mild side slopes, scanning will be conducted on the shallow side slopes using the RTRAK and HPGe instruments to monitor the activity of gamma-emitting radionuclides. The RTRAK has been used to conduct a WAC scan of the surface of some soil stockpiles that have slopes similar to shallow slopes anticipated for some excavations. HPGe measurements carried out at and/or above the toe of these shallow slopes can also provide meaningful results for above-WAC decisions. With a conservative design on ...."

Commenting Organization: U.S. EPA Commentor: Saric
Section #: 3.3.3.2 and 3.3.3.3 Page #: 3-18 to 3-21 Line #: NA
Original General Comment #: 5
Comment: The text in these sections describe general strategies regarding the delineation of certification unit (CU) boundaries. Area 1, Phase I CUs underwent a series of revisions, or reconfigurations, after certification samples were collected. The text should be revised to clarify that CUs will not undergo reconfiguration following regulatory approval of the certification design letter and should describe steps that will be taken to prevent the need for CU reconfiguration.

Response: Agree. Text will be revised on page 3-20, lines 14 and 15.

Action: Change text on line 14 to: ".... Certification Design Letter (CDL). CU boundaries will be field checked to ensure that fixed boundaries can be established for the duration of the certification process (e.g., no road surfaces, surface-water impoundments, etc). Following EPA review and approval of the CDL, CU boundaries will not be reconfigured without concurrence from the EPA."

Commenting Organization: U.S. EPA Commentor: Saric
Section #: 3.4.5 Page #: 3-27 Line #: 14
Original Specific Comment #: 6
Comment: This paragraph is titled "widespread variability," although the introduction to the section (Line 4 on this page) and the text of the paragraph refer to "widespread contamination" instead. The paragraph title should be revised to be consistent with the introduction and text.

Response: Agree.

Action: The paragraph title will be changed to "Condition 2 (Widespread Contamination)."

Commenting Organization: U.S. EPA Commentor: Saric
Section #: 4.1.3 Page #: 4-12 Line #: 3 and 4
Original Specific Comment #: 7
Comment: The text states that high-purity germanium (HPGe) measurements will be used to certify the CU with respect to uranium and thorium FRLs. However, the regulatory agencies have not yet approved the use of in situ HPGe measurement for certification purposes. The text should be revised to clarify that analytical results from physical samples will be used to certify the CU for all CU-specific constituents of concern and that HPGe measurements will be collected for comparison purposes only.

000020

Response: Agree.

Action: Lines 2 through 5 on page 4-12 will be changed as follows: ".... a sufficient number of samples (generally 12 to 16) will be collected from each CU and submitted for laboratory analysis to certify all CU-specific COCs. HPGe measurements may be collected for uranium, thorium, and radium to compare in-situ and laboratory analytical results. Comparability data may be used at a later date to make a decision on the use of HPGe measurements for certification of uranium, thorium, and radium FRLs. Section 3.4.2 provides ...."

Commenting Organization: U.S. EPA Commentor: Saric
Section #: 7.1.1 Page #: 7-2 Line #: NA
Original Specific Comment #: 8

Comment: The section describes the general content of project-specific plans (PSP). Recent experience with PSPs at sites such as the South Field and Sewage Treatment Plant indicates that it is often necessary to collect more samples than originally planned to accomplish project objectives. DOE should consider adding a section to each PSP that includes procedures for amending the plan to define additional sampling locations if necessary. Additional sampling could then be completed without the delays related to preparing a new PSP. The SEP should be revised to discuss this issue.

Response: The PSP section will be revised to note a contingency plan will be included as part of a PSP to define additional sampling needs and the decision/approval process to add additional sampling locations should it become necessary to collect additional samples.

Action: Add a the following bullet below line 17 on page 7-3: A contingency plan that identifies potential additional sampling locations based on the analytical results of the initial investigation.

Commenting Organization: U.S. EPA Commentor: Saric
Section #: G.3.1 Page #: G-22 Line #: 22
Original Specific Comment #: 9

Comment: The text refers to Figure G-2 for area factors, but Figure G-2 is missing. In addition, line 14 on Page G-23 refers to Figure G-1 for an area versus risk plot. Figure G-1 is actually the flow diagram discussed in Section G.2.3 for selecting a statistical test. The cited area figures should be added and the figure citations corrected.

Response: Agree.

Action: Figure G-2 has been reinserted and the figure callout has been corrected to note Figure G-2, not G-1.

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APPENDIX G

CERTIFICATION DESIGN RATIONALE

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

COC	Constituent of Concern
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FEMP	Fernald Environmental Management Project
FRL	Final Remediation Level
IRDP	Integrated Remedial Design Package
LBGR	lower bound of the gray region
MDC	minimum detection concentration
NaI	sodium iodide
OEPA	Ohio Environmental Protection Agency
ROD	Record of Decision
SEP	Sitewide Excavation Plan
UCL	upper confidence level

G.1 INTRODUCTION

This appendix describes the statistical approach for making certification decisions for releasing areas at the Fernald Environmental Management Project after soil remediation is complete. Although a 100 percent confidence level cannot be achieved because of inevitable uncertainty with the data, statistical methods provide assurance, to an acceptable level of uncertainty, that the final remediation levels (FRLs) are not exceeded. The described statistical approach has been agreed to by DOE and the regulatory agencies.

The statistical methods used to assess compliance with the release criteria are chosen according to the spatial distribution of contaminants. There are two possibilities in the real world: the residual contaminant may be distributed over a given area in a homogeneous or heterogeneous manner. The two most common homogeneous distributions encountered when assessing environmental data are the normal distribution and the lognormal distribution, and sample populations can be estimated based on observed or estimated variability. The more variable the data, the larger the sample population required to attain a prespecified confidence level.

Sometimes environmental contaminants are distributed in a heterogeneous manner and do not follow a normal distribution. They may be normal but data are not of sufficient number to define the distribution, or they may be multimodal, having one or more areas of higher (or lower) contamination in consistent with the remaining area. In these situations a large number of samples is required to adequately characterize the contamination over a large area.

At the FEMP, additional information on the nature and extent of contamination in a given area will be collected using scanning and direct measurement technologies [Section 2.4 of the Sitewide Excavation Plan (SEP)]. This approach serves to identify areas of elevated radioactivity so they can be removed before soil certification sampling is performed. This selective removal minimizes the possibility of finding homogeneous areas of elevated contamination during certification activities and reduces the expected variability of contaminants in the remaining soil. The result of this selective removal is the remaining data distribution will most likely be normal or lognormal. Additionally, with a known distribution and lower variability, the number of samples required to characterize the contamination in a certification unit's residual soil will be significantly reduced.

The remainder of this appendix is divided into two sections. Section G.2 presents the statistical approach for determining the certification sample number and density required to document compliance with FEMP cleanup criteria, including a discussion of input parameters and statistical test methods used to make this determination. Section G.3 contains a description of the technical approach used to identify and define areas of elevated gamma activity (i.e., hot spots) with scanning instruments.

G.2 APPROACH TO STATISTICAL ANALYSIS FOR CERTIFICATION

A statistical sensitivity analysis was conducted to determine the number of soil samples to collect from each certification unit so that reliable pass/fail determinations can be made for the certification unit. The number of samples required is based on the expected distribution of each constituent of concern (COC) (i.e., mean and standard deviations) and not the sample's physical size, the expected grid spacing, or the certification unit size. This analysis supports the sampling approach presented in Section 3.0 of the SEP.

G.2.1 Input Parameters for Estimating Sample Population

The number of samples that should be collected per certification unit for final certification was determined using the following five parameters:

1) The COC-specific final remediation levels (FRLs) taken from the Operable Unit 5 Record of Decision (ROD; DOE 1996)

2) The concentration that meets the FRL (i.e., the target or expected average residual soil concentration), assuming the acceptable error levels

3) The acceptable Type I Error probability (α). A Type I Error occurs when a certification unit is determined to meet the FRL when it really exceeds the FRL.

4) The acceptable Type II Error probability (β). A Type II Error occurs when a certification unit is determined to exceed the FRL when it really meets the FRL.

5) The expected standard deviation of the certification unit soil sample population.

These parameters are further described below.

G.2.1.1 Final Remediation Levels

The FRLs used for the statistical approach were developed based on the exposure risk calculated for the undeveloped park user, which is the final land use scenario presented in the Operable Unit 5 ROD. When determining target cleanup levels (Section G.2.1.2) and sample populations for certification decisions (Section G.2.4), FRLs are used to set the upper and lower bounds of the gray area on the power charts used to determine sample population required to meet the Type I and II Error probabilities.

G.2.1.2 Target Cleanup Levels

Before final certification begins, the target cleanup level of each COC is chosen as an answer to the question: How much lower than the FRL must the mean residual COC concentration be set to assure the certification unit will be released within the confidence level established by the Type I and Type II Error probabilities? "How much less" is defined as the target cleanup level, which is also known as the lower bound of the gray region (LBGR) on the power curve, used to estimate the number of samples required to be collected. The upper bound of the gray region is defined as the FRL. Since the FRLs are set in the RODs, the LBGR determines the width of the gray region. The lower the LBGR, the wider the gray region and less samples need to be collected to make a pass or fail decision. Conversely, the higher the LBGR (i.e., the closer the LBGR is to the FRL), the narrower the gray region and more samples need to be collected to make a pass or fail decision. The LBGR can be interpreted as the maximum expected average residual COC concentration in an area after most of the above-FRL materials are removed.

As noted above, the lower the value of the LBGR, the fewer certification samples required for making a pass/fail decision. In most cases, 75 percent of the FRL will be used as the LBGR. However, the LBGR should be distinguishable from background and if background falls within the gray region defined by the LBGR at 75 percent of the FRL, then the probability of exceeding the Type II Error is increased. An increase in the probability of exceeding the Type II Error results in wasted resources by excavating and placing background soil in the OSDF. Therefore, if the LBGR defined by 75 percent of the FRL is less than the 95 percent upper confidence level (UCL) on the mean background, the smallest LBGR considered for this analysis will be the 95 percent UCL on the mean of the background population. The 95 percent UCLs for background surface and subsurface soil, along with other summary statistics for metals and radionuclides, are presented in Tables G-1 and G-2, respectively.

Surface soil data were used only for those COCs not included in the subsurface soil data set. One half of the detection limit was used for nondetect results.

Although the LBGR will not be used to drive any excavation decisions, it should be high enough to indicate a successful remediation during precertification activities. For instance, the LBGR should be higher than the practical quantitation limit for the analytical method used to analyze certification samples. For radionuclides, it should be high enough to enable investigators to use field scanning instruments during precertification activities.

G.2.1.3 Type I Error Probability

A Type I Error occurs by falsely concluding that a certification unit meets the FRL when it really exceeds it. The Type I Error probability is usually set at 10 percent, 5 percent, or 1 percent. For certification activities at the FEMP, the Type I Error probability will be set at 5 percent for primary COCs and 10 percent for secondary COCs. Based on meetings between the U.S. Environmental Protection Agency (EPA), Ohio Environmental Protection Agency (OEPA), and DOE, these levels are considered to be protective of the public and environment.

G.2.1.4 Type II Error Probability

A Type II Error occurs by falsely concluding that a certification unit exceeds the FRL when it really meets it. The Type II Error probability is usually set at levels such as 20 percent, 15 percent, and 10 percent. Although a Type II Error of 20 percent is used for certification decisions, all three Type II Error probabilities were considered for this analysis to demonstrate the variation of sample population with the Type II Error probability.

G.2.1.5 Expected Residual Soil Standard Deviation

The expected standard deviation for certification soil samples was estimated from a subset of the sitewide remedial investigation (RI) data. First, the expected excavation footprint was block-modeled using the RI total uranium sample data for soil. Through this modeling, a remnant soil data file was created that approximates the surface soil profile after uranium-driven excavation has been completed. This modeling produced a profile corresponding to uranium values below two times the FRL and a second profile with uranium values below three times the FRL.

All data points below the modeled profiles were used in the estimation of the expected residual standard deviation. This methodology includes individual sample results exceeding the FRL in the residual data set, as long as the block average does not exceed the FRL. If the average concentration of a block exceeded the area-specific FRL, the block was removed (i.e., considered to be excavated) prior to calculating the residual standard deviation.

In the second step of the filtering process, two data sets were developed by eliminating COC results exceeding two times the FRL and three times the FRL. Both data sets were developed by eliminating sample results from the residual data set to simulate precertification hot spot removal at two different hot spot criteria levels (i.e., two and three times the FRL).

The screening method used to estimate the residual standard deviation of COCs in the soil does not inherently underestimate variability, since many individual sample results that exceed the area-specific FRLs are used in the estimation procedure. Only data from soil that is expected to be removed and potential hot spot data were filtered out of the residual data set. For COCs that are expected to drive the required number of certification samples, a comparison of the estimated residual soil standard deviations to background surface and subsurface soil standard deviations is shown in Table G-3.

The data in Table G-3 show that for background soil, subsurface standard deviations are higher than those for surface soil. The same relationship is expected for nonimpacted areas where minimum excavation is planned. That is, non-impacted areas are expected to most closely resemble the background reference areas. Thus, eliminating samples taken from the top foot of soil (which may not necessarily be excavated) should add an additional measure of conservativeness to the estimated sitewide residual soil standard deviations because subsurface standard deviations are higher than those for surface soil. Inspection of the "two times the FRL" and "three times the FRL" estimated standard deviations reveals that they are all significantly larger than the subsurface soil background standard deviations, though not significantly different from each other.

The actual certification sample population proposed for each certification unit will be documented and submitted for approval prior to conducting sampling activities. Additionally, *a posteriori* sample population calculations (Section G.2.4) will be performed to determine if the certification unit sample population was sufficient to meet the confidence criteria. Failure of this analysis would be defined as

Condition 1 - Nonattainment Scenario (high variability in the data set), with the subsequent actions as prescribed in Section 3.4.5 of the SEP.

G.2.2 Statistical Test Methods for Certification Compliance

The appropriate test method to assess attainment of the FRLs is chosen based on the distribution of the data. If the data are normally or lognormally distributed, then the Student's t-Test should be used because it provides more accurate results than the nonparametric methods. If the data are not normally or lognormally distributed, then a nonparametric method is required. The decision steps to determine the statistical test to be used for evaluating FRL compliance are shown on Figure G-1 and discussed in Section G.2.3. The analytical procedure selection process, descriptions of methods, and rationale for usage are provided below.

Within the body of certification sample data will be nondetects and duplicate results. During certification analysis, the value used in the calculations for nondetects will be one half of the reported minimum detection concentration (MDC). For duplicate samples, each duplicate sample result is equally likely to represent the true concentration at the sample location. However, the more conservative maximum result will be used in statistical calculations.

Five basic decision points are sequentially applied to the certification data sets to select the appropriate statistical tests.

1) Is there a significantly large proportion (greater than approximately 15 percent) of data reported as nondetected?

2) Are the data normally distributed?

3) Will a logtransformation of the data normalize the data?

4) If the proportion of nondetects exceeds 50 percent then perform the Sign Test.

5) If the proportion of nondetects are between 15 and 50 percent and the data are symmetrical, perform the Wilcoxon Signed Rank Test.

A detailed discussion on selecting the appropriate statistical test for assessing compliance with FRLs is presented in Section G.2.3. In all test procedures it is assumed that the certification unit exceeds the

FRLs, with the alternative that the certification unit meets the FRL requirements; therefore the testing procedures are one-sided tests.

G.2.2.1 Shapiro-Wilk Test for Normality

Tests for normality are widely available though computerized statistical packages. Madansky (1988) summarized studies by Shapiro, Wilk and Chen (1968) and Pearson, D'Agostino and Bowman (1977) concluding that the omnibus Shapiro-Wilk Test was almost always superior to other tests. The one exception was noted by Pearson, D'Agostino and Bowman. Their study concluded that if the sample distribution was symmetric and leptokurtic (long-tailed) the D'Agostino statistic outperformed the Shapiro-Wilk but never by a wide margin. For these reasons, the tests for normality will be performed using the Shapiro-Wilk Test and the resulting statistic (p) from the normality test will be repeated in the data summary tables included with the Certification Report.

The Shapiro-Wilk Test procedure essentially formalizes the process of "eyeballing" a probability plot by regressing the sample result (x_i) against the standardized quantile (q_i). But, since the ordered sample results are not independent of each other, standard regression computations are not valid. Shapiro and Wilk (1965) developed a regression-based statistic to test for normality and a table of coefficients especially derived for computing the statistic for a sample population of up to 50. For sample populations greater than 50, Shapiro and Francia (1972) developed an approximation of the statistic for a sample population up to 99. This statistic is known as the Shapiro-Francia statistic and will be used if the sample population exceeds 50. See Madansky (1988) for specific details of the Shapiro-Wilk and Shapiro-Francia procedures. These procedures can also be applied to logtransformed data to test for lognormality.

G.2.2.2 Student's t-Test

The Student's t-Test is a parametric statistical method that can be used to test whether the mean of the COC sample results from the certification unit is less than the FRL at the stated Type I Error probability. This test is performed for each COC in a certification unit that meets the minimum requirements of normality, as defined by the Shapiro-Wilk Test. The following equation is applied to calculate the Student's t-Test statistic (t):

$$t = \frac{FRL - \bar{X}}{\sqrt{S^2 / N}}$$

Where:

FRL = *final remediation level*
$\bar{X}$ = *the sample mean of the certification sample results*
S^2 = *the sample variance of the certification sample results*
N = *the number of certification sample results*

The t-distribution table of critical values for varying numbers of samples and Type I Error probabilities (i.e., rate) is consulted to make the pass/fail determination for the certification unit. If the computed value (t) exceeds the critical value, then the certification unit passes. The Type I Error rate is 0.05 for primary COCs and 0.10 for secondary COCs. The Student's t-Test requires a near-normal distribution of soil sampling results and is influenced more than nonparametric methods by nondetects. In t-Test calculations, nondetects will be assigned a value of one half the MDC.

The Student's t-Test will most likely be used for the vast majority of contaminants, since environmental data are usually normally or lognormally distributed. To simplify the process and interpretation of the methodology, the UCL of the mean, based on the Student's t-distribution, will be compared to the FRL. This is equivalent to performing the t-Test using the data mean and the FRL. If the calculated UCL is less than the FRL than the certification unit passes certification, otherwise the certification unit fails certification and the cause is evaluated to determine the subsequent action (see Section 3.4 of the SEP).

G.2.2.3 Sign Test

This procedure tests the hypothesis that at least 50 percent of the data are greater than the FRL, indicating that the median (a nonparametric estimate of the midpoint of the data) is greater than the FRL, with a prespecified level of confidence. If more than 50 percent of the sample results are greater than the FRL, it is likely that the overall constituent level within the certification unit would be greater than the FRL, indicating certification failure. Conversely, if fewer than 50 percent of the sample results are greater than the FRL, it is likely that the overall constituent level within the certification unit would be less than the FRL, and meet the FRL requirement. Exact probabilities of the Sign Test have been developed to assess the confidence level on test of the hypothesis.

The Sign Test method will be used in two situations: when greater that 50 percent of the sample results are reported as below the MDC level, and when the t-Test cannot be used reliably because the data distribution is not normal or lognormal. The first situation may arise with organic COCs, that are difficult to quantify, but which pose a potential risk when present. Traditional methods (e.g., t-Test) require data results above the MDC to calculate the test statistic, whereas the Sign Test only requires that the result be discernible from the FRL. If the MDC is below the FRL, the Sign Test can be used to determine, with a specified level of confidence, if the median of the data is above the FRL. The test method withstanding wide data variations, high percentages of nondetects (assuming the detection level is below the FRL), and does not require any prior knowledge of the underlying distribution or that the data be symmetrically distributed (i.e., mean and median are equal).

The probabilities for the binomial distribution when sample populations are between 10 and 16 are shown in Table G-4. The column represents the sample size excluding sample results that are equal to the FRL and the row represents the number of results greater than the FRL. If the resultant probability is less than the prespecified confidence level than the hypothesis would be rejected and the certification unit would meet the FRL (median is less than the FRL).

For example, if 0 of 16 samples taken from a certification unit equaled the FRL, the prespecified confidence level is 0.05 (5%), and four of the samples exceeded the FRL, Table G-4 shows that the probability is 0.038, which is less than 0.05 and the conclusion is that the certification unit passes certification. If five samples exceeded the FRL, the probability increases to 0.105, which is greater than 0.05 and the certification unit would fail certification. Even if the prespecified confidence level was 0.10 (10%), the certification unit would fail certification, because the probability of 0.105 is greater than 0.10.

G.2.2.4 Wilcoxon Signed Rank (One Sample) Test

If the data are symmetrically distributed but are not normally distributed, nor is the logtransformed data normally distributed, then the Wilcoxon Signed Rank Test will be employed to assess compliance with the FRLs. It may also be possible to transform the data to make the data distribution symmetrical.

The Wilcoxon Signed Rank Test is implemented as follows:

- Subtract the FRL from each of the certification sample results
- Sort, then rank the absolute deviations from the FRL
- Carry over the sign of the calculated deviation (positive if the result is greater than the FRL or negative if it is less than) to the rank of the absolute deviation
- Sum the negative ranks (those below the FRL) and positive ranks (those above the FRL).

For compliance with the FRLs, the absolute sum of the negative ranks (results less than the FRL) must exceed that of the positive ranks (results greater than the FRL). Exact probabilities can be obtained from Wilcoxon Signed Rank probability tables. If the ranks derived from the certification data results are significantly below the FRL, then the certification unit passes. The probability levels are 5 percent for primary COCs and 10 percent for secondary COCs.

G.2.3 Determination of the Appropriate Methodology to Assess Achievement of FRLs

Five decision points will be applied to the certification data sets to choose the appropriate statistical methodology prior to preparing the certification summary table. A discussion of the selection method follows and a summary of the decision hierarchy is shown on Figure G-1.

Step 1. Determine if the maximum concentration/activity of the COC less than the FRL.

If all results for a given COC are below the FRL, the certification unit has passed certification and the data summary table can be prepared without conducting statistical analysis. When one sample result or more exceeds the FRL, the evaluation moves to Step 2.

Step 2. Determine if a significant proportion of the data (> 15 percent) is reported as nondetected.
When a significant proportion of the data (i.e., greater than 15 percent) is below the detection level, the normal or lognormal distribution of the data is questionable. At this point, nonparametric tests need to be used because they do not rely on the assumption of normality (Step 4). A large percentage of nondetects tends to bias the sample distribution to low values and also lowers the mean and increases the standard deviation. When the percentage of nondetects is less than 15 percent, the Shapiro-Wilk Test (Section G.2.2.1) is performed to evaluate if the data can be adequately described by a normal and/or lognormal distribution (Step 3).

There is no exact percentage that invalidates normal or lognormal testing procedures, and 15 percent is not based on any well-studied statistical theory. Therefore, 15 percent should be recognized as a rule-of-thumb value rather than an exact value. Table G-5 summarizes the proposed guidance for assessing whether the data set should be evaluated with the Shapiro-Wilk Test.

Step 3: Perform the Shapiro-Wilk Test to evaluate if the data are normally or lognormally distributed.
If nondetects are less than 15 percent of the data set, the next step is to perform the Shapiro-Wilk Test (Section G.2.2.1) to evaluate the data distribution. If the Shapiro-Wilk Test indicates that the data cannot be assumed to be a normal or lognormal distribution, the data are evaluated by nonparametric methods (Step 4), because the Student t-Test cannot evaluate outliers/extreme values in a realistic manner when the sample population is small.

If the Shapiro-Wilk Test indicates both normal and lognormal distributions fit the data, the distribution with the highest p value will be used in the Student's t-Test (Section G.2.2.2) to make the certification decision. However, the Shapiro-Wilk Test will generally return a pass decision for either the normal or lognormal distribution.

When a normal distribution is indicated, the most accurate determination of compliance with FRLs will be achieved. This is because the normal distribution is the most studied statistical distribution and more is known about its properties and exact probability levels than any other distribution. Additionally, the Central Limit Theorem states that the data distribution, known or unknown, of sample means within a random sample population is approximately normal - provided the sample population is sufficiently large. This indicates that although the underlying distribution may not fit the definition of a normal distribution precisely, the Student's t-Test can be used to evaluate compliance with FRLs if no significant deviation from this assumption is present.

When the Shapiro-Wilk Test indicates a lognormal distribution is present, the data are evaluated with the Student's t-Test using the logtransformed data. A distribution is lognormal if the data are normally distributed once they have been transformed using the natural log function. The limitations noted above apply.

It is expected that the majority of data will be analyzed with the Student's t-Test assuming either a normal or lognormal data set. During Area 1, Phase I and Area 1, Phase II certification, nearly 85 percent of the primary COCs and approximately 80 percent of all COCs tested used the Student's t-Test on normal and lognormal data sets.

Step 4: Is the proportion of nondetects greater than 50 percent?
If the proportion of nondetects is greater than 50 percent, the Sign Test will be used to make the pass/fail decision for the certification unit (Section G.2.2.3). The Sign Test does not assume any underlying distribution and can accommodate nondetects as long as the detection level is less than the FRL. Unlike the Wilcoxon Signed Rank Test, there is no requirement for the underlying distribution to be symmetric.

When the percentage of nondetects is less than 50 percent, the data distribution is evaluated for symmetry according to Step 5.

Step 5: Are the data symmetrically distributed?
If the data are symmetrically distributed, the Wilcoxon Signed Rank Test is used (Section G.2.2.4). The Wilcoxon Signed Rank Test does not require that the data be normally distributed but assumes that the data be symmetrically distributed. Tests for symmetry are often devised from the chi-square distribution and simple histograms to assess the appropriateness of using the Wilcoxon procedure. Generally speaking, the distribution of sample results should be evenly (but not uniformly) distributed on either side of a central point. Assuming that the data are approximately symmetric, and there are not too many results with the same value, this procedure can provide reliable results. If the data

indicate a nonsymmetric distribution, the Sign Test (Section G.2.2.3) will be performed for the certification statistical analysis.

G.2.4 Determination of Number of Samples for Certification

A certification unit can be certified when it can be demonstrated that the average concentration or activity level for each certification unit-specific COC is below its respective FRL within an acceptable confidence level. To estimate of the number of certification samples required per certification unit, the following formula was employed:

$$n = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{(\frac{RG - \bar{x}_{target}}{S_{Est.}})^2}$$

where

α = *probability of a Type I Error*
β = *probability of a Type II Error*
Z = *critical level (for the designated probability) the normal distribution*
RG = *the Remedial Goal (i.e., FRL for the given analyte)*
$\bar{x}_{target}$ = *target clean-up level mean (i.e., LBGR)*
$S_{Est.}$ = *standard deviation estimated the remnant soil data*

This equation is based on the assumption that the data are normally distributed. The justification for using this equation is that the majority of environmental data are either normally or lognormally distributed. A review of the data gathered during the Area 1, Phase I and Area 1, Phase II sampling and analysis efforts indicate that this assumption is valid. Eighty percent of certification unit data sets (85 percent for primary COCs) passed the normality or lognormality check. Furthermore, these percentages are low because several of the analytes were seldom detected above their detection limits, with the majority of the certification unit data sets having too few detects for these analytes to determine the distribution. For beryllium, 21 out of 32 certification units had too few detects; for cesium-137, 3 out of 5; and for Aroclor-1260, all 10 had too few detects. If we remove these secondary COCs as erroneously skewing the results, the overall percentage of certification unit data sets that are normal/lognormal climbs from 80 to 85 percent. Clearly, the vast majority of data sets could be analyzed using normal probability theory. Therefore, estimating sample sizes based on the assumption of normality is valid.

To meet the confidence levels for certification (95 percent for primary COCs and 90 percent for secondary COCs) additional assumptions are required. The first assumptions deal with Type I and Type II Errors. A Type I Error is defined as the probability of declaring that a certification unit meets the FRL when the average exceeds the FRL, whereas a Type II Error is defined as the probability of declaring the certification unit as not meeting the FRL when in fact the average is below the FRL. The acceptable Type I Error for the primary COCs is 5 percent and for secondary COCs is 10 percent. The Type I Error was evaluated at 5 and 10 percent while varying the Type II Error at 10, 15 and 20 percent. A sensitivity analysis of the effects of varying the Type I and Type II Errors on the estimated sample populations is given in Tables G-6 through G-8 (using the remnant data set defined by all values below two times the FRL) and Tables G-9 through G-11 (using the remnant data set defined by all values below three times the FRL) (Section G.2.1.5).

The second assumption is the maximum expected average concentration or activity level for the certification unit at the time of certification sampling. This is referred to as the "target cleanup level" or the LBGR. This assumed target level or LBGR is set at 75 percent of the FRL for evaluating sample populations for certification or at the 95 percent UCL of the background mean if 75 percent of the FRL is lower than the background mean (Section G.2.1.2). This is the assumed maximum expected average concentration or activity level at the time that certification sampling is to begin. Estimated sample populations are given in Tables G-6 through G-8 assuming the "less than two times the FRL" remnant data set and Tables G-9 through G-11 assuming the "less than three times the FRL" remnant data set.

The last assumption required to calculate certification sample size is an estimate of the data variability (standard deviation) for postremedial conditions. This has been discussed in Section G.2.1.5.

Table G-12 presents the resultant target levels or LBGR and percentages of FRL if the sample population was set at 12 samples, using the assumptions listed above.

G.2.4.1 Examples of Sample Population Calculation

An example calculation for estimating the sample population using this method is provided below. The example calculation is based on thorium-228 remnant soil data, a Type I Error of 0.05, a Type II Error of 0.20, and a target cleanup level or LBGR of 75 percent of the FRL. These were the parameters assumed in the estimation of certification sample populations in Area 1, Phase I. The standard deviation used in this sensitivity analysis was estimated from the remnant data set using values less than two times the FRL, as previously described. Under the current recommended scenario of:

- Type I Error rate = 0.05 (primary COC),
- Type II Error rate = 0.20, and
- An assumed estimated maximum residual level of approximately 75 percent of the FRL,

the following example equation is presented. Starting with the initial equation:

$$n = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{\left(\frac{RG - \bar{x}_{target}}{S_{Est.}}\right)^2}$$

Then, substituting the values for

$$\alpha = \textit{probability of a Type I Error} = 0.05$$
$$Z_{(1-0.05)} = Z_{0.95} = 1.645$$
$$\beta = \textit{probability of a Type II Error} = 0.20$$
$$Z_{(1-0.20)} = Z_{0.80} = 0.842$$
$$RG = \textit{the Remedial Goal, FRL} = 1.7\ pCi/g$$
$$\bar{x}_{target} = \textit{target clean-up level mean}$$
$$= 75\%\ \textit{of the FRL} = 1.28\ pCi/g$$
$$S_{Est.} = \textit{standard deviation estimated from remnant dataset} = 0.498\ (\textit{from Table G-6})$$

yields

$$n = \frac{(1.645 + .842)^2}{(\frac{1.7 - 1.28}{0.498})^2} = 8.7$$

Under the given assumptions, the calculated number is always rounded up to the next highest integer to ensure that the alpha and beta error rates are satisfied. In this case, the calculated value of 8.7 is rounded up to 9. The additional 20 percent safety factor is added to bring the sample size to 11. Therefore, under the given assumptions, we would need to collect a minimum of 11 samples per certification unit and analyze 9 samples for thorium-228 in order to certify the certification unit.

G.2.5 Sample Size *a posteriori* Confirmation

After the certification testing procedure has been identified an *a posteriori* sample population calculation will be performed to determine if sufficient samples were taken to assess certification. The actual calculated sample size, m, is dependent upon the testing procedure used. The equations used were taken from the EPA document EPA QA/G-9, "Guidance for Data Quality Assessment" (January 1998).

G.2.5.1 Student t-Test

For the Student t-Test under the assumption of normality or lognormality, the *a posteriori* sample population required to assess meeting the FRL is

$$m = \frac{S^2(Z_{1-\alpha} + Z_{1-\beta})}{(\mu_1 - C)^2} + (0.5)Z^2_{1-\alpha}$$

where

S^2 = sample variance
Z = coefficients from the Normal distribution
α = Type I Error percentage
β = Type II Error percentage
μ_1 = sample mean
C = FRL Criterion

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G.2.5.2 Wilcoxon Signed Rank Test

For the Wilcoxon Signed Rank Test, the *a posteriori* sample population required to assess FRL attainment is equivalent to the sample calculation for the t-Test plus a multiplier to account for a slight loss in power. The equation is

$$m = [\frac{S^2(Z_{1-\alpha}+Z_{1-\beta})}{(\mu_1-C)^2}+0.5Z^2_{1-\alpha}]x1.16$$

where

S^2 = sample variance
Z = coefficients from the Normal distribution
α = Type I error percentage
β = Type II error percentage
μ_1 = sample mean
C = FRL Criterion

G.2.5.3 Sign Test

For the Sign Test, the *a posteriori* sample size required to assess meeting the FRL is

$$m = [\frac{Z_{1-\alpha}\sqrt{P_0(1-P_0)}+Z_{1-\beta}\sqrt{P_1(1-P_1)}}{P_1-P_0}]^2$$

where

P_0 = the hypothesized proportion equivalent to the median, 0.5,
P_1 = the sample proportion greater than the median,
Z = coefficients from the Normal distribution,
α = Type I error percentage, and
β = Type II error percentage.

It can be determined that enough samples were taken to assess FRL attainment by comparing the calculated *m* to the actual sample population. If m is greater than the sample population, more samples should be taken to conclude that the certification criteria are met.

G.2.6 Summary and Recommendations

The appropriate sample population to assess FRL attainment depends on the assumed parameters. The only fixed parameters in the equation are the FRL and the Type I Error (5 percent for primary COCs and 10 percent for secondary COCs); all others are subject to sensitivity analysis. This interdependence on the estimated sample population is summarized in Table G-13.

Tables G-6 through G-11 indicate that, based on the remnant data, sample population is most sensitive to thorium-228 activity. The sample populations used in Area 1, Phase I were based on estimated residual standard deviations calculated from "unimpacted" areas (based on database queries). More refined estimates were derived using the block modeling technique previously described to generate the remnant data sets. If the remnant data set standard deviation is a good estimate of the residual standard deviation and the target level of 75 percent of the FRL is a good estimate of the residual activity level after remediation, then a sample population of 12 used in Area 1, Phase I is very conservative (more than a sufficient population), nearly a full 50 percent greater than the estimated sample population (Table G-6, maximum N = 9 for thorium-228).

Further evidence of the conservative sample population (i.e., greater then sufficient size) used in Area 1, Phase I can be seen from the summary of analytical results from Area 1, Phase 1 presented in Table G-14. The actual average residual certification unit mean level for the primary COCs is below the estimated 75 percent level, with total uranium concentrations being less than 15 percent of the FRL. For the secondary metal COCs, the arsenic results were similar, whereas the beryllium mean was less than 44 percent of the FRL (many being nondetects). Stronger evidence of the conservative nature of the sample population estimate is the observed variability levels. The actual standard deviations observed in the Area 1, Phase 1, certification data sets were, on average, well below estimated values. Observed standard deviation for primary COCs was actual down in the range of approximately 35 to 55 percent of estimates, whereas metals were about 65 to 76 percent of estimates. As shown above, the variability of the data within a certification unit greatly influences the required number of samples to demonstrate FRL attainment. The lower the variability the fewer sample points are required to accurately estimate the true average COC level/concentration in the certification unit. The Area 1, Phase I, certification units are far less variable than estimated, especially for the primary COCs, which demonstrates that the estimated sample size of 12 is very conservative to determine FRL attainment.

Because of the apparent conservativeness of the sample population estimate used in Area 1, Phase I, the actual sample populations will be calculated and justified during the development of the Certification

Design Letter for the area to be certified. Better estimates for standard deviations may be obtained from precertification sampling.

The parameters and assumptions to be used in the calculation of sample size are as follows:

- Data are normally distributed
- Type I error rate = 0.05 (primary COCs) and 0.10 (secondary COCs)
- Type II error rate = 0.20
- An assumed estimated maximum residual level of approximately 75 percent of the FRL.

For Group 1 certification units, the number of certification samples for primary COCs will be established at a minimum of 12 samples but no greater than 16. In the rare and unforeseen situation where 16 samples would not be enough to meet the Type I and Type II error rates, the target cleanup level may need to be adjusted downward based on actual conditions. Secondary COCs will be sampled in Group I certification units at a rate of 8 to 12 samples. For Group 2 certification units, the sampling rate will be 8 to 12 samples for both primary and secondary COCs. The expected variability should be very low, since there should be little or no secondary contamination prior to excavation. Regardless of the numbers of laboratory samples determined, the HPGe gamma spectrometry field measurement will also be conducted at all potential random sampling locations (i.e., 16 locations per certification unit) for comparison to certification sample results, as discussed in Section 2.4 of the SEP.

G.3 JUSTIFICATION FOR SCANNING AS AN INTEGRAL PART OF PRECERTIFICATION

The goal of certification is to document that the release criteria for a certification unit [set forth in the Integrated Remedial Design Package (IRDP) and Certification Design Letter] are met. This will be done by taking direct measurements using a HPGe and by collecting samples of surface soil and analyzing them. This information will be supplemented by the use of scanning technologies during precertification activities.

A typical soil sampling program is based on collecting a finite number of samples over the surface of an area. Such a program will miss elevated areas of contamination located between the sampling points. The propensity of the sampling program to miss a hypothetical hot spot depends on the spacing between the sampling points. As the distance between two sampling points increases, the possibility of missing an area containing contaminated soil increases. Performing a 100 percent scan of the surface for gamma-emitting radionuclides addresses the possibility of missing a hot spot by supplying semiquantitative information between the points.

At the FEMP, for example, approximately 125 feet separate sampling locations on a triangular grid in a 500-ft by 500-ft certification unit with 16 sampling points.[1] This spacing would encompass an unsampled circular area of 24,544 ft^2. For a 250-ft by 250-ft area with 16 sampling points, the distance between points shrinks to about 62.5 ft, and the unsampled area becomes 6,136 ft^2. In order to justify the size of these certification units and the resulting grid spacing, it is necessary to demonstrate that any areas that might be missed by this sampling do not significantly affect the final risk to humans.

G.3.1 Impact of Area Size on Risks

The risk to the undeveloped park user from a large area of soil containing uranium at the FRL of 82 mg/kg was determined during the Operable Unit 5 remedial investigation/feasibility study (RI/FS) process. Using this risk as a starting point, the impact on the receptor exposed to this risk in a shrinking area was investigated using RESRAD (DOE 1993). RESRAD was used to calculate doses from circular areas of soil containing 82 mg/kg natural uranium, using the scenario for the undeveloped park user. The only variation between the runs was the size of the contaminated area. Table G-15 lists the site-specific parameters used in this exercise.

The results of the RESRAD runs were then used to calculate a ratio of the risk produced by a certification unit with soil containing 82 mg/kg uranium compared to the risk produced by a smaller soil area with the same uranium concentration. This ratio, called the area factor, provides a measure of the effect that area size has on risk to the receptor from residual levels of uranium. These area factors, based on a Group 2 certification unit size of 500-ft by 500-ft, are plotted on Figure G-2.

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[1] $\sqrt{\frac{Area}{No.\,Samples}} = \sqrt{\frac{250{,}000 ft}{16}} = 125 ft$

The uranium concentration required to produce the same exposure to the undeveloped park user increases as the area decreases for both sets of area factors. For example, the maximum size of a circular hot spot that may be missed in a 500-ft by 500-ft certification unit with 16 samples laid out in a randomly placed systematic grid is about 25,000 ft^2. The area factor for a hot spot this size would approach 10. This means the uranium concentration in that limited area would have to approach 10 times the uranium FRL to produce the same level of risk to a roving receptor as the undeveloped park user at concentrations of one times the FRL in a Group 2 certification unit (250,000 ft^2). Similarly, soil concentrations in a 6,000 ft^2 unsampled area would need to exceed 40 times the FRL to match the risk from exposure to one times the FRL in soil in a Group 2 (250,000 ft^2) certification unit. Figure G-2 plots the relationship between area and the area factor in terms of FRL. Above the 30 times value, the health effects calculations (shown by the dotted line) are provide for reference only, since they are superceded by the DOE directed limit of 30 times the FRL.

This exercise is not intended to justify leaving such material in place, but rather to point out that inadvertently leaving a few isolated hot spots does not necessary result in unacceptable risks to users of the site. The "Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD" (DOE 1993) states that: "Every reasonable effort shall be made to identify and remove any source that has a radionuclide concentration exceeding 30 times the authorized limit, irrespective of area." ALARA implies that it is desirable to minimize the possibility that hot spots will remain after excavation.

G.3.2 Role of Scanning

The proper use of wide area scanning such as RTRAK at the FEMP will greatly reduce the possibility that hot spots will remain undetected. A hot spot is an identifiable area of soil containing radionuclides that is measurably elevated when compared to surrounding areas. The ability of available instrumentation to detect such areas depends on the amount of activity in the area and the size of the area. Larger areas are easier to detect than smaller areas with the same activity, and areas with higher activity are easier to detect than similar sized areas with less activity.

Recent work with the RTRAK and other large volume NaI detectors and the HPGe systems currently deployed at the FEMP indicate that these systems can be used to identify areas of soil containing elevated uranium concentrations. Running at 1 mph and using a spectrum acquisition time of 4 seconds allows these systems to discriminate uranium, radium-226 and thorium-232 concentrations at levels equal to three times the Operable Unit 5 FRL in areas larger than 300 ft^2 (DOE 1997). These performance-based screening levels, presented in Table G-16 are much lower than the health-based limits derived by the scoping calculation presented in Section G.2.1.

Because area scanning will be able to reliably detect the activity from most hot spots, and procedures such as the ones described in the precertification activities defined in Section 3.0 of the SEP will be in place to remove the soil in those areas if required, then the scanning technology can be used to provide assurance that no areas between the fixed sampling points will exceed the hot-spot criteria. Since these criteria are well below the health based limits for contamination in small areas, this provides additional confidence the final certification decision is health protective.

Scanning with large-volume NaI detectors currently available at the FEMP will be sufficient to detect elevated areas of radioactivity in surface soils. This technology, when combined with direct measurements taken by HPGe instrumentation and supplemented be discrete soil sampling and analysis, will be adequate to identify elevated areas that may pose a health risk. This implies that the combination of RTRAK scanning, selective use of the HPGe to characterize areas of elevated activity, and the sampling and analysis of discrete soils samples taken on a random sampling pattern for certification will be sufficient to certify that the remediation has met the specific certification criteria set forth for soils.

G.3.3 Implementation of FEMP-Specific Hot Spot Criteria

Section 3.4.6 summarizes the hot spot criteria to be evaluated during precertification and certification activities. The hot spot criteria will be evaluated with the RTRAK and HPGe instruments for the primary radiological COCs (i.e., uranium, thorium, and radium), as well as by the collection and analysis of physical samples. The User Guidelines, Measurement Strategies, and Operational Factors for Deployment of In Situ Gamma Spectrometry at the Fernald Site (DOE 1998) provides details on the set up and collection of data when the RTRAK and HPGe are used during the precertification and certification process.

During precertification scanning, two-point averages will be calculated from RTRAK measurements for the primary COCs and the averages will be compared to values corresponding to three times the FRL to make the hot-spot decision. Areas that exceed three times the FRL will be scanned again with the HPGe instrument to confirm and delineate the hot spot area. If the HPGe measurements confirm the existence of a hot spot (i.e., three times the FRL), the hot spot will be excavated and the the scanning will be repeated until the area is precertified as free of hot spots.

During the certification activities, several hot spot criteria are evaluated when any individual laboratory sample result indicates a COC is greater than two times its FRL. First, HPGe measurements are taken above the sample location and surrounding area to delineate the hot spot area. If these measurements indicate any primary COC has exceeded 30 times its FRL, the hot spot is excavated. When this initial evaluation is passed, the hot spot is evaluated with respect to the area represented by the HPGe measurement. If the area is less than $10m^2$ and any primary COC exceeds a value of three times the FRL, the delineated hot spot area will be excavated. When the area is greater than 10 m^2, the hot spot criterion is defined as greater than three times the FRL. Failure to meet any of the above criteria will result in excavation of the hot spot followed by an additional round of sampling and analysis to demonstrate all certification criteria have been met.

G.4 REFERENCES

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TABLE G-1

BACKGROUND SURFACE SOIL SUMMARY STATISTICS

Analyte	Number of Samples	Number Detected	Statistical Distribution	95% UCL on the Mean[1]
Radium-226	30	30	Normal	1.223
Radium-228	30	30	Undefined	1.101
Thorium-228	30	29	Normal	1.119
Thorium-232	30	30	Lognormal	1.08
Uranium, Total[2]	30	30	Normal	3.27
Cesium-137	30	30	Lognormal	0.443
Lead-210	30	30	Lognormal	1.005
Strontium-90	30	0	-	-
Thorium-230	30	29	Normal	1.496
Arsenic	26	26	Lognormal	6.03
Beryllium	14	1	Undefined	0.31
Lead	27	27	Lognormal	18.24

Source: CERCLA/RCRA Background Soil Study, November 1992.

[1] All radionuclides are given in pCi/g; total uranium, arsenic, beryllium and lead are given in ppm.
[2] Total uranium was not included in the Background Soil Study and has been calculated from the original background data.

TABLE G-2

BACKGROUND SUBSURFACE SOIL SUMMARY STATISTICS

Analyte	Sample Depth Interval	Number of Samples	Number Detected	Statistical Distribution	95% UCL on the Mean
Radium-226	36"-42"	30	30	Undefined	1.021
	48"-54"	21	21	Undefined	0.923
Radium-228	36"-42"	30	30	Lognormal	0.911
	48"-54"	21	21	Lognormal	0.865
Thorium-228	36"-42"	30	25	Normal	0.955
	48"-54"	21	16	Normal	0.856
Thorium-232	36"-42"	30	20	Undefined	0.91
	48"-54"	21	16	Normal	0.846
Uranium, Total*	36"-42" + 48"-54"	51	-	Normal	2.572
Cesium-137	36"-42"	-	-	-	-
	48"-54"	-	-	-	-
Lead-210	36"-42"	30	26	Undefined	0.658
	48"-54"	21	17	Undefined	0.684
Strontium-90	36"-42"	30	0	-	-
	48"-54"	21	1	Undefined	0.283
Thorium-230	36"-42"	30	26	Normal	1.268
	48"-54"	21	19	Normal	1.311

TABLE G-2

BACKGROUND SUBSURFACE SOIL SUMMARY STATISTICS
(Continued)

Analyte	Sample Depth Interval	Number of Samples	Number Detected	Statistical Distribution	95% UCL on the Mean
Arsenic	36"-42"	26	26	Lognormal	6.77
	48"-54"	18	18	Normal	5.42
Beryllium	36"-42"	30	9	Undefined	0.37
	48"-54"	20	6	Undefined	0.4
Lead	36"-42"	28	28	Lognormal	10.93
	48"-54"	19	19	Normal	8.8

Source: CERCLA/RCRA Background Soil Study, November 1992.

[1] All radionuclides are given in pCi/g; total uranium, arsenic, beryllium and lead are given in ppm.
[2] Total uranium was not included in the Background Soil Study and has been calculated from the original background data.

TABLE G-3

COMPARISON OF ESTIMATED RESIDUAL SOIL STANDARD DEVIATIONS TO BACKGROUND SOIL STANDARD DEVIATIONS*

Analyte	Surface Soil Background	Subsurface Soil Background	Less than 2 x FRL Soil Data File	Less than 3 x FRL Soil Data File
Radium-226 pCi/g	0.15	0.24	0.45	0.49
Radium-228 pCi/g	0.12	0.27	0.38	0.38
Thorium-228 pCi/g	0.23	0.32	0.50	0.52
Thorium-232 pCi/g	0.19	0.32	0.36	0.39
Uranium, total mg/kg	0.32	0.58	12.60	13.90
Arsenic mg/kg	1.98	2.45	2.96	2.96
Beryllium mg/kg	0.06	0.16	0.42	0.45

* Calculated assuming a normal distribution for comparison purposes.

TABLE G-4

SIGN TEST PROBABILITIES FOR THE BINOMIAL DISTRIBUTION

	Sample Population[a]						
B	10	11	12	13	14	15	16
0	0.001	0.000	0.000	0.000	0.000	0.000	0.000
1	0.011	0.006	0.003	0.002	0.001	0.000	0.000
2	0.055	0.033	0.019	0.011	0.006	0.004	0.002
3	0.172	0.113	0.073	0.046	0.029	0.018	0.011
4	0.377	0.274	0.194	0.133	0.090	0.059	0.038
5	0.623	0.500	0.387	0.291	0.212	0.151	0.105
6			0.613	0.500	0.395	0.304	0.227
7					0.605	0.500	0.402
8							0.598

[a] Excluding sample results that are equal to the FRL.

TABLE G-5

PROPOSED MAXIMUM NUMBER OF NONDETECTS FOR A GIVEN SAMPLE SIZE

Sample Size	Number of Nondetects	Percentage of Nondetects
8	1	13%
9	1	11%
10	2	20%
11	2	18%
12	2	17%
13	2	15%
14	2	14%
15	3	20%
16	3	19%

TABLE G-6

ESTIMATED SAMPLE POPULATIONS FOR A TYPE II ERROR RATE OF 20%
Remnant Data Less Than 2 Times the FRL

	Type I Error Rate = 5%					
	FRL[1]	LBGR[2]	SD	calc N	N	N+20%
Radium-226	1.7	1.275	0.448	6.87	7	9
Radium-228	1.8	1.350	0.376	4.32	5	6
Thorium-228	1.7	1.275	0.498	8.49	9	11
Thorium-232	1.5	1.125	0.364	5.83	6	8
Uranium, total[3]	82	61.50	12.6	2.34	3	4
Uranium, total	50	37.50	12.6	6.28	7	9
Arsenic	12	9.000	2.96	6.02	7	9
Beryllium	1.5	1.125	0.419	7.72	8	10

	Type I Error Rate = 10%					
	FRL	LBGR	SD	calc N	N	N+20%
Radium-226	1.7	1.275	0.448	5.01	6	8
Radium-228	1.8	1.350	0.376	3.15	4	5
Thorium-228	1.7	1.275	0.498	6.19	7	9
Thorium-232	1.5	1.125	0.364	4.25	5	6
Uranium, total	82	61.50	12.6	1.70	2	3
Uranium, total	50	37.50	12.6	4.58	5	6
Arsenic	12	9.000	2.96	4.39	5	6
Beryllium	1.5	1.125	0.419	5.63	6	8

[1] All radionuclides are given in pCi/g; total uranium, arsenic, and beryllium are given in mg/kg.
[2] LBGR is calculated as 75% of the FRL (i.e., 0.75 x FRL).
[3] Total uranium was not included in the Background Soil Study and has been calculated fromthe original background data.

FRL = Final remediation level
LBGR = Lower bound of the gray region
N = Size of sample population
SD = Standard deviation

TABLE G-7

ESTIMATED SAMPLE POPULATIONS FOR A TYPE II ERROR RATE OF 15%

Remnant Data Less Than 2 Times the FRL

		Type I Error Rate = 5%				
	FRL[1]	LBGR[2]	SD	calc N	N	N+20%
Radium-226	1.7	1.275	0.448	7.99	8	10
Radium-228	1.8	1.350	0.376	5.02	6	8
Thorium-228	1.7	1.275	0.498	9.87	10	12
Thorium-232	1.5	1.125	0.364	6.77	7	9
Uranium, total[3]	82	61.50	12.6	2.72	3	4
Uranium, total	50	37.50	12.6	7.30	8	10
Arsenic	12	9.000	2.96	7.00	7	9
Beryllium	1.5	1.125	0.419	8.98	9	11

		Type I Error Rate = 10%				
	FRL	LBGR	SD	calc N	N	N+20%
Radium-226	1.7	1.275	0.448	5.97	6	8
Radium-228	1.8	1.350	0.376	3.75	4	5
Thorium-228	1.7	1.275	0.498	7.38	8	10
Thorium-232	1.5	1.125	0.364	5.06	6	8
Uranium, total	82	61.50	12.6	2.03	3	4
Uranium, total	50	37.50	12.6	5.46	6	8
Arsenic	12	9.000	2.96	5.23	6	8
Beryllium	1.5	1.125	0.419	6.71	7	9

[1] All radionuclides are given in pCi/g; total uranium, arsenic, and beryllium are given in mg/kg.
[2] LBGR is calculated as 75% of the FRL (i.e., 0.75 x FRL).
[3] Total uranium was not included in the Background Soil Study and has been calculated fromthe original background data.

FRL = Final remediation level
LBGR = Lower bound of the gray region
N = Size of sample population
SD = Standard deviation

TABLE G-8

ESTIMATED SAMPLE POPULATIONS FOR A TYPE II ERROR RATE OF 10%

Remnant Data Less Than 2 Times the FRL

	Type I Error Rate = 5%					
	FRL[1]	LBGR[2]	SD	calc N	N	N+20%
Radium-226	1.7	1.275	0.448	9.52	10	12
Radium-228	1.8	1.350	0.376	5.98	6	8
Thorium-228	1.7	1.275	0.498	11.8	12	15
Thorium-232	1.5	1.125	0.364	8.07	9	11
Uranium, total[3]	82	61.50	12.6	3.24	4	5
Uranium, total	50	37.50	12.6	8.70	9	11
Arsenic	12	9.000	2.96	8.34	9	11
Beryllium	1.5	1.125	0.419	10.7	11	14

	Type I Error Rate = 10%					
	FRL	LBGR	SD	calc N	N	N+20%
Radium-226	1.7	1.275	0.448	7.30	8	10
Radium-228	1.8	1.350	0.376	4.59	5	6
Thorium-228	1.7	1.275	0.498	9.02	9	12
Thorium-232	1.5	1.125	0.364	6.19	7	9
Uranium, Total	82	61.50	12.6	2.48	3	4
Uranium, Total	50	37.50	12.6	6.68	7	9
Arsenic	12	9.000	2.96	6.40	7	9
Beryllium	1.5	1.125	0.419	8.20	9	11

[1] All radionuclides are given in pCi/g; total uranium, arsenic, and beryllium are given in mg/kg.
[2] LBGR is calculated as 75% of the FRL (i.e., 0.75 x FRL).
[3] Total uranium was not included in the Background Soil Study and has been calculated fromthe original background data.

FRL = Final remediation level
LBGR = Lower bound of the gray region
N = Size of sample population
SD = Standard deviation

TABLE G-9

ESTIMATED SAMPLE POPULATIONS FOR A TYPE II ERROR RATE OF 20%

Remnant Data Less Than 3 Times the FRL

	Type I Error Rate = 5%					
	FRL	LBGR	Stand. Dev.	calc N	N	N+20%
Radium-226	1.7	1.275	0.492	8.29	9	11
Radium -228	1.8	1.350	0.376	4.32	5	6
Thorium-228	1.7	1.275	0.515	9.08	10	12
Thorium-232	1.5	1.125	0.387	6.59	7	9
Uranium, total[3]	82	61.50	13.9	2.84	3	4
Uranium, total	50	37.50	13.9	7.65	8	10
Arsenic	12	9.000	2.96	6.02	7	9
Beryllium	1.5	1.125	0.451	8.95	9	11

	Type I Error Rate = 10%					
	FRL	LBGR	Stand. Dev	calc N	N	N+20%
Radium-226	1.7	1.275	0.492	6.05	7	9
Radium-228	1.8	1.350	0.376	3.15	4	5
Thorium-228	1.7	1.275	0.515	6.62	7	9
Thorium-232	1.5	1.125	0.387	4.80	5	6
Uranium, total	82	61.50	13.9	2.07	3	4
Uranium, total	50	37.50	13.9	5.58	6	8
Arsenic	12	9.000	2.96	4.39	5	6
Beryllium	1.5	1.125	0.451	6.53	7	9

[1] All radionuclides are given in pCi/g; total uranium, arsenic, and beryllium are given in mg/kg.
[2] LBGR is calculated as 75% of the FRL (i.e., 0.75 x FRL).
[3] Total uranium was not included in the Background Soil Study and has been calculated fromthe original background data.

FRL = Final remediation level
LBGR = Lower bound of the gray region
N = Size of sample population
SD = Standard deviation

TABLE G-10

ESTIMATED SAMPLE POPULATIONS FOR A TYPE II ERROR RATE OF 15%

Remnant Data Less Than 3 Times the FRL

	Type I Error Rate = 5%					
	FRL[1]	LBGR[2]	SD	calc N	N	N+20%
Radium-226	1.7	1.275	0.492	9.63	10	12
Radium-228	1.8	1.350	0.376	5.02	6	8
Thorium-228	1.7	1.275	0.515	10.6	11	14
Thorium-232	1.5	1.125	0.387	7.66	8	10
Uranium, total[3]	82	61.50	13.9	3.31	4	5
Uranium, total	50	37.50	13.9	8.89	9	11
Arsenic	12	9.000	2.96	7.00	7	9
Beryllium	1.5	1.125	0.451	10.4	11	14

	Type I Error Rate = 10%					
	FRL	LBGR	SD	calc N	N	N+20%
Radium-226	1.7	1.275	0.492	7.20	8	10
Radium-228	1.8	1.350	0.376	3.75	4	5
Thorium-228	1.7	1.275	0.515	7.89	8	10
Thorium-232	1.5	1.125	0.387	5.72	6	8
Uranium, total	82	61.50	13.9	2.47	3	4
Uranium, total	50	37.50	13.9	6.64	7	9
Arsenic	12	9.000	2.96	5.23	6	8
Beryllium	1.5	1.125	0.451	7.77	8	10

[1] All radionuclides are given in pCi/g; total uranium, arsenic, and beryllium are given in mg/kg.
[2] LBGR is calculated as 75% of the FRL (i.e., 0.75 x FRL).
[3] Total uranium was not included in the Background Soil Study and has been calculated fromthe original background data.

FRL = Final remediation level
LBGR = Lower bound of the gray region
N = Size of sample population
SD = Standard deviation

TABLE G-11

ESTIMATED SAMPLE POPULATIONS FOR A TYPE II ERROR RATE OF 10%

Remnant Data Less Than 3 Times the FRL

	Type I Error Rate = 5%					
	FRL[1]	LBGR[2]	SD	calc N	N	N+20%
Radium-226	1.7	1.275	0.492	11.5	12	15
Radium-228	1.8	1.350	0.376	5.98	6	8
Thorium-228	1.7	1.275	0.515	12.6	13	16
Thorium-232	1.5	1.125	0.387	9.12	10	12
Uranium, total[3]	82	61.50	13.9	3.94	4	5
Uranium, total	50	37.50	13.9	10.6	11	14
Arsenic	12	9.000	2.96	8.34	9	11
Beryllium	1.5	1.125	0.451	12.4	13	16

	Type I Error Rate = 10%					
	FRL	LBGR	SD	calc N	N	N+20%
Radium-226	1.7	1.275	0.492	8.80	9	11
Radium-228	1.8	1.350	0.376	4.59	5	6
Thorium-228	1.7	1.275	0.515	9.65	10	12
Thorium-232	1.5	1.125	0.387	7.00	7	9
Uranium, total	82	61.50	13.9	3.02	4	5
Uranium, total	50	37.50	13.9	8.12	9	11
Arsenic	12	9.000	2.96	6.40	7	9
Beryllium	1.5	1.125	0.451	9.50	10	12

[1] All radionuclides are given in pCi/g; total uranium, arsenic, and beryllium are given in mg/kg.
[2] LBGR is calculated as 75% of the FRL (i.e., 0.75 x FRL).
[3] Total uranium was not included in the Background Soil Study and has been calculated fromthe original background data.

FRL = Final remediation level
LBGR = Lower bound of the gray region
N = Size of sample population
SD = Standard deviation

TABLE G-12

ESTIMATED TARGET LEVELS (LBGR) REQUIRED FOR A SAMPLE SIZE OF 12:

Type I Error Rate = 5% (* = 10%);

Type II Error rate = 0.20

		Less than 2 times the FRL		Less than 3 times the FRL	
Analyte	FRL	LBGR % of FRL	LBGR	LBGR % of FRL	LBGR
Radium-226 (pCi/g)	1.7	79%	1.34	77%	1.31
Radium-228 (pCi/g)	1.8	83%	1.49	83%	1.49
Thorium-228 (pCi/g)	1.7	76%	1.29	76%	1.29
Thorium-232 (pCi/g)	1.5	80%	1.20	79%	1.19
Uranium, total (mg/kg)	82	87%	71.3	86%	70.5
Uranium, total (mg/kg)	50	80%	40.0	78%	39.0
Arsenic (mg/kg)*	12	83%	9.96	83%	9.96
Beryllium (mg/kg)*	1.5	81%	1.22	79%	1.19

Type II Error rate = 0.15

		Less than 2 times the FRL		Less than 3 times the FRL	
Analyte	FRL	LBGR % of FRL	LBGR	LBGR % of FRL	LBGR
Radium-226 (pCi/g)	1.7	77%	1.31	75%	1.28
Radium-228 (pCi/g)	1.8	82%	1.48	82%	1.48
Thorium-228 (pCi/g)	1.7	75%	1.28	74%	1.26
Thorium-232 (pCi/g)	1.5	79%	1.19	78%	1.17
Uranium, total (mg/kg)	82	86%	70.5	85%	69.7
Uranium, total (mg/kg)	50	78%	39.0	76%	38.0
Arsenic (mg/kg)*	12	81%	9.72	81%	9.72
Beryllium (mg/kg)*	1.5	79%	1.19	77%	1.16

Type II Error rate = 0.10

		Less than 2 times the FRL		Less than 3 times the FRL	
Analyte	FRL	LBGR % of FRL	LBGR	LBGR % of FRL	LBGR
Radium-226 (pCi/g)	1.7	75%	1.28	73%	1.24
Radium-228 (pCi/g)	1.8	80%	1.44	80%	1.44
Thorium-228 (pCi/g)	1.7	72%	1.22	71%	1.21
Thorium-232 (pCi/g)	1.5	77%	1.16	76%	1.14
Uranium, total (mg/kg)	82	85%	69.7	84%	68.9
Uranium, total (mg/k)g	50	76%	38.0	74%	37.0
Arsenic (mg/kg)*	12	80%	9.60	80%	9.60
Beryllium (mg/kg)*	1.5	77%	1.16	75%	1.13

TABLE G-13

VARIATION OF SAMPLE POPULATION WITH CHANGE IN PARAMETER

Parameter	Increase Value	Decrease Value
Type II Error	Fewer Samples	More Samples
Target Level	More Samples	Fewer Samples
Estimated Standard Deviation	More Samples	Fewer Samples

TABLE G-14

COMPARISON OF AREA 1, PHASE I CERTIFICATION RESULTS TO ESTIMATES USED IN THE DETERMINATION OF SAMPLE SIZE

Primary COCs	FRL	Avg. CU Mean	% FRL	Remnant SD (2x FRL)	Avg. CU St. Dev.	% Remnant
Radium-226 (pCi/g)	1.7	1.210	71.2%	0.448	0.188	42.0%
Radium-228 (pCi/g)	1.8	1.241	69.0%	0.376	0.208	55.2%
Thorium-228 (pCi/g)	1.7	1.224	72.0%	0.498	0.175	35.2%
Thorium-232 (pCi/g)	1.5	1.117	74.5%	0.364	0.150	41.1%

Secondary COCs	FRL	Avg. CU Mean	% FRL	Remnant SD 2x FRL	Avg. CU St. Dev.	% Remnant
Uranium, total (mg/kg)	82	11.712	14.3%	12.602	6.625	52.6%
Arsenic (mg/kg)	12	8.310	69.2%	2.962	2.258	76.2%
Beryllium (mg/kg)	1.5	0.648	43.2%	0.419	0.271	64.8%

TABLE G-15

SITE-SPECIFIC VALUES IN RESRAD AREA SIZE ANALYSES

Parameter Name	ID	Value	Units	Reference
Exposure Duration	ED	38	y/life	OU5 FS
Exposure Frequency	EF	40	d/y	OU5 FS
Exposure Time	ET	2	h/d	OU5 FS
Inhalation Rate	IRair	0.83	m3/h	OU5 FS (20/24)
	IRair	66.7	m3/y	0.8333*2*40
Soil Ingestion Rate	IRsoil	13	mg/d	OU5 FS
	IRsoil	0.52	g/y	40*13/1000
Soil Porosity	P	0.457	unitless	OU5 RI Appendix A.VIII-5
Effective Porosity		0.25		OU5 FS
Density of Contaminated Zone	RHO	1.44	g/cm	OU5 RA
Radon Emanation Fraction	E	0.2	unitless	OU5 RI Appendix A.VIII-5
Radon Diffusion Coefficient	D	-1	cm2/s	Flag indicating code calcs
Thickness of Contaminated Zone		0.45	m	OU5 FS
Erosion Rate		0.00001	m/y	OU5 FS
Hydraulic Conductivity		22	m/y	OU5 FS
Mass Loading in Air		2.00E-05	g/m3	OU5 FS

TABLE G-16

RTRAK PERFORMANCE AT THE FRL AND AT THREE TIMES THE FRL (DOE 1997)

	Ra-226 (pCi/g)			Th-232 (pCi/g)			Total U (ppm)		
Activity Level	Error (pCi/g)	Averaging Radius (ft)	# of points	Error (pCi/g)	Averaging Radius (ft)	# of points	Error (pCi/g)	Averaging Radius (ft)	# of points
FRL	0.17	20	25	0.15	10	12	8	40	100
3 x FRL	0.51	10	12	0.45	8	5	24	25	45

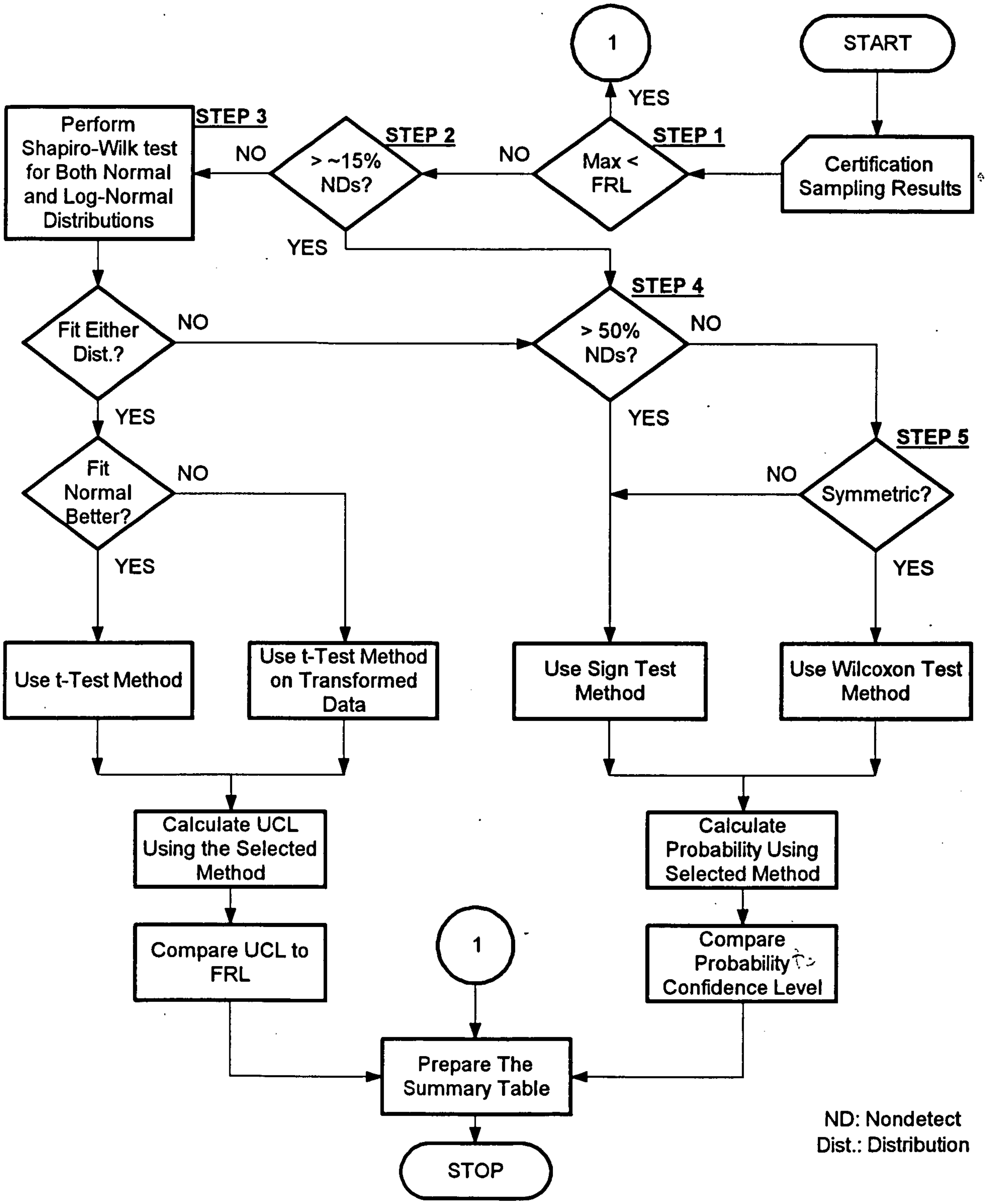

FIGURE G-1 SELECTION PROCEDURE FOR THE CERTIFICATION STATISTICAL ANALYSIS METHOD

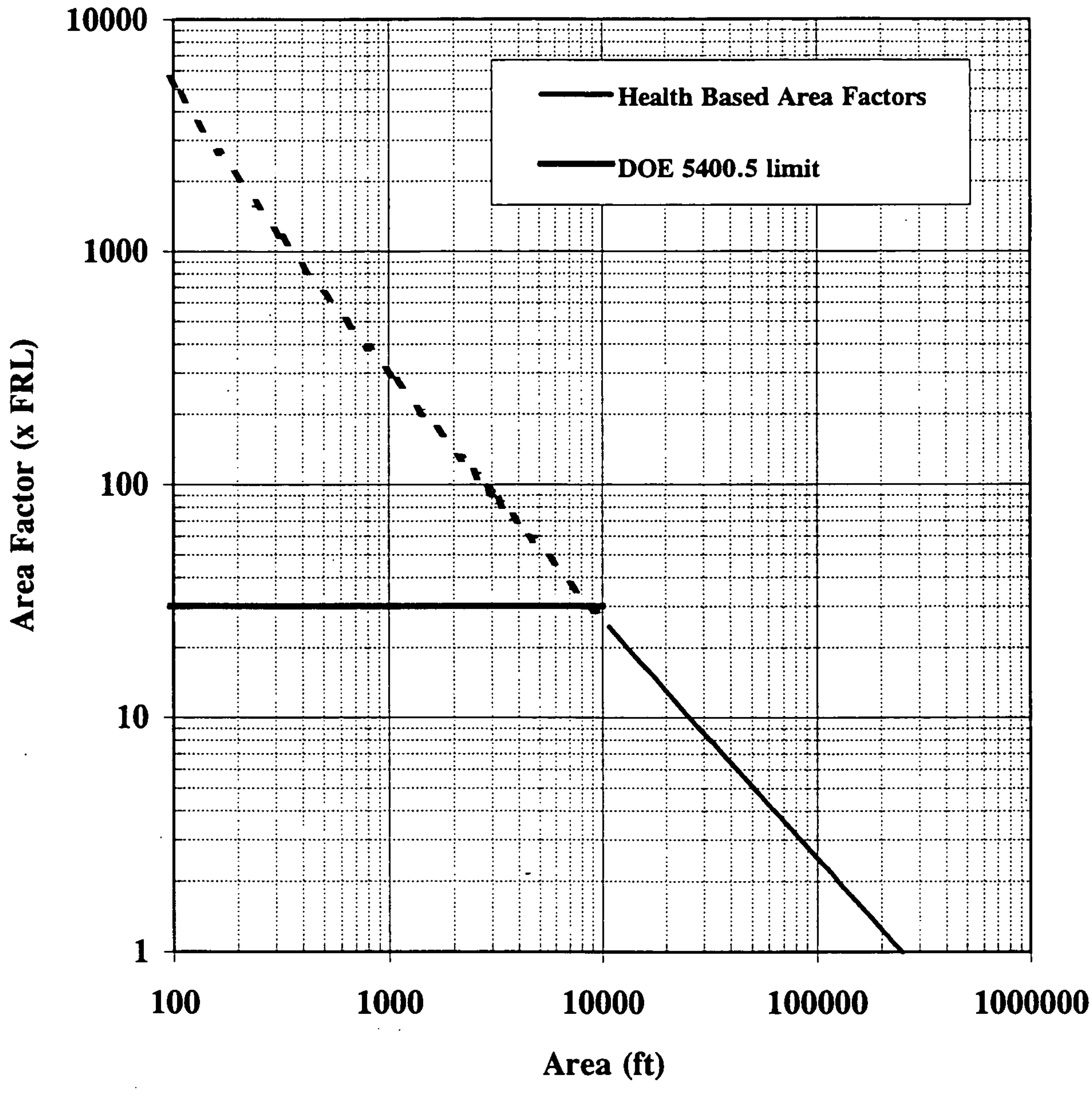

Figure G-2 Site-Specific Area Factors for a Roving Undeveloped Park User Based on Health Effects and DOE Order 5400.4 Upper Limit of 30 Times the Guideline Limit