MAINE YANKEE
FINAL STATUS SURVEY RELEASE RECORD
FR-0110 PAB ALLEYWAY
SURVEY UNIT 2

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A. SURVEY UNIT DESCRIPTION

Survey Unit FR0110-02 is an excavated area that consists of soil media. The excavation was made in order to remove buried pipes running between the PAB and the Containment Spray Building. The survey unit is located near grid coordinates 407,500 N and 623,800 E using the Maine State Coordinate System (West Zone) NAD 1927, as shown on Map FR 0110-00, Attachment 1.

The Alleyway was a paved area located above the pipe excavation within the Restricted Area, bordered on the west by the Personnel Hatch, Main Steam Valve House, Reactor Motor Control Center, and the Emergency Feedwater Pump Room, on the east by the Service Building, and by the PAB on the north. The survey unit is approximately 130 m^2.

B. SURVEY UNIT DESIGN INFORMATION

The area was designated a Class 1 land survey unit per the LTP (Table 5-1C, R0100, RCA Yard West). The Alleyway excavation was begun in late 2002 and the removed soil was spread and surveyed for possible reuse. Nearly all of the removed soil was found to be acceptable for reuse. The soil survey effort was suspended when the ground froze, and upon returning to soil surveying in the spring of 2003, it was determined that radioactivity had migrated into the remaining soil from the open, abandoned pipes in the excavation pit. Consequently, significant soil remediation had to be performed. Since the survey unit was already Class 1, no reassessment of classification was required.

The survey unit design parameters are shown in Table 1. Given a relative shift of 1.2, it was determined that 23 direct measurements were required for the Sign Test; however, the number of samples was increased to improve the area factor. Fifty-two direct measurements were actually performed. Measurement locations were determined using a fixed grid with a randomly determined start point and are illustrated on the map FR0110-SS-02 (Attachment 1). All direct measurements consisted of soil samples obtained at the required locations. The samples were analyzed by laboratory gamma spectroscopy.

Twenty-eight scan grids of from approximately 3 m^2 to 6 m^2 were established, as indicated on survey map FR0110-02. A 100% scan coverage of the area was required. The survey instruments used, their MDCs, and alarm setpoints are provided in Attachment 2.

Background values were established for the scan measurements based on local scaler values in the survey area. These background values were used to establish scan alarm setpoints and to confirm the scan MDCs used were appropriate. Since the design $DCGL_{EMC}$ is greater than the investigation level, no sample size adjustment is necessary.

TABLE 1

SURVEY UNIT DESIGN PARAMETERS

Survey Unit	Design Criteria	Basis
Area	130 m^2	< Class 1 limit per LTP Rev. 3
Number of Direct Measurements Required	50 (23 required)	Based on an LBGR of 1.6 pCi/g, sigma of 1.33 pCi/g[1], and a relative shift of 1.2, N was adjusted to increase the area factor. Type I = Type II = 0.05
Sample Area	2.6 m^2	130 m^2 / 50
Sample Grid Spacing	1.5 m x 1.5 m	(2.6 m^2) ½
Scan Grid Area	Variable ~ 3 to 6 m^2	
Area Factor	4.2 (conservative)	LTP Rev 3, Table 6-12
Scan Survey Area	130 m^2	Class 1 Area – 100%
Background		
SSPA-3 (scan)	Average background ± 1000 cpm	DI 6-150, LTP Section 5
Scan Investigation Level	~ 12.0 pCi/g (See Table 2-2)	EC-009-01 (MY) (Reference 1)
DCGL	3.2 pCi/g[2]	LTP Rev. 3 and Addenda (Reference 3 and 4)
Design $DCGL_{EMC}$	13.4	Area factor * DCGL

C. SURVEY RESULTS

As required, 52 direct soil samples were collected and the results are presented in Table 2. One of the direct measurements was greater than the DCGL unity fraction. The maximum direct result was 1.15 times the DCGL unity fraction and the mean residual activity is 22% of the unity fraction.

The 28 grids were scanned. No verified alarms occurred. As there were no verified alarms in the scan survey, no investigations were required.

It should be noted that the Co-60 DCGL is 0.86 pCi/g. This is an "adjusted DCGL" and can be derived from the unitized dose for surface soil, LTP Table 6-7 and the updated dose model in the activated concrete related license amendment (Reference 5 and 6). The Co-60 DCGL for surface soil is 1 pCi/g x 10/6.58 mrem/y (from LTP Table 6-7) or 1.5 pCi/g Co-60. This DCGL is further limited by the dose contribution allowed for surface soil only in the basement fill model per LTP Section 6 Attachment IX (revised LTP Table 6-11), in the activated concrete license amendment. Thus, the Co-60 adjusted DCGL is 1.5 pCi/g x 5.63/10 mrem/y or 0.86 pCi/g.

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1 Design sigma from the LTP Rev. 3 Table 5-1C for R0100, RCA Yard West.

2 Design initially used from a DCGL of 3.2 pCi/g Cs-137 but is evaluated to the revised 2.39 pCi/g Cs-137 DCGL (Reference 5).

TABLE 2

DIRECT MEASUREMENTS

Sample Number	Co-60 (pCi/g)	Uncertainty	Cs-137 (pCi/g)	Uncertainty	Unitized Value of Unity Rule
FR0110-02-S001	<5.68E-02		<6.05E-02		0.09
FR0110-02-S002	<5.72E-02		<5.21E-02		0.09
FR0110-02-S003	<6.14E-02		<6.01E-02		0.10
FR0110-02-S004	<6.80E-02		<5.64E-02		0.10
FR0110-02-S005	<5.32E-02		<5.68E-02		0.09
FR0110-02-S006	<5.96E-02		<6.34E-02		0.10
FR0110-02-S007	<5.65E-02		<5.81E-02		0.09
FR0110-02-S008	<5.38E-02		**5.33E-02**	**2.79E-02**	0.08
FR0110-02-S009	<5.66E-02		<3.42E-02		0.08
FR0110-02-S010	<6.52E-02		<6.97E-02		0.10
FR0110-02-S011	<5.81E-02		<6.03E-02		0.09
FR0110-02-S012	<6.12E-02		<5.64E-02		0.09
FR0110-02-S013	<6.04E-02		<6.43E-02		0.10
FR0110-02-S014	<7.04E-02		<5.84E-02		0.11
FR0110-02-S015	<6.79E-02		<6.07E-02		0.10
FR0110-02-S016	<6.08E-02		<6.02E-02		0.10
FR0110-02-S017	<6.61E-02		<5.31E-02		0.10
FR0110-02-S018	<6.32E-02		<5.22E-02		0.10
FR0110-02-S019	**9.66E-01**	**7.14E-02**	<5.66E-02		**1.15**
FR0110-02-S020	<7.72E-02		<5.88E-02		0.11
FR0110-02-S021	**8.87E-02**	**2.68E-02**	<5.93E-02		0.13
FR0110-02-S022	<7.88E-02		<4.72E-02		0.11
FR0110-02-S023	**9.01E-02**	**3.25E-02**	<5.36E-02		0.13
FR0110-02-S024	<6.09E-02		<4.90E-02		0.09
FR0110-02-S025	<7.36E-02		<6.54E-02		0.11
FR0110-02-S026	<6.07E-02		<5.55E-02		0.09
FR0110-02-S027	**2.29E-01**	**4.21E-02**	**5.66E-02**	**3.39E-02**	0.29
FR0110-02-S028	<8.70E-02		<6.11E-02		0.13
FR0110-02-S029	<7.01E-02		<6.18E-02		0.11
FR0110-02-S030	**1.73E-01**	**3.00E-02**	**1.21E-01**	**3.38E-02**	0.25
FR0110-02-S031	**4.14E-01**	**5.01E-02**	**2.71E-01**	**5.39E-02**	0.59
FR0110-02-S032	<1.05E-01		<7.81E-02		0.15
FR0110-02-S033	**2.07E-01**	**4.59E-02**	**1.57E-01**	**5.13E-02**	0.31
FR0110-02-S034	<5.92E-02		<6.13E-02		0.09
FR0110-02-S035	**9.14E-02**	**2.54E-02**	<5.51E-02		0.13
FR0110-02-S036	<8.54E-02		**5.33E-02**	**3.25E-02**	0.12
FR0110-02-S037	<8.32E-02		<7.69E-02		0.13
FR0110-02-S038	**1.62E-01**	**3.23E-02**	**2.25E-01**	**4.86E-02**	0.28
FR0110-02-S039	**2.38E-01**	**4.26E-02**	**2.97E-01**	**4.54E-02**	0.40
FR0110-02-S040	**3.27E-01**	**4.58E-02**	**4.45E-01**	**6.99E-02**	0.57

FR0110-02-S041	<7.88E-02		8.69E-02	3.15E-02	0.13
FR0110-02-S042	7.99E-02	2.87E-02	1.19E-01	3.74E-02	0.14
FR0110-02-S043	<6.81E-02		1.18E-01	3.13E-02	0.13
FR0110-02-S044	2.60E-01	4.24E-02	4.01E-01	6.65E-02	0.47
FR0110-02-S045	<9.20E-02		1.94E-01	4.09E-02	0.19
FR0110-02-S046	1.70E-01	4.84E-02	1.14E-01	3.68E-02	0.25
FR0110-02-S047	1.88E-01	3.73E-02	1.49E-01	4.40E-02	0.28
FR0110-02-S048	1.42E-01	3.11E-02	1.14E-01	3.72E-02	0.21
FR0110-02-S049	2.76E-01	4.49E-02	1.99E-01	4.82E-02	0.40
FR0110-02-S050	6.68E-01	5.83E-02	4.94E-01	6.57E-02	0.98
FR0110-02-S051	1.30E-01	3.31E-02	1.60E-01	4.10E-02	0.22
FR0110-02-S052	6.67E-01	6.13E-02	5.26E-01	7.34E-02	0.996
Mean	1.49E-01		1.19E-01		0.22
Median	7.88E-02		6.12E-02		0.12
Standard Deviation	1.76E-01		1.17E-01		0.24
Range	0.053 to 0.97		0.034 to 0.53		0.080 to 1.147

"<" indicates values less than the minimum detectable activity (MDA)

D. SURVEY UNIT INVESTIGATIONS PERFORMED AND RESULTS

Survey Unit 2 was partitioned into 28 scan grids as shown on map FR 0110-02 (Attachment 1). No grids had scans which exceeded the alarm setpoints, so no investigations were required. One direct measurement exceeded the new DCGL. This sample was not investigated because there was no scan alarm. However, the sample has been included in the Elevated Measurement Comparison summarized in Attachment 3 (Table 3-1).

E. SURVEY UNIT DATA ASSESSMENT

An analysis of the direct sample measurement results, including the mean, median, standard deviation, and sample result range, are provided in Table 2. Of the 52 soil/rock samples, one had concentrations of Co-60 and Cs-137 that exceeded unity. The average of the DCGL unity fractions was 0.22 and the maximum unity fraction was 1.15 times the DCGL. The Elevated Measurement Comparison unity test conservatively includes the one direct sample that was in a grid that was not investigated. The EMC test was 45% of unity, passing the EMC test. Final sigma was less than the design sigma, and when combined with the extra samples designed into the survey, no additional samples were required.

For illustrative purposes, as indicated in LTP Section 5.9.3, a simplified general retrospective dose estimate can be calculated from the average residual contamination level by subtracting the established mean fallout Cs-137 background value[3] (0.19 pCi/g) for disturbed soil from the survey unit sample mean Cs-137 activity (0.119 pCi/g). The result is a net value of -0.071 pCi/g or 0.0 mrem/y. When the survey unit mean for Co-60 (0.149 pCi/g) is included, this would equate to an annual dose rate of 0.97 mrem/y[4]. However, for the purposes of demonstrating compliance with the radiological criteria for license termination and the enhanced State Criteria, background activity is not subtracted from the soil sample analysis activity values.

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3 See Attachment E to Maine Yankee Procedure PMP 6.7.8 (Reference 2)

4 Based on DCGL of 0.86 and 5.63 mrem/y at the DCGL per the LTP

F. ADDITIONAL DATA EVALUATION

Attachment 4 provides additional data evaluation associated with this Survey Unit, including relevant statistical information. Based on survey unit direct measurement data, this attachment provides the Sign Test Summary, Quantile Plot, Histogram, and Retrospective Power Curve.

1. The Sign Test Summary provides an overall summary of design input and resulting calculated values used to determine the required number (N) of direct measurements (per LTP Section 5.4.2). The Sign Test Summary is a separate statistical analysis that also calculates the mean, median, and standard deviation of the direct measurements.

   The critical value and the result of the Sign Test are provided in the Sign Test Summary table, as well as a listing of the key release criteria. As is shown in the table, all of the key release criteria, except for one elevated sample, were clearly satisfied for the FSS of this survey unit. The elevated sample met the EMC unity limit. Therefore, all requirements were satisfied.

2. The Quantile Plot was generated from direct measurement data listed in Table 2. The data set and plot are consistent with expectations for a Class 1 survey unit. The survey unit average is well below the DCGLs of 0.86 pCi/g and 2.39 pCi/g for Co-60 and Cs-137 respectively.

3. A Histogram Plot was also developed based on the direct measurement values. This plot shows that the direct data were essentially a log-normal distribution with three outliers.

4. A Retrospective Power Curve was constructed, based on FSS results. The curve shows that this survey unit having a mean residual activity at a small fraction of the DCGL has a high probability ("power") of meeting the release criteria. Thus, it can be concluded that the direct measurement data support rejection of the null hypothesis, providing high confidence that the survey unit satisfied the release criteria and that the data quality objectives were met.

G. CHANGES IN INITIAL SURVEY UNIT ASSUMPTIONS ON EXTENT OF RESIDUAL ACTIVITY

The survey was designed as a Class 1 area; the FSS results were consistent with that classification. The direct measurement sample standard deviation was less than the design sigma. Thus, no additional measurements were required. Since the DCGLs were changed (decreased) by addendum to the LTP to account for the activated containment concrete pathway the design of the survey unit was confirmed and data reviewed against the revised DCGLs. The direct sample that is above DCGL unity would not be above unity with the previous, higher DCGLs.

H. LTP CHANGES SUBSEQUENT TO SURVEY UNIT FSS

The FSS of Survey Unit 2 was designed and performed per the criteria LTP Rev. 3 with Addenda (References 3 and 4). The subsequent LTP change with potential impact to this FSS requiring evaluations was the LTP change related to the activated concrete license amendment (References 5 and 6) which reduced the DCGLs for soil inside the RA.

These changes were evaluated and found to have no impact on the FSS results or conclusions for this survey unit. The revised DCGLs were used for the evaluation of the results included herein.

I. CONCLUSION

The FSS of this survey unit was designed based on the LTP designation as a Class 1 area. The survey design parameters are presented in Table 1. The required number of direct measurements was determined for the Sign Test in accordance with the LTP. As presented in Table 2, the average of the direct measurements was well below the DCGL unity. The one elevated sample met the elevated measurement comparison unity limit per LTP methodology.

A Sign Test Summary analysis demonstrated that the Sign Test criteria were satisfied. The direct measurement sigma was determined to be less than that used for design, thus indicating that a sufficient number of samples was taken.

The Retrospective Power Curve shown in Attachment 4 confirmed that sufficient samples were taken to support rejection of the null hypothesis, providing high confidence that the survey unit satisfied the release criteria and the data quality objectives were met. Attachment 4 also revealed that direct measurement data represented essentially a log-normal distribution, with three outliers.

The scan survey design for this survey unit was developed in accordance with the LTP with significant aspects of the design discussed in Section B and Table 1. There were no alarms, so no alarm investigations were required.

It is concluded that FR0110 Survey Unit 2 meets the release criteria of 10CFR20.1402 and the State of Maine enhanced criteria.

J. REFERENCES

1. Maine Yankee Engineering Calculation, EC-009-01

2. Approach for Dealing with Background Radioactivity for Maine Yankee Final Status Surveys, Attachment E to Maine Yankee Procedure PMP 6.7.8, FSS Data Processing and Reporting

3. Maine Yankee License Termination Plan, Revision 3, Maine Yankee letter to NRC, MN-02-048, dated October 15, 2002

4. Maine Yankee License Termination Plan, Revision 3, Maine Yankee letter to NRC, MN-02-061, dated November 26, 2002

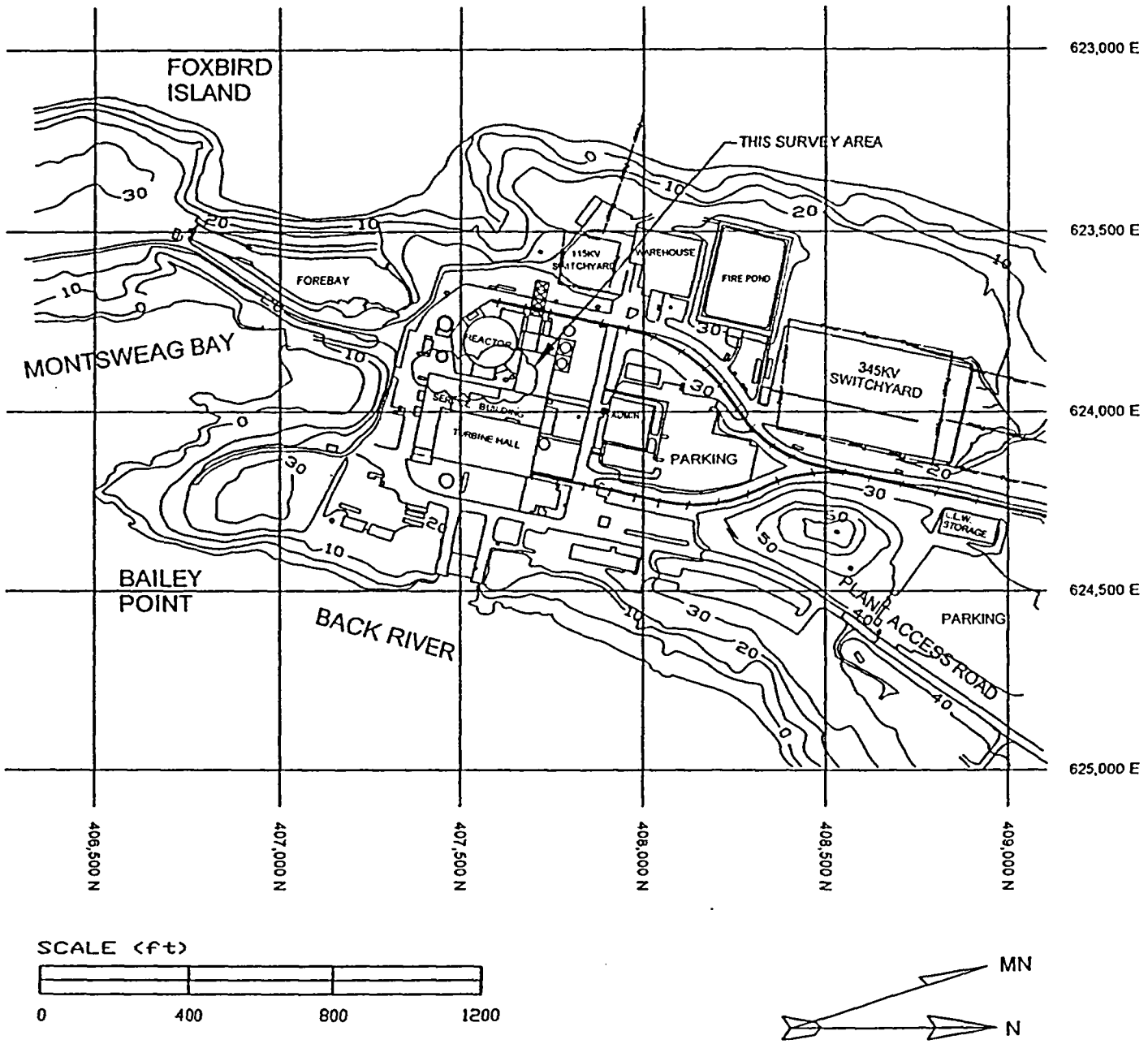
5. Proposed License Amendment Related to Changes in the Activated Concrete Remediation Plans, Maine Yankee letter to the NRC, MN-03-049, dated September 11, 2003

6. Issuance of License Amendment No. 170, NRC letter to Maine Yankee, dated February 18, 2004

Attachment 1

Survey Unit Maps

Maine Yankee Decommissioning Team	*Maine Yankee Decommissioning Project Survey Form*	Map ID #: FR 0110-00
Survey Type: ☐ Characterization ☐ Turnover ☒ Final Status Survey	Survey Area Name: Alleyway Excavation	Date: 6-25-03



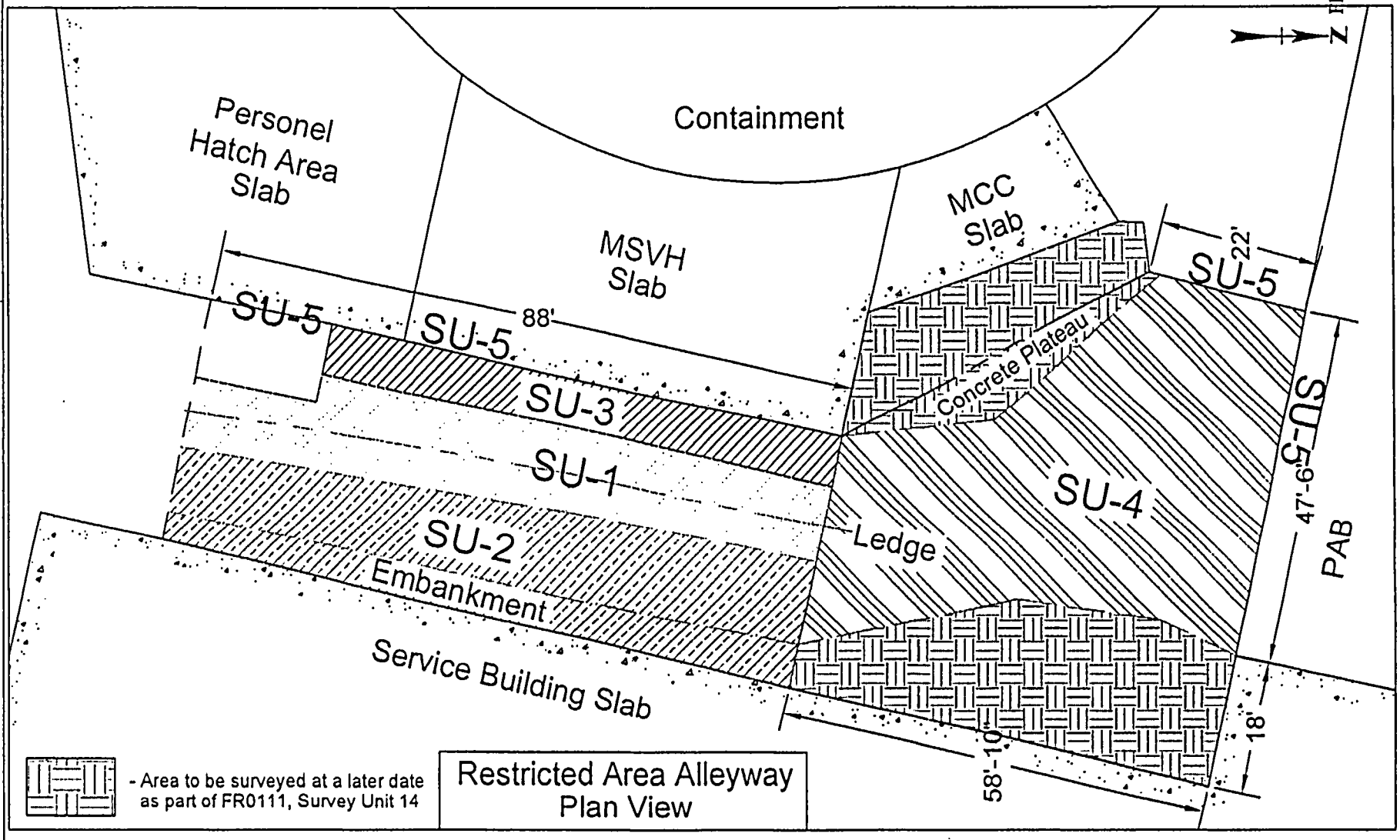
SCALE (ft)

0 400 800 1200

MN

N

Final Status Survey Unit Reference Map
Alleyway Piping Excavation Pit



Maine Yankee Decommissioning Team

Maine Yankee Decommissioning Project Survey Form

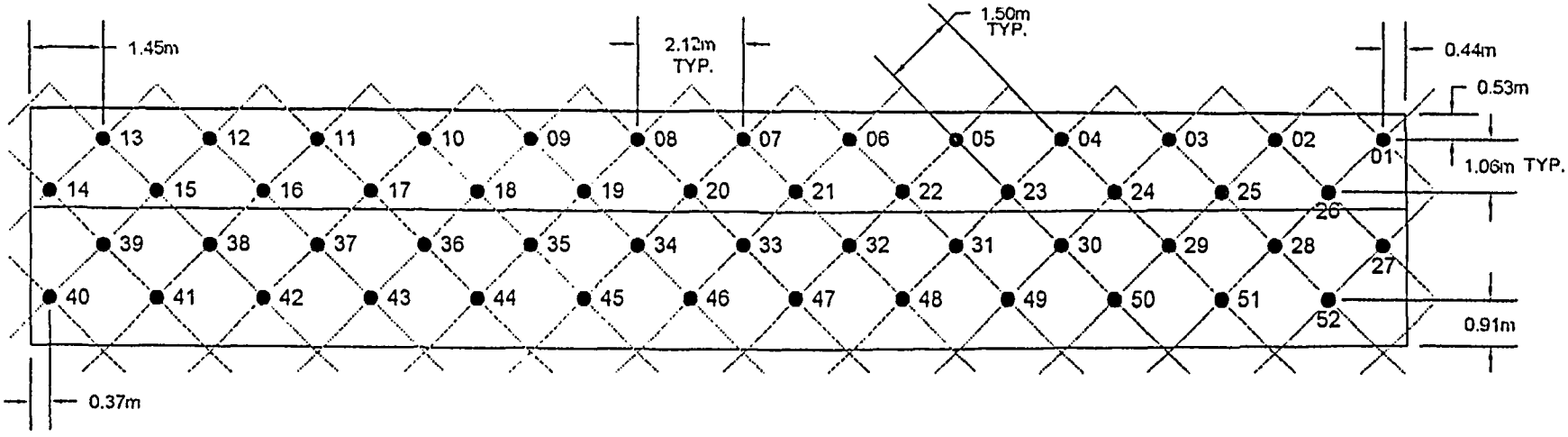
Map ID #: FR 0110-REF

Survey Type: ☐ Characterization ☐ Turnover ☒ Final Status Survey

Survey Area Name: Alleyway Excavation

Date: 6-25-03

FR 0110-SS-02, Direct Point Survey, Soil
Survey Unit 02
Alleyway Piping Excavation Pit
Soil Area East of Ledge (Inc. Embankments)



L=1.5, N=50

This survey area unit is approximately 130 square meters

Maine Yankee Decommissioning Team

Maine Yankee Decommissioning Project Survey Form

Map ID #: FR 0110-SS-02 Survey Unit 02

Survey Type: ☐ Characterization ☐ Turnover ☒ Final Status Survey

Survey Area Name: Alleyway Excavation

Date: 6-25-03

Maine Yankee Decommissioning Team

Map ID #: FR 0110-02

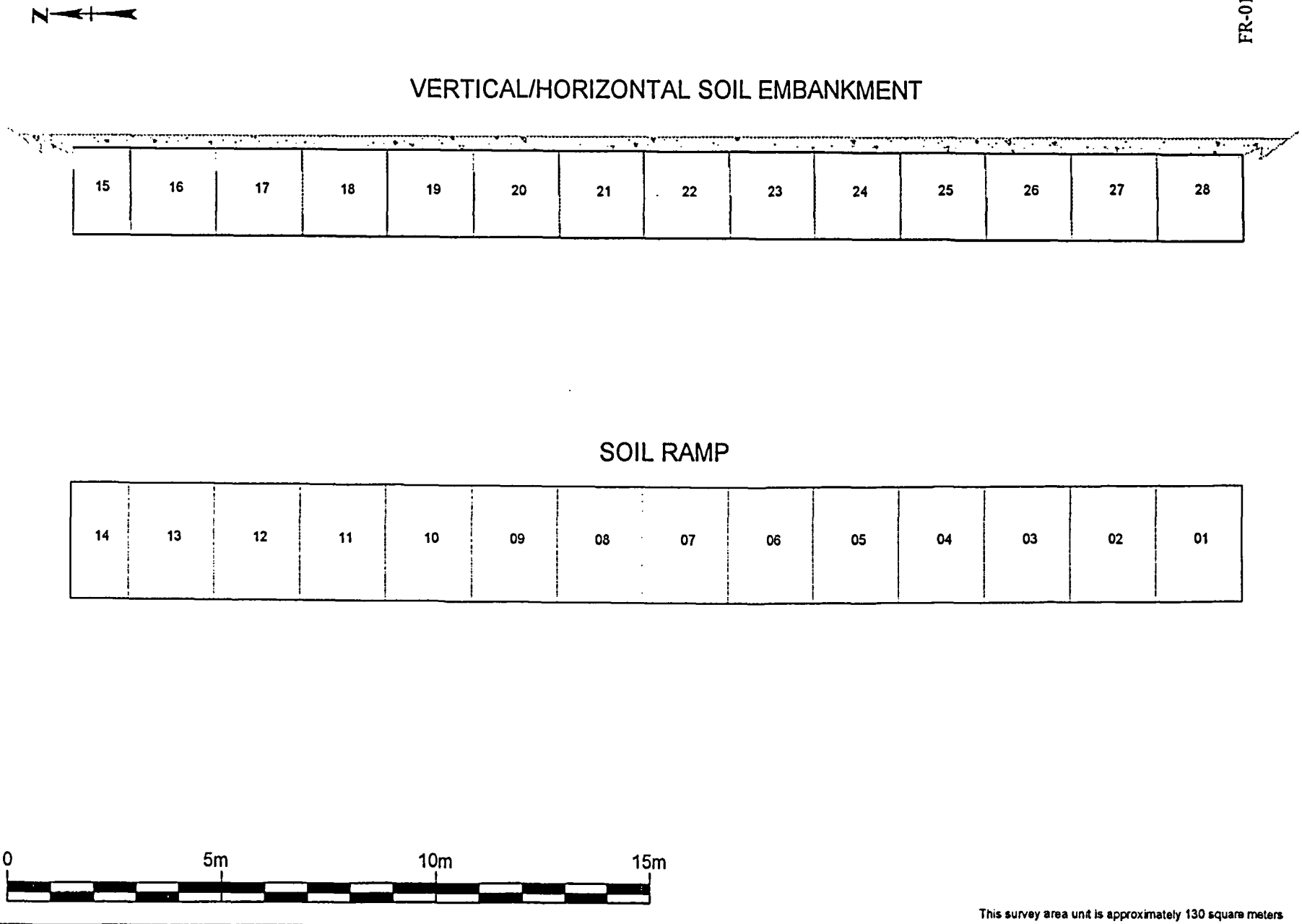
Date: 6-25-03

Maine Yankee Decommissioning Project Survey Form

Survey Area Name: Alleyway Excavation

Survey Type: ☐ Characterization ☐ Turnover ☒ Final Status Survey

FR 0110-02: Alleyway Piping Excavation Pit
Soil Area East of Ledge (Inc. Embankments) Survey Scan 01-28



This survey area unit is approximately 130 square meters

Attachment 2

Survey Unit Instrumentation

TABLE 2-1

INSTRUMENT INFORMATION

E-600 S/N	Probe S/N (type)
2491	726560 (SSPA-3)
2488	725890 (SSPA-3)

HPGe Detectors for Lab Analysis of Volumetric Samples

Detector Number	MDC (pCi/g)
FSS-1	0.04 – 0.10
FSS-2	0.04 – 0.10

TABLE 2-2

INSTRUMENT SCAN MDC, DCGL, INVESTIGATION LEVEL, AND $DCGL_{EMC}$

Detector	SSPA-3	Comments
Scan MDC (pCi/g)	5.9	Design Scan MDC, LTP Table 5-6 (Reference 4)
DCGL (pCi/g)	2.39 Cs-137 0.86 Co-60	Reference 5
Investigation Level (Alarm Setpoint) cpm	18,950 (~ 84% Cs-137 $DCGL_{EMC}$)	3 sigma of Background + Background + 6.1 pCi/g
$DCGL_{EMC}$ (pCi/g)	14.3 Cs-137 5.2 Co-60	DCGL * AF (6.0 as performed)

Attachment 3

Investigation Table

TABLE 3-1

INVESTIGATION TABLE

INITIAL SURVEY			INVESTIGATION RESULTS								
Grid[5]	Alarm Setpoint cpm	Scan Value cpm	Max. Scan Value	Elevated[6] Area m^2	Area Factor	$DCGL_{EMC}$ Unity AF	Sample Number	Co-60 pCi/g		Cs-137 pCi/g	$DCGL_{EMC}$ Unity
S020	18950	18930	N/A	4.5	3.9	3.9	FR0110-02-S019	9.66E-01	7.14E-02	< 5.66 E-2	0.25
							Unit mean	1.33E-01		1.20E-01	0.20
							EMC Unity Sum				0.45

"<" indicates values less than the minimum detectable activity (MDA)

5 S020 is the value from the direct sampling, included because the direct value was >DCGL but there was no alarm in the grid.

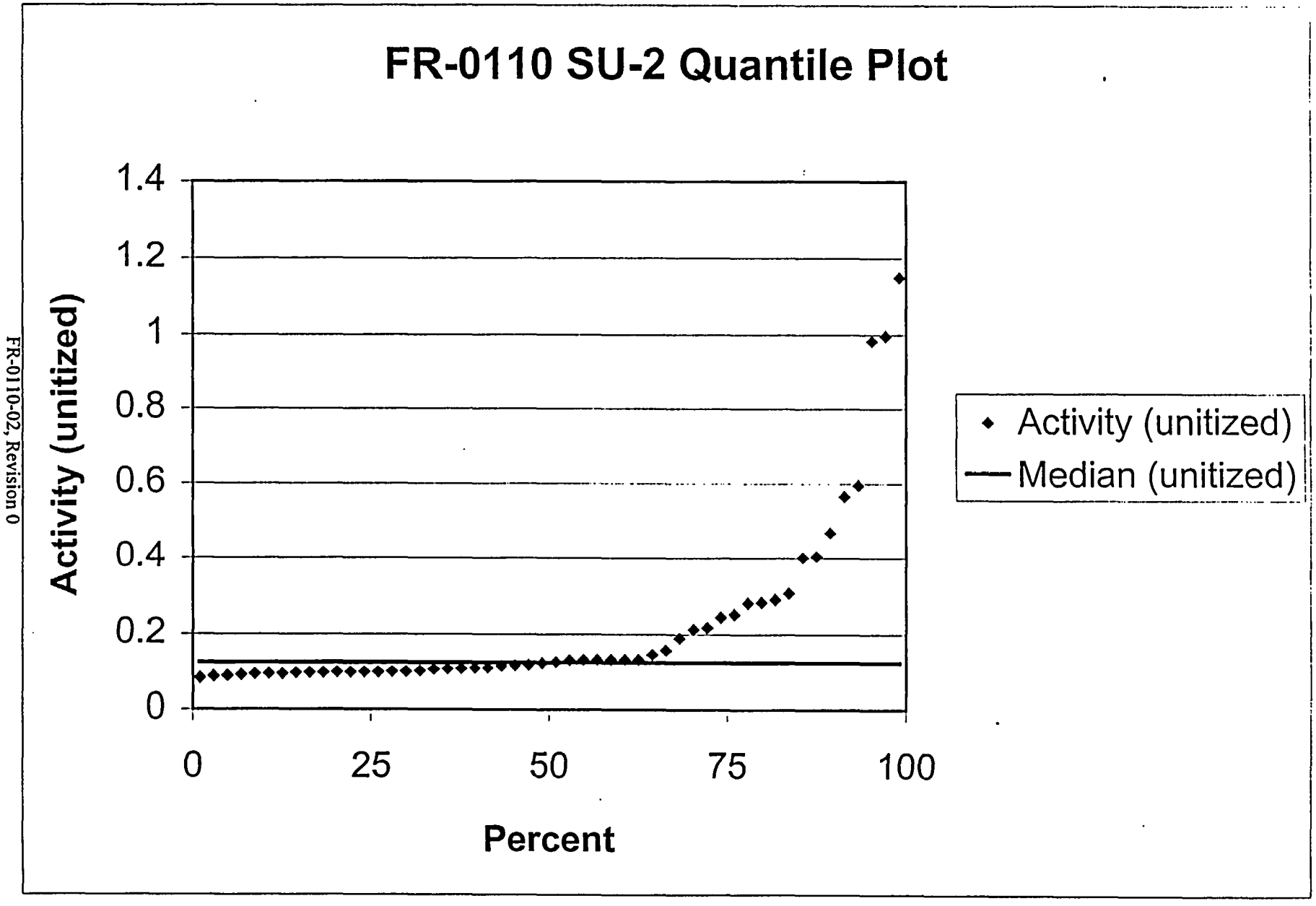
6 The elevated area was conservatively assumed to be the area bounded by (4) adjacent sample points (2.12m x 2.12m = 4.5 m^2); therefore, the AF = 3.9 (Reference LTP Table 6-12).

Attachment 4

Statistical Data

Survey Package FR0110 Unit 2 UNITY Soil Sign Test Summary

Evaluation Input Values		Comments
Survey Package:	FR0110	Alleyway Excavation
Survey Unit:	02	
Evaluator:	WJC	
$DCGL_w$:	1.00E+00	
$DCGL_{emc}$:	6.00E+00	As performed LTP 6-12 130/52
LBGR:	5.00E-01	
Sigma:	5.56E-01	based on new 2.39 pCi/g Cs137 DCGL
Type I error:	0.05	
Type II error:	0.05	
Nuclide:	UNITY	
Soil Type:	N/A	
Calculated Values		**Comments**
$Z_{1-\alpha}$:	1.645	
$Z_{1-\beta}$:	1.645	
Sign p:	0.788145	
Calculated Relative Shift:	0.8	
Relative Shift Used:	0.8	Uses 3.0 if Relative Shift is >3
N-Value:	33	
N-Value+20%:	40	
Sample Data Values		**Comments**
Number of Samples:	52	
Median:	1.24E-01	
Mean:	2.23E-01	
Net Sample Standard Deviation:	2.39E-01	
Total Standard Deviation:	2.39E-01	Sum of samples and reference
Maximum:	1.15E+00	
Sign Test Results		**Comments**
Adjusted N Value:	52	
S+ Value:	51	
Critical Value:	32	
Sign test results:	Pass	
Criteria Satisfaction		**Comments**
Sufficient samples collected:	Pass	
Maximum value <$DCGL_w$:	Investigate	Sign test passes (Critical value <S+)
Median value <$DCGL_w$:	Pass	
Mean value <$DCGL_w$:	Pass	
Maximum value <$DCGL_{emc}$:	Pass	
Total Standard Deviation <=Sigma:	Pass	
Criteria comparison results:	Investigate	
Final Status		**Comments**
The survey unit passes all conditions:	Investigate	Satisfactory - passes


FR-0110 SU-2 Quantile Plot
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1.2
1
0.8
0.6
0.4
0.2
0
0
25
50
75
100
Percent
Activity (unitized)
Median (unitized)

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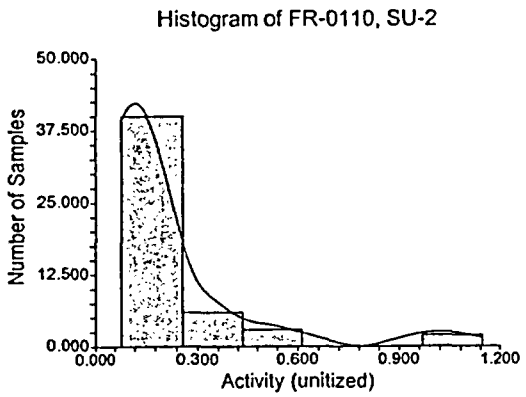
Variable C2

Plots Section



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