**United States
Department of
Agriculture**

Office of the
Assistant Secretary
for Administration

Office of Homeland
Security and
Emergency
Coordination

Radiation Safety
Division

5601 Sunnyside
Avenue, MS 5510
Beltsville, MD
20705

May 12, 2014

US Nuclear Regulatory Commission
Region I
ATTN: Mark Roberts, Decommissioning Branch, DNMS
2100 Renaissance Boulevard
Renaissance Park
King of Prussia, PA 19406-1415

L8

19-00915-03

License No. 19-00915-03
Docket No. 030-04530

Dear Mr. Roberts:

This is in reference to Condition 29 of NRC License Number 19-00915-03
and the Decommissioning Plan (DP) and Final Status Survey (FSS) for the
low-level radioactive waste burial site in Beltsville, Maryland. Excavation
activities at the Beltsville site have revealed that the actual locations of
buried materials within the well-defined burial site area were not as deep
as assumed when developing the DP and FSS. We have also determined
that some of the soil sampling and surveying protocols in the DP and FSS
are contradictory or incomplete or do not comply with Multi-Agency
Radiation Survey and Site Investigation Manual (MARSSIM) guidance.
The enclosed BARC Technical Memo – Final Status Survey Plan
Improvements, dated May 2014 (developed for USDA by TPMC – Energy
Solutions Services, LLC), describes proposed changes to the site
excavation depth, number of soil samples to be analyzed, type of radiation
level surveys to be performed, and extent of area to be surveyed. These
changes are consistent with MARSSIM guidance and will ensure that we
obtain sufficient data for release of the site for unrestricted use.

We would appreciate your expedited review of this request so that we can
continue to move forward with this important work. If you have any
questions, please contact me on 301-504-2441.

Sincerely,
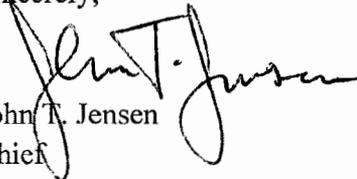
John T. Jensen
Chief

Enclosure

584055

NMSS/RGN1 MATERIALS-002

BARC Technical Memo
Final Status Survey Plan Improvements
BTM-02
Rev. 2

Low Level Radioactive Burial Site Remediation
Beltsville Agricultural Research Center
Beltsville, Maryland

Contract No. W52P1J-11-D-0001

Prepared for:

USDA

United States Department of Agriculture

Prepared by:

*TPMC-Energy*Solutions *Environmental Services*, LLC

TES

May 2014

Technical Memo – Title Page

WORK
INSTRUCTION

Project:		
	Project No.	91003
	TM No.	BTM-02
	Rev. No.	2
	Effective Date:	May 12, 2014

Written By/Date		
Kelly Ellis	May 12, 2014	*Kelly D Ellis*
Approved By/Date		
Brian Clayman	May 12, 2014	*[signature]*
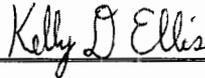
Title: Final Status Survey Plan Improvements

Table of Contents

BTM-02, Rev. 2   **May 12, 2014**

1.0 PURPOSE

This document compares guidance provided in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM, NUREG 1575) to the requirements specified in the BARC final status survey plan (FSSP) regarding surveys that support removal of the BARC low level radioactive burial site (LLRBS) from the U.S. Department of Agriculture's (USDA) radioactive materials license. It then suggests modifications to the FSSP that will result in more consistency with MARSSIM guidance.

2.0 BACKGROUND

The USDA located at Beltsville, MD requires the free release/decommissioning, and license termination of the BARC burial sites. The FSSP was prepared by Cabrera Services for the USDA and approved by the Nuclear Regulatory Commission (NRC) in January 2012. TPMC-Energy*Solutions* Environmental Services, LLC (TES) was selected to perform the decommissioning activities and began site mobilization in May 2013.

3.0 DISCUSSION

The Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM, NUREG 1575) provides information on planning, conducting, evaluating, and documenting building and surface soil final status radiological surveys for demonstrating compliance with dose or risk-based regulations or standards. MARSSIM is a multi-agency consensus document that was developed collaboratively by four Federal agencies having authority and control over radioactive materials: Department of Defense (DOD), Department of Energy (DOE), Environmental Protection Agency (EPA), and Nuclear Regulatory Commission (NRC). Its objective is to provide a consistent approach for building and surface soil final status surveys to meet established dose or risk-based release criteria, while at the same time encouraging an effective use of resources.

The BARC decommissioning plan (DP), which includes the FSSP, is part of the USDA's radioactive material license. It provides historical information regarding the BARC Site and defines the requirements for the performance of decommissioning activities.

The final status survey (FSS) was designed in accordance with MARSSIM guidance and is being performed to support the release of the BARC Low-Level Radioactive Burial Site (LLRBS) for unrestricted use. The FSSP states that MARSSIM provides acceptable methodology to demonstrate compliance with project cleanup goals. In no instance does the FSSP indicate that a departure from the guidance presented in MARSSIM is intended. The FSSP provides project specific survey and sampling requirements that were designed using the guidance presented in MARSSIM, and if properly executed, should result in the release of the BARC site from the USDA's radioactive material license. Section 3.7 of the FSSP provides detail regarding the number of sample locations and the amount of survey coverage.

3.1   Determining the Number of Data Points for Statistical Tests

Section 5.5 of MARSSIM specifies the criteria and methods used to design final status surveys. MARSSIM Section 5.5.2.2 contains the criteria for determining the number of data points for statistical tests when the contaminant is present in background. Select portions of Section 5.5.2.2 are provided below as _underlined and italicized text_ to aid the reader in understanding the final status survey design.

> _The comparison of measurements from the reference area and survey unit is made using the WRS test, which should be conducted for each survey unit…_

> _This section introduces several terms and statistical parameters that will be used to determine the number of data points needed to apply the nonparametric tests. An example is provided to better illustrate the application of these statistical concepts._

Survey design data from the BARC decommissioning plan will be presented in the example.

> **_Calculate the Relative Shift_**_. The lower bound of the gray region (LBGR) is selected during the DQO Process along with the target values for α and β. The width of the gray region, equal to (DCGL_W _- LBGR), is a parameter that is central to the WRS test. This parameter is also referred to as the shift, Δ. The absolute size of the shift is actually of less importance than the relative shift, Δ/σ, where σ is an estimate of the standard deviation of the measured values in the survey unit. This estimate of σ includes both the real spatial variability in the quantity being measured and the precision of the chosen measurement system. The relative shift, Δ/σ, is an expression of the resolution of the measurements in units of measurement uncertainty._

> _The shift (Δ = DCGL_W _- LBGR) and the estimated standard deviation in the measurements of the contaminant (σ_r _and σ_s_) are used to calculate the relative shift, Δ/σ._

From Section 3.7.1 of the FSSP:

$$\Delta\!\big/\!_\sigma = \frac{DCGL_W - LBGR}{\sigma}$$

The DCGL$_W$ is equal to a sum of the ratios value of 1. The LBGR is set at half the DCGL$_W$ and has a value of 0.5. σ is estimated as 0.3 times the DCGL$_W$ (0.3*1 = 0.3) or 0.3.

$$\Delta\!\big/\!_\sigma = \frac{1 - 0.5}{0.3} = \frac{0.5}{0.3} = 1.67$$

> **_Determine P_**_r_. _The probability that a random measurement from the survey unit exceeds a random measurement from the background reference area by less than the DCGL_W _when the survey unit median is equal to the LBGR above background is defined as P_r. _P_r _is used in Equation 5-1 for determining the number of measurements to be performed during the survey. Table 5.1 lists relative shift values and values for P_r. _Using the relative shift calculated in the preceding section, the value of P_r _can be obtained from Table 5.1. Information on calculating individual values of P_r _is available in NUREG-1505 (NRC 1998)._

> _If the actual value of the relative shift is not listed in Table 5.1, always select the next lower value that appears in the table. For example, Δ/σ =1.67 does not appear in Table 5.1. The next lower value is 1.6, so the value of_ **_P_**_r would be_ **_0.871014_**_._

Table 5.1 Values of P_r for Given Values of the Relative Shift, Δ/σ,
when the Contaminant is Present in Background

Δ/σ	P_r	Δ/σ	P_r
0.1	0.528182	1.4	0.838864
0.2	0.556223	1.5	0.855541
0.3	0.583985	**1.6**	**0.871014**
0.4	0.611335	1.7	0.885299
0.5	0.638143	1.8	0.898420
0.6	0.664290	1.9	0.910413
0.7	0.689665	2.0	0.921319
0.8	0.714167	2.25	0.944167
0.9	0.737710	2.5	0.961428
1.0	0.760217	2.75	0.974067
1.1	0.781627	3.0	0.983039
1.2	0.801892	3.5	0.993329
1.3	0.820978	4.0	0.997658

If Δ/σ > 4.0, use P_r = 1.000000

Determine Decision Error Percentiles. *The next step in this process is to determine the percentiles, $Z_{1-\alpha}$ and $Z_{1-\beta}$, represented by the selected decision error levels, α and β, respectively (see Table 5.2). $Z_{1-\alpha}$ and $Z_{1-\beta}$ are standard statistical values (Harnett 1975).*

Table 5.2 Percentiles Represented by Selected Values of α and β

α (or β)	$Z_{1-\alpha}$ (or $Z_{1-\beta}$)	α (or β)	$Z_{1-\alpha}$ (or $Z_{1-\beta}$)
0.005	2.576	0.10	1.282
0.01	2.326	0.15	1.036
0.015	2.241	0.20	0.842
0.025	1.960	0.25	0.674
0.05	**1.645**	0.30	0.524

Section 3.7.2 of the FSSP establishes the values for α and β = 0.05 with a corresponding $Z_{1-\alpha}$ and $Z_{1-\beta}$ = 1.645.

Calculate Number of Data Points for WRS Test. *The number of data points, N, to be obtained from each reference area/survey unit pair for the WRS test is next calculated using Equation 5-1:*

$$N = \frac{\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2}{3\left(P_r - 0.5\right)^2} \quad (5\text{-}1)$$

For the BARC project:

$$N = \frac{\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2}{3\left(P_r - 0.5\right)^2} = \frac{\left(1.645 + 1.645\right)^2}{3\left(0.871014 - 0.5\right)^2} = \frac{(3.29)^2}{3(0.371014)^2} = \frac{10.8241}{0.412954} = 26.21$$

The value of N calculated using equation 5-1 is an approximation based on estimates of σ and P_r, so there is some uncertainty associated with this calculation. In addition, there will be some missing or unusable data from any survey. The rate of missing or unusable measurements, R, expected to occur in survey units or reference areas and the uncertainty associated with the calculation of N should be accounted for during survey planning. The number of data points should be increased by 20%, and rounded up, over the values calculated using equation 5-1 to obtain sufficient data points to attain the desired power level with the statistical tests and allow for possible lost or unusable data. The value of 20% is selected to account for a reasonable amount of uncertainty in the parameters used to calculate N and still allow flexibility to account for some lost or unusable data. The recommended 20% correction factor should be applied as a minimum value. Experience and site-specific considerations should be used to increase the correction factor if required. If the user determines that the 20% increase in the number of measurements is excessive for a specific site, a retrospective power curve should be used to demonstrate that the survey design provides adequate power to support the decision (see Appendix I).

For BARC:

N with 20% overage = N+(N*0.2) = 26.21+(26.21*0.2) = 26.21+5.242 = 31.452

N must be divisible by two; therefore the value 31.452 is rounded up to the next whole number divisible by two, which in this case is 32.

$$N = 32$$

N is the total number of data points for each survey unit/reference area combination. The N data points are divided between the survey unit, n, and the reference area, m. The simplest method for distributing the N data points is to assign half the data points to the survey unit and half to the reference area, so n=m=N/2. This means that N/2 measurements are performed in each survey unit, and N/2 measurements are performed in each reference area. If more than one survey unit is associated with a particular reference area, N/2 measurements should be performed in each survey unit and N/2 measurements should be performed in the reference area.

$$N/2 = 16$$

Table 5.3 Values of N/2 for Use with the Wilcoxon Rank Sum Test

Δ/σ	α=0.01 β					α=0.025 β					α=0.05 β					α=0.10 β					α=0.25 β				
	0.01	0.025	0.05	0.10	0.25	0.01	0.025	0.05	0.10	0.25	0.01	0.025	0.05	0.10	0.25	0.01	0.025	0.05	0.10	0.25	0.01	0.025	0.05	0.10	0.25
0.1	5452	4627	3972	3278	2268	4627	3870	3273	2646	1748	3972	3273	2726	2157	1355	3278	2646	2157	1655	964	2268	1748	1355	964	459
0.2	1370	1163	998	824	570	1163	973	823	665	440	998	823	685	542	341	824	665	542	416	243	570	440	341	243	116
0.3	614	521	448	370	256	521	436	369	298	197	448	369	307	243	153	370	298	243	187	109	256	197	153	109	52
0.4	350	297	255	211	146	297	248	210	170	112	255	210	175	139	87	211	170	139	106	62	146	112	87	62	30
0.5	227	193	166	137	95	193	162	137	111	73	166	137	114	90	57	137	111	90	69	41	95	73	57	41	20
0.6	161	137	117	97	67	137	114	97	78	52	117	97	81	64	40	97	78	64	49	29	67	52	40	29	14
0.7	121	103	88	73	51	103	86	73	59	39	88	73	61	48	30	73	59	48	37	22	51	39	30	22	11
0.8	95	81	69	57	40	81	68	57	46	31	69	57	48	38	24	57	46	38	29	17	40	31	24	17	8
0.9	77	66	56	47	32	66	55	46	38	25	56	46	39	31	20	47	38	31	24	14	32	25	20	14	7
1.0	64	55	47	39	27	55	46	39	32	21	47	39	32	26	16	39	32	26	20	12	27	21	16	12	6
1.1	55	47	40	33	23	47	39	33	27	18	40	33	28	22	14	33	27	22	17	10	23	18	14	10	5
1.2	48	41	35	29	20	41	34	29	24	16	35	29	24	19	12	29	24	19	15	9	20	16	12	9	4
1.3	43	36	31	26	18	36	30	26	21	14	31	26	22	17	11	26	21	17	13	8	18	14	11	8	4
1.4	38	32	28	23	16	32	27	23	19	13	28	23	19	15	10	23	19	15	12	7	16	13	10	7	4
1.5	35	30	25	21	15	30	25	21	17	11	25	21	18	14	9	21	17	14	11	7	15	11	9	7	3
1.6	32	27	23	19	14	27	23	19	16	11	23	19	**16**	13	8	19	16	13	10	6	14	11	8	6	3
1.7	30	25	22	18	13	25	21	18	15	10	22	18	15	12	8	18	15	12	9	6	13	10	8	6	3
1.8	28	24	20	17	12	24	20	17	14	9	20	17	14	11	7	17	14	11	9	5	12	9	7	5	3
1.9	26	22	19	16	11	22	19	16	13	9	19	16	13	11	7	16	13	11	8	5	11	9	7	5	3
2.0	25	21	18	15	11	21	18	15	12	8	18	15	13	10	7	15	12	10	8	5	11	8	7	5	3
2.25	22	19	16	14	10	19	16	14	11	8	16	14	11	9	6	14	11	9	7	4	10	8	6	4	2
2.5	21	18	15	13	9	18	15	13	10	7	15	13	11	9	6	13	10	9	7	4	9	7	6	4	2
2.75	20	17	15	12	9	17	14	12	10	7	15	12	10	8	5	12	10	8	6	4	9	7	5	4	2
3.0	19	16	14	12	8	16	14	12	10	6	14	12	10	8	5	12	10	8	6	4	8	6	5	4	2
3.5	18	16	13	11	8	16	13	11	9	6	13	11	9	8	5	11	9	8	6	4	8	6	5	4	2
4.0	18	15	13	11	8	15	13	11	9	6	13	11	9	7	5	11	9	7	6	4	8	6	5	4	2

MARSSIM Table 5.3 provides a list of the number of data points used to demonstrate compliance using the WRS test for selected values of α and β (decision errors), and the relative shift (Δ/σ). The values listed in Table 5.3 represent the number of measurements to be performed in each survey unit as well as in the corresponding reference area. The values were calculated using Equation 5-1 and increased by 20% for the reasons discussed in the previous section.

In section 3.7.2 of the FSSP, N/2 is correctly taken from Table 5.3 in MARSSIM as 16 (which matches the result of the calculation previously presented), but then the value is increased by an additional 20% to a value of 20 without technical justification.

Using the design data in the FSSP and the guidance presented in MARSSIM we have verified through calculations that N/2 can be conservatively set at a value of 16.

It is important to note that Section 3.7.2 of the FSSP further states that a minimum of 20 sample locations is required in each Class 1 survey unit (disposal pit bottoms and interstitial soil), each Class 2 survey unit (soil from five to six feet below original surface grade), each Class 3 survey unit (soil from original surface grade to five feet below original surface grade), and the reference area. With the exception of the specified value for N/2, these requirements are consistent with MARSSIM guidance.

3.2   Volumetric Survey and Sampling Protocols

MARSSIM does not address volumetric survey and sampling protocols. However the FSSP provides a method for applying MARSSIM guidance to a given volume of soil and is presented in section 3.11 of the FSSP. The section relating to Class 1 survey units consisting of interstitial soils is presented below:

Systematic soil samples will be collected from Class 1 interstitial soils at a rate of one sample for every 398 cubic yards of soil; given that MARSSIM does not address depth and sampling per unit volume, this volumetric sampling rate is approximated by multiplying the six-inch thickness of the Class 1 lifts by the MARSSIM recommended size limitation for a Class 1 area (2,000 m² or 2,392 square yards 0.167 yards depth [i.e., six inches depth] = 398 cubic yards of soil).

While a Class 1 volumetric survey unit is reasonably defined as 398 yd³ of soil, it is inconsistent with MARSSIM guidance to collect only one sample from each of these survey units. It would be much more appropriate to increase the sampling rate to 16 samples per 398 yd³ of Class 1 interstitial soils as explained in the previous section.

3.3   Field Scanning Surveys of Land Areas

Both MARSSIM and the FSSP prescribe that scanning surveys be performed as part of a final status survey of land areas. Excerpts from both MARSSIM and the FSSP are included below to better highlight their guidance.

MARSSIM Chapter 6 clearly prescribes the performance of gamma scan surveys for land areas:

<u>Scan MDCs for Structure Surfaces and Land Areas. The survey design for determining the number of data points for areas of elevated activity (see Section 5.5.2.4) depends on the scan MDC for the selected instrumentation. In general, alpha or beta scans are performed on structure surfaces to satisfy the elevated activity measurements survey design, while gamma scans are performed for land areas.</u>

The many reasons for performing only gamma scan surveys on land areas are further detailed in NRC report NUREG-1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*, (NRC 1998).

The FSSP satisfies the scanning requirement for land areas through the performance of beta and gamma walkover surveys. However Section 3.1 of the FSSP contains the following passage:

Beta scan surveys do not have calculated MDCs because these surveys are for qualitative use only; beta scan survey data is intended solely for the purpose of locating areas of elevated radioactivity to direct biased sample collection.

From the excerpts presented above we can conclude the following:

- MARSSIM requires gamma scans of land areas when performing final status surveys;

- The beta scan surveys prescribed in the FSSP are for qualitative use only and, unlike gamma scan survey results, cannot be correlated to a value of residual radioactivity.

Therefore the FSSP should prescribe that only gamma scan surveys be performed on land areas.

3.4   Assumed Extents of Contamination versus Final Depth of Excavation

This section discusses the project planning assumption that residual contamination at the BARC LLRBS extends vertically to a depth of 15 feet below grade and the impact of this assumption on specified project excavation requirements.

3.4.1   MARSSIM

As previously stated in section 3.0, MARSSIM provides information on planning, conducting, evaluating, and documenting building and surface soil final status radiological surveys for demonstrating compliance with dose or risk-based regulations or standards. It therefore provides no guidance relative to the physical extent of waste removal activities.

3.4.2   BARC DP

The BARC DP references a depth of 15 feet in 2 instances as identified below.

1. BARC DP Section 3.0, Radiological Status of the LLRBS (page 3-4), contains the following passage, which is historical information that specifies no project requirements:

    Soil borings were advanced beneath the excavated burial pits as well in a background reference area. Soil borings from the background reference area were similar to previous results, while the boring beneath Pit 1 encountered a three-foot clay lens at a depth of 12 to 15 feet. This lens was not encountered beneath every pit nor in borings on the outside edges of the LLRBS.

2. BARC DP Appendix B, Site-Specific Derived Concentration Guideline Level, Section 3.2, Conceptual Site Model (CSM, page 3-1), contains the following passage, which relates only to the modeling assumptions used to generate the DCGLs and again specifies no project requirements:

    The thickness of the contaminated zone is assumed to be 15 feet (4.57 meter). As a part of decommissioning plan, soils below the soil DCGL will be re-used as a fill material for the Site.

3.4.3   BARC FSSP

The FSSP references a depth of 15 feet in 5 instances as identified below.

1. Section 2.10, Conceptual Site Model (page 9), contains the following passage, which relates only to the modeling assumptions used to generate the DCGLs and again specifies no project requirements:

    The thickness of the contaminated zone is assumed to be 15 feet (4.6 meter). In addition, during the decommissioning of the site, soils below DCGL criteria will be used as a backfill material for the Site.

2. Section 3.6, Identify Survey Units (page 17), contains the following passages, which are specific to survey unit design but not to the actual extents of the residual contamination:

    The Site has three types of survey units:

    -   *Class 1 (soil from disposal pit bottoms to <u>15 feet</u> below original surface grade and interstitial soil residing below a height of six feet below original surface grade between individual disposal pits throughout the North Field area)*

    -   *Class 2 (soil from five to six feet below original surface grade)*

    -   *Class 3 (soil from original surface grade to five feet below original surface grade)*

    Since the limits of the final disposal pit excavations are unknown prior to remediation activities, each excavation area will be evaluated for size and subdivided into suitable MARSSIM compliant Class 1 survey units before initiating the final status surveys. Several areas of excavation together totaling 2,000 m2 will be combined to comprise a single Class 1 survey unit.

3. Section 3.11, Final Status Survey Methodology Summary, contains the following passage, which establishes a <u>requirement</u> to excavate to 15 feet below grade:

    Once all interstitial soils have been excavated and transported to the laydown area, the excavated areas within the North Field area will represent a single, large excavation. <u>Any material remaining of the upper 15 feet of material below original surface grade</u> (consisting of clean fill, waste, contaminated soil, and interstitial soil present within each disposal pit) <u>will be excavated and removed.</u> (FSSP page 22)

4. Section 4.4, Step 4(A): Define the Study Boundaries, (FSSP page 25), contains the following passage, which is specific to survey unit design and project scope but has no direct application to excavation requirements:

    The populations of interest for the Site are the concentration of ROCs and their associated SORs in Class 1 areas (soil from disposal pit bottoms to <u>15 feet</u> below original surface grade and interstitial soil from between individual disposal pits), Class 2 areas (soil from five to six feet below original surface grade), and Class 3 areas (soil from original surface grade to five feet below original surface grade). The population will be subdivided, as necessary, through the use of survey units.

5. Section 4.4, Step 4(B): Define the Study Boundaries, (FSSP page 25), contains the following passage, which is specific to survey unit design and project scope but has no direct application to excavation requirements:

    The spatial boundaries of this project are horizontally limited to the land area within the North Field of the Site. Vertically, the boundaries are limited to the bottoms of the exhumed disposal pits, <u>15 feet</u> below original ground surface, and the groundwater interface (approximately 25 feet below original ground surface).

3.4.4   Excavation Depth Recommendations

The excerpts presented above clearly show that the depths, 5 feet, 6 feet, and 15 feet, are assumptions that were used to estimate the physical extents of the waste pits for project planning purposes. Waste removal activities at the burial site have revealed that there are no uniform depths associated with the pits. For example, the DP and FSSP indicate that there is 6 feet of non-waste material above each pit, when in fact some of the pits have only 2 to 3 feet of non-waste material covering them. The bottoms of the pits have been reached at non-uniform depths as well, and the horizontal distance between the pits varies from less than a foot to several feet.

To account for these variances the project has implemented the following administrative controls:

1.   The cover material above each pit is removed slowly and cautiously until the top of the waste pit is detected. At this point, regardless of depth; any cover material remaining above the pit becomes part of the waste envelope.

2.   The first foot of bounding interstitial soil, on all sides and the bottom of the waste pit, is considered part of the waste envelope.

3.   Excavation of the pit is considered complete when the waste envelope has been removed.

These administrative controls provide high confidence that all of the waste in each pit is recovered for disposal and that non-waste soil planned for reuse is acceptable for unconditional release while minimizing unnecessary sampling of undisturbed soil.

Therefore the project recommends that the excavation depth requirement specified in Section 3.11 of the FSSP (detailed in Section 3.4.3.3 above) be modified in the following manner:

> *Once all interstitial soils have been excavated and transported to the laydown area, the excavated areas within the North Field area will represent a single, large excavation.* ~~Any material remaining of the upper 15 feet of material below original surface grade (consisting of clean fill, waste, contaminated soil, and interstitial soil present within each disposal pit) will be excavated and removed.~~ *The excavation bottom will be contoured as necessary to provide a relatively smooth surface suitable for the performance of planned survey and sampling activities.*

3.5   Excavation Bottom Final Status Survey Design

The following survey design, which incorporates the recommendations presented previously in this technical memo, is recommended for the performance of the final status survey of the excavation bottom.

3.5.1   Survey Units

The excavation area will be divided into three survey units, similar to those shown in Figure BTM-02-1, Excavation Bottom FSS Design Method. The portion of the excavation bottom which was previously occupied by the burial site will be divided into two Class 1 survey units, each having an area of approximately 1,455 m². The portion of the excavation bottom surrounding the Class 1 survey units will comprise one Class 3 survey unit with an area of approximately 1,395 m².

Figure BTM-02-1
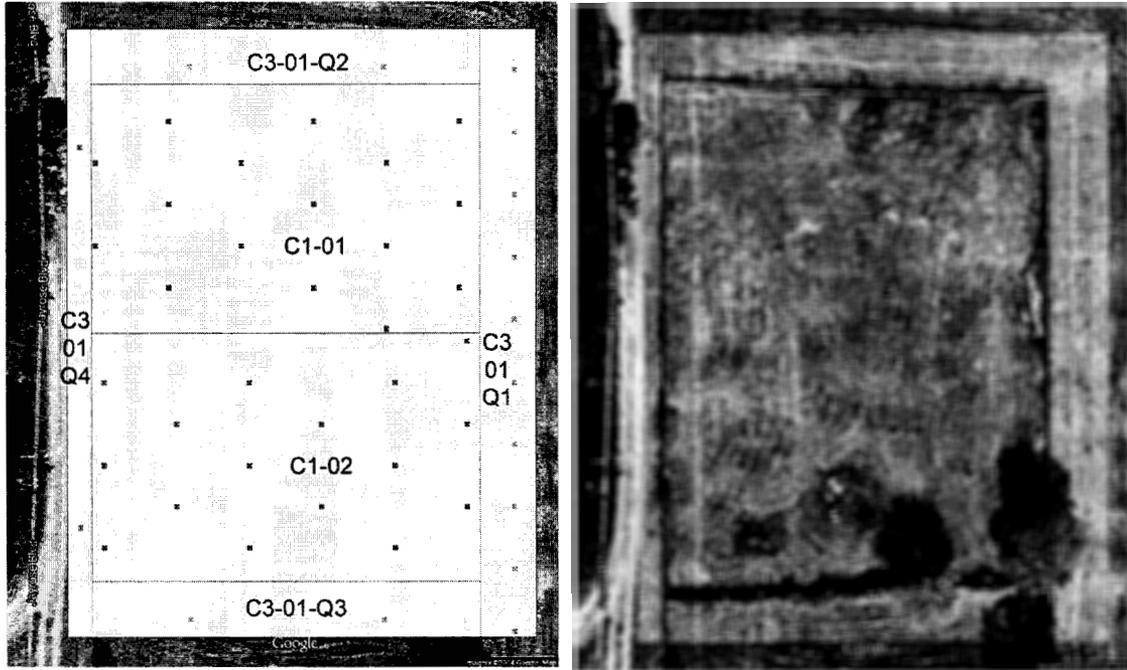**Excavation Bottom FSS Design Method**

Figure BTM-02-1 survey units and sample locations are presented to convey an understanding of the survey design with respect to the survey unit layout and the sample distribution pattern with associated grid spacing. The actual survey units and sample locations, while quite similar to those illustrated, will be marginally different since they will be generated using the final GPS coordinates of the entire excavation, which will not be acquired until excavation activities are complete.

3.5.2   Survey and Sampling

Gamma scan surveys will be performed on 100% of the accessible surfaces of each survey unit.

Sixteen (16) systematic samples will be collected from each survey unit. Systematic sample locations will be established using a triangular grid pattern with a random start point. The samples in the Class 3 survey unit will be biased towards the downslope (eastern) portion of the survey unit. This will be accomplished by dividing the survey unit into the four quadrants shown in Figure BTM-02-1, then distributing the samples as shown in the Table BTM-02-1 below:

Table BTM-02-1
Survey Unit Systematic Sampling

Survey Unit	Quadrant	Samples	Area (m^2)	Sample Density (m^2/sample)
C1-01	N/A	16	1,455	91
C1-02	N/A	16	1,455	91
C3-01	1	10	517	52
C3-01	2	2	324	162
C3-01	3	2	324	162
C3-01	4	2	230	115

Number of samples in Class 3 Quadrants may be adjusted to achieve a sample density between 40 and 200, biased downslope.

4.0 SUMMARY

The observations presented in this technical memo are summarized below:

1. Consistent with MARSSIM guidance, N/2 can be established at a value of 16 for the BARC project.

    a. The number of samples, which will be used for statistical testing, that are collected from each Class 1 interstitial soils survey unit should be increased from 1 sample to 16 samples.

    b. The number of samples, which will be used for statistical testing, that are collected from all other survey units should be decreased from 20 samples to 16 samples.

2. The requirement to perform beta and gamma walkover surveys as part of the final status survey should be modified to require only gamma scan surveys of land areas.

3. The requirement to excavate to a depth of 15 feet below grade should be modified to require excavation to a relative depth of 1 foot below each waste pit with the excavation bottom contoured as necessary to provide a relatively smooth surface suitable for the performance of planned survey and sampling activities.

4. The survey design described in Section 3.5 of this document, consisting of two Class 1 survey units surrounded by one Class 3 survey unit, should be adopted for the final status survey of the excavation bottom.

5.0 REFERENCES

DoD, DOE, NRC, and EPA; Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG-1575, Rev. 2, August 2000.

NRC, Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions, NUREG-1507, June 1998.

CABRERA SERVICES, Decommissioning Plan, BARC LLRWS. Revised Final. January 2012.