

MAINE YANKEE
FINAL STATUS SURVEY RELEASE RECORD
FR-0400 FOREBAY
SURVEY UNIT 5

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A. SURVEY UNIT DESCRIPTION

Survey Unit 5 is located within Survey Area FR-0400, the Forebay. The Forebay is located south of the radiologically Restricted Area of the site at coordinates 407,000 N and 623,600 E (See Map FR 0400 SITE, Attachment 1). The Forebay is a large, rock-lined basin in which condenser cooling water collected prior to its release through the diffuser system out to the ocean. During plant operation, the Forebay/Diffuser System was the licensed discharge path for liquid, radiological effluent. After plant shutdown, stop logs were set in place at the Forebay end of the diffuser to isolate the Forebay in order to prevent the release of Forebay sediment into the river during remediation activities.

Two earthen dikes make up the north-south running walls of the Forebay with concrete walls at the extreme north and south ends to support the circulating water and diffuser pipes. The dike walls form a V at the southern end of the Forebay (adjacent to Foxbird Island). The diffuser discharge pipes originate at the notch of the V. A concrete dam, or weir, runs in the east west direction at the northern end of the Forebay and creates a small, water-filled area called the sealpit. The sealpit maintained a water seal over the circulating water pipes to prevent loss of flow with tidal fluctuations.

Survey Unit 5 consists of the South floor of the Forebay basin, bounded to the North by Survey Unit 4. The survey unit is bounded to the West by Survey Unit 7 (at the toe of the Forebay dike's slope) and to the East by Survey Unit 8. Its southern boundary is the intake structure of the diffuser. Survey Unit 5 consists of rock and sediment media. The Survey Unit has a surface area of approximately 1,410 m².

B. SURVEY UNIT DESIGN INFORMATION

The Forebay received the liquid radioactive discharges from the plant. It was known to have been contaminated to levels in excess of the release limits and extensive remediation activities including underwater dredging, underwater vacuuming, and dry surface vacuuming were performed. Given the high probability of residual contamination, the Forebay was classified as Class 1.

Revision 3 of the Maine Yankee License Termination Plan (LTP)¹ states that the Forebay dose from residual radioactivity "is so insignificant and the probability so low that an individual would be able to successfully place a viable well within the Forebay, survey measurements of the Forebay surfaces including rip-rap will be limited". As a result, the survey design for the Forebay is a reasonable approach to demonstrate compliance with the release criteria while not necessarily meeting all of the requirements for a "MARSSIM" survey.

¹ LTP, Revision 3 refers to the LTP submitted in October 2002 (Reference 1) as amended by the MY's addenda of November 2002 (Reference 2). LTP, Revision 3 was approved by the NRC in February 2003 (Reference 3).

A technical basis document outlining the proposed Forebay survey plan was submitted to the NRC prior to commencing the surveys (Reference 4). The Technical Basis document described and established the technical sufficiency of the underwater *in situ* and NaI(Tl) techniques for use in the Forebay. Attachment 2H of the LTP describes the characterization data obtained from the Forebay. This data formed the basis for the Forebay survey design.

The survey unit design parameters are shown in Table 1. This table reflects the current design parameters, some of which have been revised since the survey was completed as discussed in Section H. The survey unit design was not based on sigma and relative shift (per Reference 4). A minimum number of 50 direct samples were planned for the Survey Unit. This number was determined based on the Survey Unit size and was selected to attain a design area factor of 10 per the Forebay Technical Basis Document. Since the data assessment is unitized, the Sign Test Summary in Attachment 4 uses a value of sigma obtained from volumetric samples from FR 0400 Survey Unit 1. Direct measurement locations were determined using a random start point and a square grid. These locations are presented on survey map FR 0400-5a in Attachment 1. The direct measurements consisted of *in situ* measurements obtained with the ISOCS detector.

The survey unit design also included 179 individual scan grids of 3 m by 3 m (see map FR0400-5b in Attachment 1). Each grid was scanned using a NaI detector with an alarm setpoint established at background plus 4,000 c/m. This scan survey ensured there were no unidentified areas exceeding approximately 1/2 of the DCGL_{EMC} limit. The survey instruments used, their MDC value, and alarm setpoints are provided in Attachment 2.

In order to establish the alarm setpoint for the E-600 used for scanning, the underwater background of the Forebay must be known. Due to the varied materials of composition and the bottom topography of the Forebay, background can only be approximated. As such, two approaches were used to estimate a background for this survey. The first approach consisted of an analytical model based compiled volumetric sample data from several types of Forebay samples. The next approach consisted of an evaluation of actual Forebay scan data. Based on an evaluation of the results from the two approaches, the generic background value for the Forebay was set at 16,000 cpm. Adding 4,000 cpm to this value provided an alarm setpoint of 20,000 cpm which is equivalent to a scan MDC of approximately 180,000 dpm/100 cm².

TABLE 1
SURVEY UNIT DESIGN PARAMETERS

Survey Unit	Design Criteria	Basis
Area	1,410 m ²	
Number of Direct Measurements Required	50	Selected based on design basis of Forebay
Sample Area	28.2 m ²	1,410 / 50 samples
Sample Grid Spacing	5.25 m	(28.2) ^{1/2}
Area Factor	10 (conservative)	Design value from the Forebay Technical Basis Document
Scan Grid Survey Area	9 m ²	
Background		
SSPA-3 (scan)	16,000 cpm	DI 6-150
ISOCS (direct)	N/A	
Scan Investigation Level	Background + 4,000 cpm See Table 2-2	Provides a scan MDC of approximately 180,000 dpm/100 cm ² Source: Forebay Technical Basis Document
DCGL ²	1.62E6 pCi/m ²	Forebay Technical Basis Document
DCGL _{EMC}	1.62E7 pCi/m ²	Area Factor x DCGL

C. SURVEY RESULTS

As required, 50 direct measurements were obtained. The direct measurement data are presented in Table 2. The ISOCS measurements are presented in units of pCi/m². Six direct measurement results were greater than the DCGL, but less than the DCGL_{EMC}. These measurements were investigated as discussed in Section D.

The survey was designed for 179 scan grids. Three grids could not be scanned due to the rock ledge being present in the grids. The scan process identified 48 grid locations for investigation. A total of 51 grids received investigation measurements. The grids are indicated on survey map XR 0400-05a and XR 0400-05b of Attachment 1. The investigation results are discussed in Section D.

² $1.62E6 \text{ pCi/m}^2 = 36,000 \text{ dpm/100 cm}^2 \times \frac{1 \text{ pCi}}{2.22 \text{ dpm}} \times 10,000 \frac{\text{cm}^2}{\text{m}^2}$

TABLE 2

DIRECT MEASUREMENTS

Sample Number	Cs-137 (pCi/m ²)	Co-60 (pCi/m ²)	Unitized Value of Unity Rule
FR0400051R001	4.19E+05 ± 25.85%	9.27E+05 ± 7.28%	0.831
FR0400051R002	2.13E+05 ± 31.90%	5.00E+05 ± 7.99%	0.440
FR0400051R003	2.09E+05 ± 24.77%	1.11E+05 ± 15.24%	0.197
FR0400051R004	2.19E+05 ± 26.41%	3.44E+04 ± 37.05%	0.156
FR0400051R005	2.25E+06 ± 35.91%	5.63E+05 ± 22.87%	1.735
FR0400051R006	2.51E+05 ± 34.71%	1.80E+05 ± 15.74	0.266
FR0400051R007	0.00E+00	< 3.47E+04	0.021
FR0400051R008	4.07E+04 ± 38.00%	2.04E+04 ± 27.03%	0.038
FR0400051R009	0.00E+00	5.88E+05 ± 12.12%	0.363
FR0400051R010	4.05E+05 ± 54.68%	9.76E+05 ± 8.52%	0.852
FR0400051R011	3.58E+04 ± 49.87%	< 1.50E+04	0.031
FR0400051R012	5.39E+04 ± 43.38%	< 1.90E+04	0.045
FR0400051R013	0.00E+00	< 7.61E+04	0.047
FR0400051R014	1.97E+06 ± 86.34%	4.50E+05 ± 43.91%	1.496
FR0400051R015	1.55E+07 ± 13.56%	2.85E+05 ± 43.32%	9.738
FR0400051R016	7.67E+04 ± 53.67%	2.20E+04 ± 42.67%	0.061
FR0400051R017	5.35E+04 ± 42.84%	9.97E+03 ± 52.68%	0.039
FR0400051R018	8.61E+06 ± 29.99%	< 5.35E+05	5.643
FR0400051R019	0.00E+00	< 5.27E+05	0.325
FR0400051R020	2.63E+04 ± 61.19%	< 1.31E+04	0.024
FR0400051R021	8.09E+04 ± 18.74%	1.20E+04 ± 24.95%	0.057
FR0400051R022	0.00E+00	< 4.77E+05	0.294
FR0400051R023	0.00E+00	1.41E+05 ± 32.93%	0.087
FR0400051R024	2.29E+06 ± 49.32%	3.57E+05 ± 59.01%	1.633
FR0400051R025	6.90E+04 ± 100.24%	4.68E+05 ± 9.36%	0.331
FR0400051R026	0.00E+00	2.21E+05 ± 19.93%	0.136
FR0400051R027	0.00E+00	< 4.39E+05	0.271
FR0400051R028	0.00E+00	4.24E+05 ± 9.89%	0.261
FR0400051R029	0.00E+00	1.05E+05 ± 29.52%	0.065
FR0400051R030	0.00E+00	< 6.31E+04	0.039
FR0400051R031	0.00E+00	3.51E+05 ± 11.92%	0.217
FR0400051R032	0.00E+00	3.19E+05 ± 10.57%	0.197
FR0400051R033	0.00E+00	1.79E+05 ± 13.55%	0.111
FR0400051R034	0.00E+00	6.05E+05 ± 19.64%	0.374
FR0400051R035	0.00E+00	1.93E+05 ± 12.52%	0.119
FR0400051R036	0.00E+00	7.05E+05 ± 7.20%	0.435
FR0400051R037	0.00E+00	3.25E+05 ± 10.93%	0.200
FR0400051R038	0.00E+00	4.20E+05 ± 12.89%	0.259
FR0400051R039	0.00E+00	2.21E+05 ± 11.78%	0.136
FR0400051R040	0.00E+00	3.26E+05 ± 9.70%	0.201
FR0400051R041	5.59E+04 ± 45.87%	5.20E+05 ± 7.82%	0.355

FR0400051R042	0.00E+00	9.15E+04 \pm 21.95%	0.056
FR0400051R043	0.00E+00	3.74E+05 \pm 9.36%	0.231
FR0400051R044	0.00E+00	1.98E+05 \pm 12.67%	0.122
FR0400051R045	0.00E+00	3.32E+05 \pm 11.06%	0.205
FR0400051R046	0.00E+00	6.94E+05 \pm 8.56%	0.428
FR0400051R047	0.00E+00	7.92E+05 \pm 7.53%	0.489
FR0400051R048	0.00E+00	4.15E+05 \pm 9.84%	0.256
FR0400051R049	0.00E+00	1.81E+06 \pm 6.69%	1.118
FR0400051R050	0.00E+00	6.71E+05 \pm 9.03%	0.414
Mean	N/A	N/A	0.628
Median	N/A	N/A	0.224
Standard Deviation	N/A	N/A	1.558
Range	N/A	N/A	0.021 – 9.738

“<” indicates MDA value for non-detect Co-60 results.

D. SURVEY UNIT INVESTIGATIONS PERFORMED AND RESULTS

The scan process identified 48 grid locations for investigation. These grids, plus three additional, were evaluated using investigation package XR0400-05. All investigations consisted of *in situ* measurements with the ISOCS detector. The investigation results were combined with the 6 direct measurement results, which were greater than the DCGL, for comparison with the DCGL_{EMC} criteria. The aggregate results were determined to be in compliance with the Elevated Measurement Comparison limit. This assessment is included as Attachment 3 (Table 3-1).

E. SURVEY UNIT DATA ASSESSMENT RESULTS

An analysis of the direct sample measurement results, including the mean, median, standard deviation, and sample result range, are provided in Table 2. Positively detected values are **bolded** in the table. Since Cobalt-60 is the primary radionuclide of concern, non-detect values were assumed present at the MDA. Non-detected values for Cesium-137 were assumed not to be present. However, some Cs-137 values were reported positive with high uncertainties that were less than the post-priori MDA. These have been included in Table 2 and 3-1 as positive results. The column to the right is the DCGL unity column. The mean value of this column indicates that the direct samples were at 62.8% of the DCGL limit. This is equivalent to an annual dose rate of $1.17\text{E-}2$ mrem³. The maximum direct sample result was equivalent to 97.4% of the design DCGL_{EMC}. A total of six measurements exceeded the DCGL. These measurements were evaluated and found to be acceptable. The sample standard deviation is larger than the design sigma, however, no additional measurements were required due to the results of the sign test.

Forty-eight SSPA-3 scan alarms were encountered while surveying. Since the scan grids were 3m x 3m squares, an Area Factor of 35 was used. This area factor was also conservatively applied to direct measurements for the EMC comparison since the area extent for the ISOCS measurement geometries is approximately 8 m².

The 48 verified alarms, along with three additional grids and the six direct measurements that were above the DCGL, were investigated as shown in Table 3-1 of Attachment 3, and determined to be approximately 93% of the DCGL_{EMC}, satisfying the EMC criteria.

³ This number is calculated by multiplying the mean value for direct measurements (62.8% of the DCGL) by $1.87\text{E-}2$ mrem/y, the dose scenario outcome for the Forebay floor area.

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 (Table 1) 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, several attributes required further evaluation. As discussed in Section E, the subject release criteria have been 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.
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 two outliers.
4. A Retrospective Power Curve was constructed, based on FSS results. The curve is inconclusive, but based on the Sign Test, the data provides good confidence that the survey unit satisfied the release criteria.

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

Due to remediation activities which removed the Co-60 containing sediment, the source term appears to have an increased Cs-137 to Co-60 ratio. This was addressed by specifically including the Cs-137 results (positive detects) in the data evaluation.

As stated in the LTP, the Forebay survey was anticipated to be a "limited" survey with "limited" never defined. The intent was to demonstrate adequate remediation of the Forebay source term using the new survey techniques described in the Technical Basis Document. Because Co-60 was the predominant nuclide in terms of both abundance and dose contribution, the measurements focused on detection of Co-60 activity. Some instances of high Cs-137 activity were found in FR-0400 Survey Unit 4 and Survey Unit 5 which challenged the EMC unity calculation. Had these high Cs-137 values been anticipated, the investigation criterion could have been adjusted to better account for them.

H. LTP CHANGES SUBSEQUENT TO SURVEY UNIT FSS

The FSS of Survey Unit 5 was designed and performed using the criteria of the approved Forebay Technical Basis Document (Reference 4) and LTP (Revision 3 Addenda). In order to deal with the initial failure to meet the EMC unity criteria, a change to the DCGL for the Forebay floor from 18,000 dpm/100 cm² to 36,000 dpm/100 cm² was processed under 10CFR50.59 as allowed by the LTP. The dose remained within the 10 mrem/y and 4 mrem/y drinking pathway limits. The annual dose from the Forebay floor with contamination levels at the new DCGL remains very low with a value of 1.87E-02 mrem/y. No other LTP changes have been made that would affect the survey results or conclusions for this survey unit.

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 direct measurements passed the Sign Test.

A Sign Test Summary analysis demonstrated that the Sign Test criteria were satisfied. The sample standard deviation is larger than the design sigma (which was based on *in situ* measurement data). No additional measurements were required because the number of samples was increased in the initial design of the survey in order to achieve a higher area factor and the survey unit passed the Sign Test.

Attachment 4 also revealed that direct measurement data represented essentially a log-normal distribution, with variance consistent with expectations for a Class 1 survey unit.

The scan survey design for this survey unit was developed in accordance with the Forebay Technical Basis Document with significant aspects of the design discussed in Section B and Table 1. Scanning resulted in a number of verified alarms (Section C) for evaluation. Attachment 3 shows the areas identified by verified alarms and provides the results of the investigation actions. The areas under investigation were evaluated using the appropriate area factor. The survey unit was determined to satisfy the elevated measurement comparison unity rule per LTP methodology (approximately 93% of the DCGL_{EMC} criteria limit.).

It is concluded that FR0400 Survey Unit 5 meets the release criteria of 10CFR20.1402 and the State of Maine enhanced criteria.

J. REFERENCES

1. Maine Yankee License Termination Plan, Revision 3, October 15, 2002
2. Maine Yankee letter to the NRC, MN-02-061, dated November 26, 2002
3. NRC letter to Maine Yankee, dated February 28, 2003
4. Maine Yankee letter to the NRC, "Forebay Technical Basis Document", MN-03-51, dated September 3, 2003
5. Maine Yankee Calculation EC-041-01
6. Maine Yankee Calculation EC-003-04

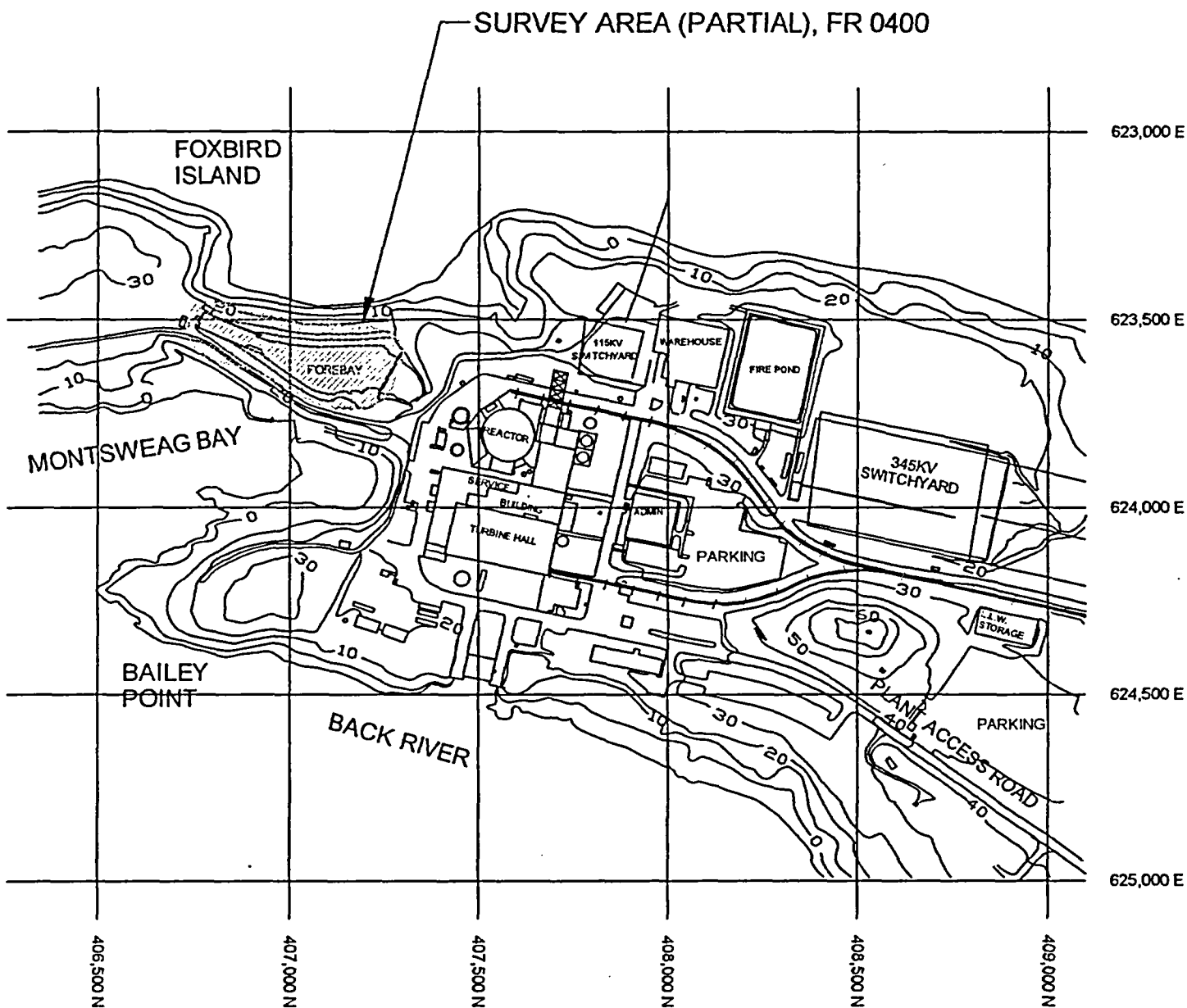
Attachment 1 Survey Unit Maps

Survey Type: ☐ Remediation

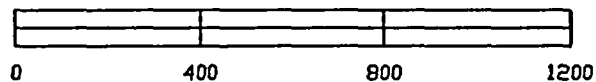
☐ Turnover

☒ Final Status Survey

Survey Area Name: Forebay Site Map



SCALE



Note: Grid based on Maine State Coordinate System
(West Zone) NAD 1927



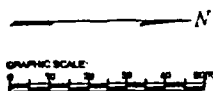
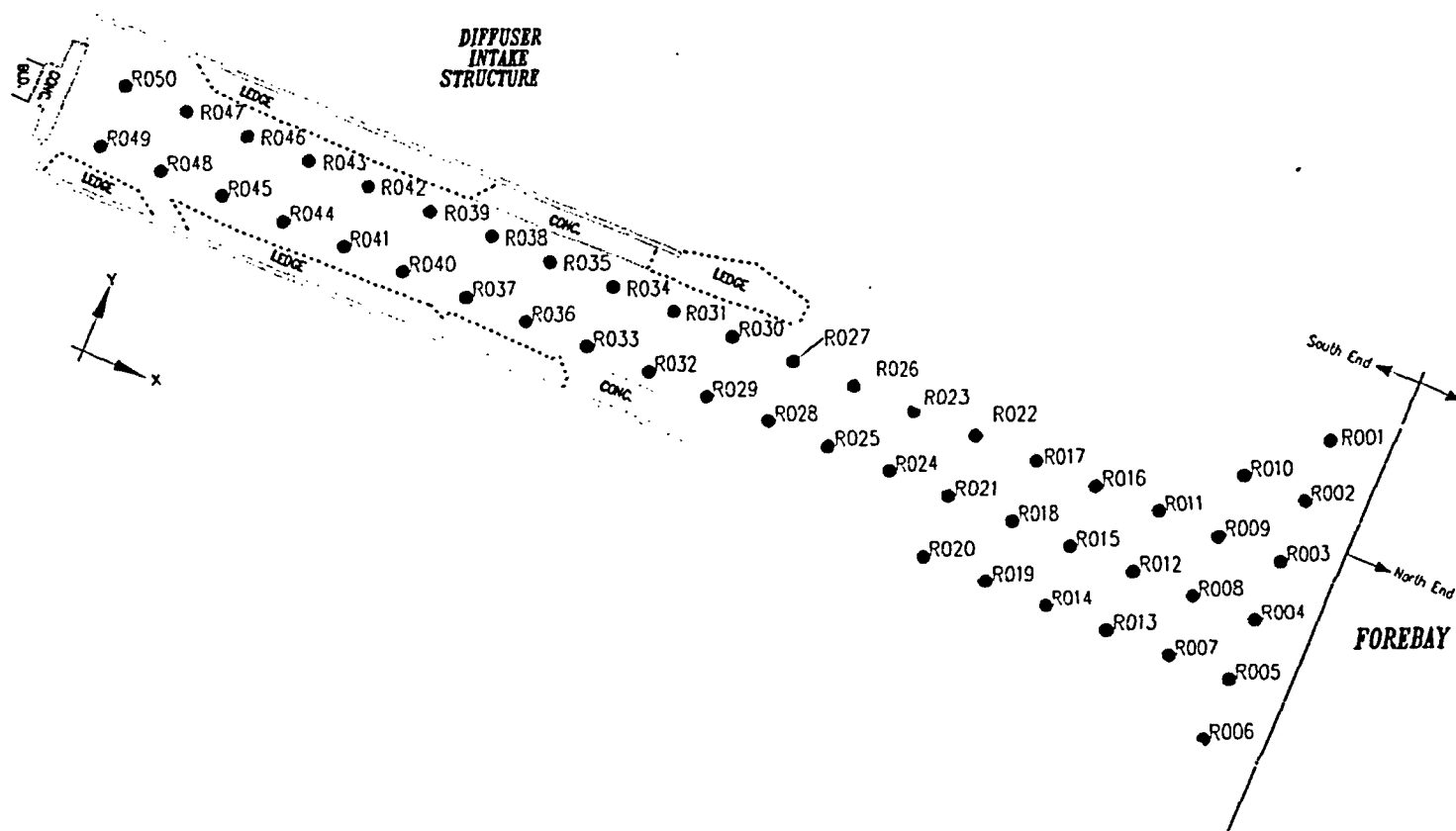
Survey Type: ☐ Characterization ☐ Turnover ☒ Final Status Survey

Survey Area Name: Forebay Floor

FR 0400: FOREBAY

Survey Unit 5, South End Forebay Floor

Direct Points R001 - R050



LEGEND

Rip-Rap Extents (Forebay Bottom)

Concrete

Ledge

5.25m (L) Square Grid

●R016

Direct Point Location

FR-0400-05, Revision 0

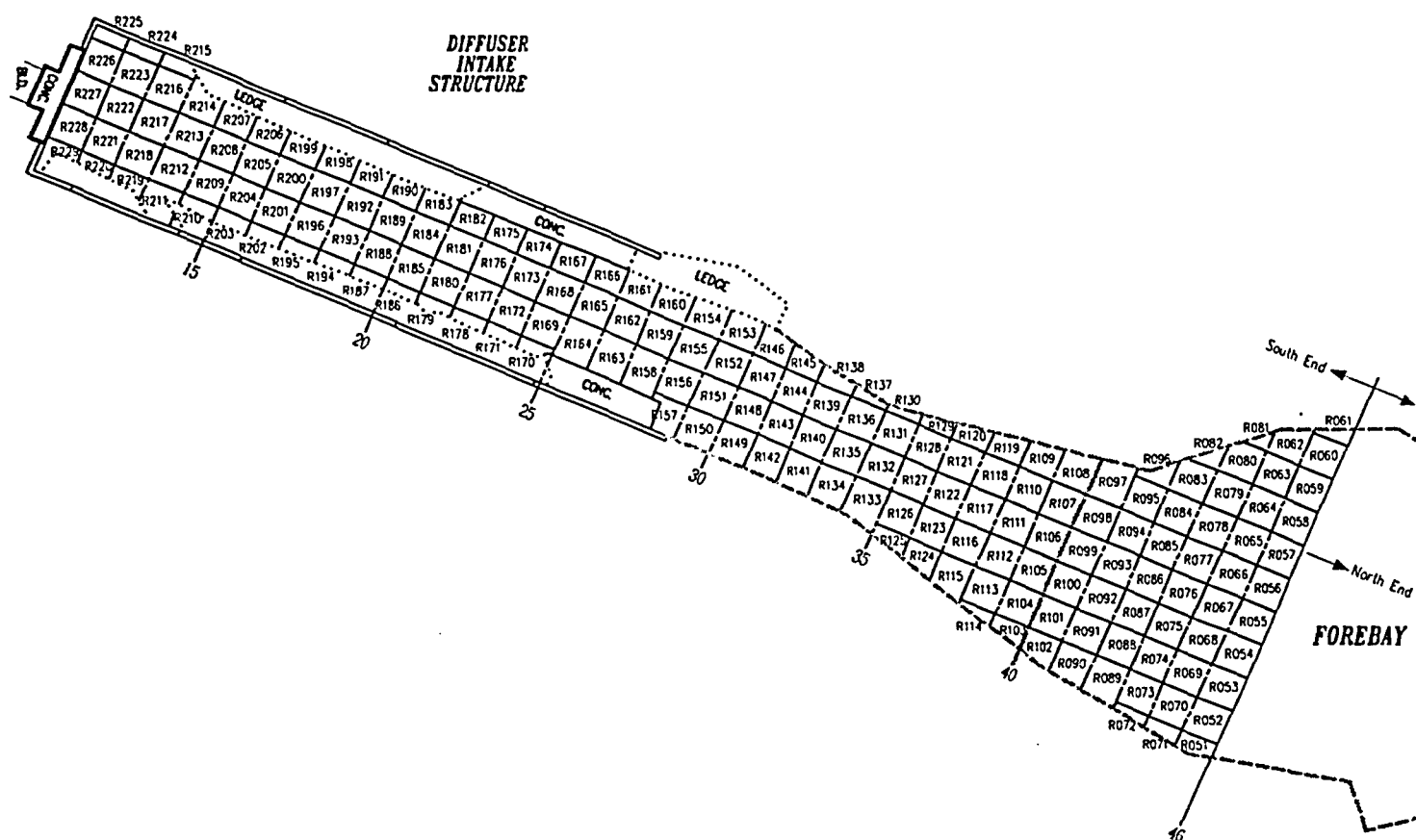
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L = 5.25, N = 50 SA = 1410 sq-m Scale : 1"=50'

Survey Type: ☐ Characterization ☐ Turnover ☒ Final Status Survey

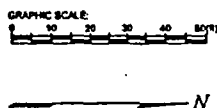
Survey Area Name: Forebay Floor

FR 0400: FOREBAY
Survey Unit 5, South End Forebay Floor
Survey Scans R051 - R229



LEGEND

- Rip-Rap Extents (Forebay Bottom)
- _____ Concrete
- Ledge
- _____ 3m Square Grid
- R151 Survey Scan Number

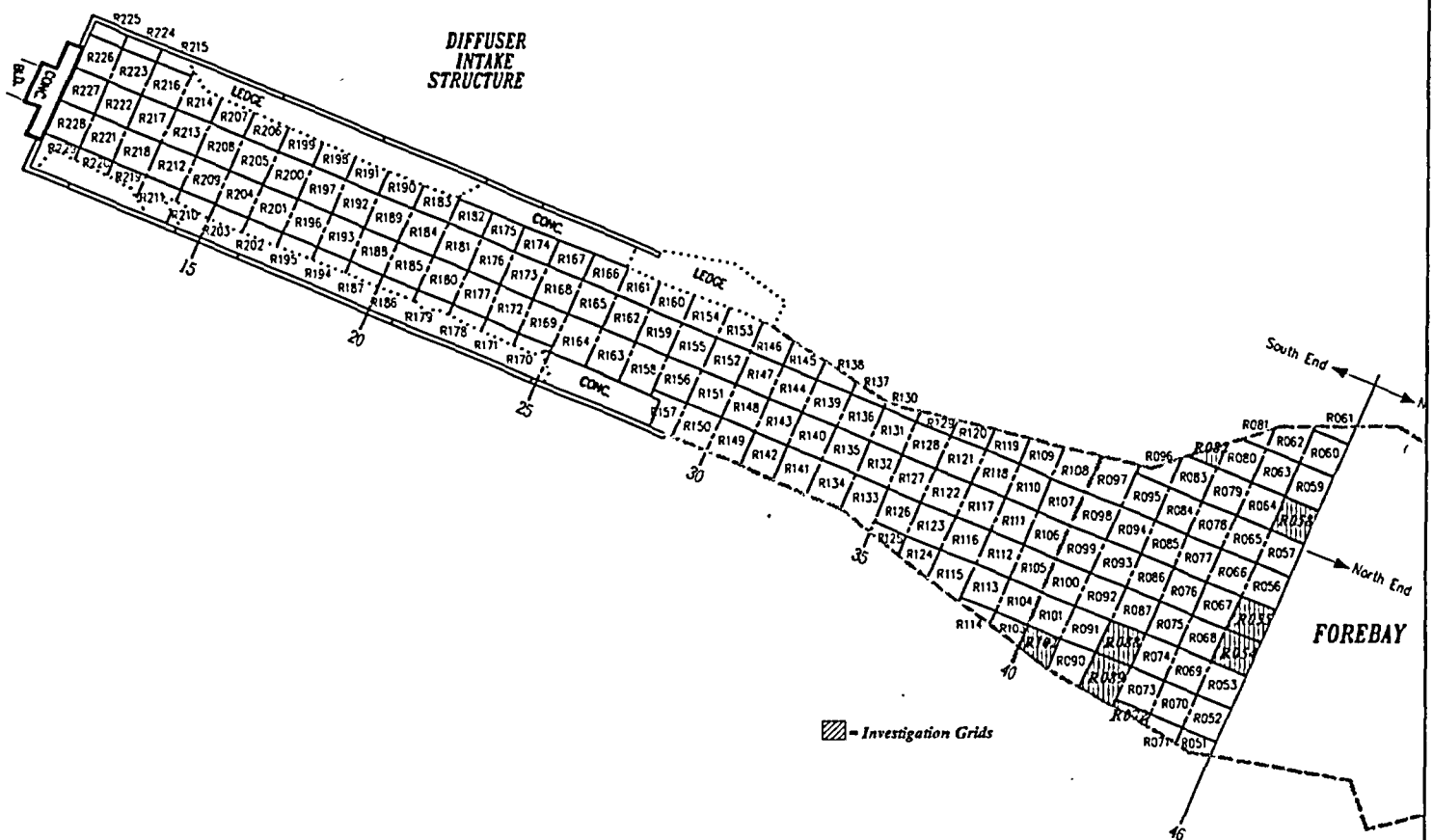


Survey Type: ☐ Characterization ☐ Turnover ☒ Final Status Survey Survey Area Name: Forebay Floor

XR 0400: FOREBAY

Survey Unit 5, South End Forebay Floor

Investigation Grids



LEGEND

- Rip-Rap Extents (Forebay Bottom)
- Concrete
- Ledge
- 3m Square Grid
- R151 Survey Scan Number



———— N

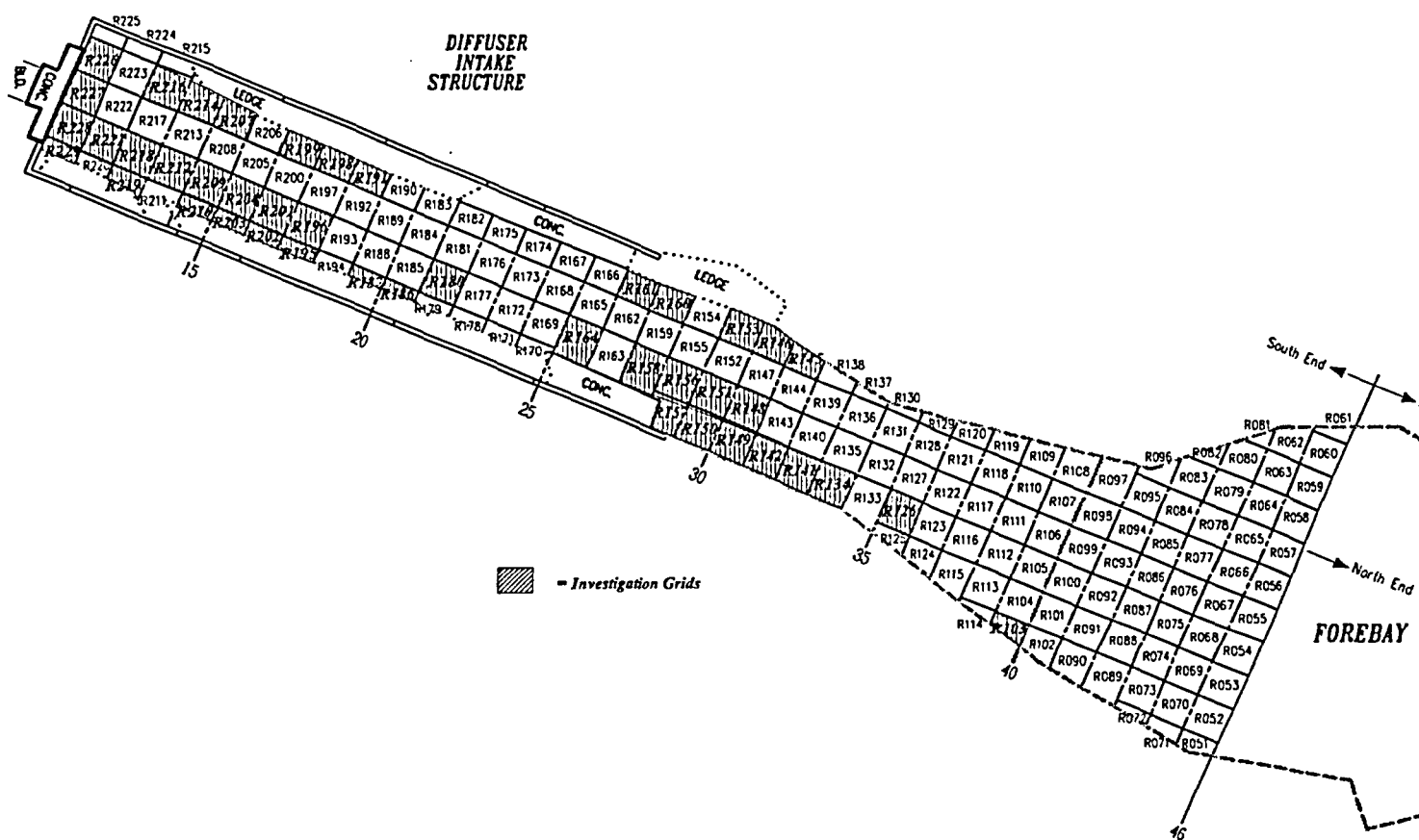
Survey Type: ☐ Characterization ☐ Turnover ☒ Final Status Survey

Survey Area Name: Forebay Floor

XR 0400: FOREBAY

Survey Unit 5, South End Forebay Floor

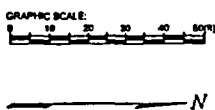
Investigation Grids



LEGEND

- Rip-Rap Extents (Forebay Bottom)
- Concrete
- Ledge
- 3m Square Grid

R151 Survey Scan Number



Attachment 2
Survey Unit Instrumentation

TABLE 2-1**INSTRUMENT INFORMATION**

E-600 S/N	Probe S/N (type)	Design Scan MDC / MDA
1929	726557 (SSPA-3)	180,000 dpm/100 cm ²
2619	2253 (SSPA-3)	180,000 dpm/100 cm ²

ISOCS DETECTORS
(*in situ* measurements)

ISOCS Detector	MDC (pCi/m²)
7605	See Table 2-2
7607	See Table 2-2

TABLE 2-2

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

Detector	SSPA-3	ISOCS
Scan MDC	180,000 dpm/100 cm ²	5.0E05 pCi/m ² (nominal)
DCGL	1.62E6 pCi/m ² or 36,000 dpm/100 cm ²	1.62E6 pCi/m ² or 36,000 dpm/100 cm ²
Investigation Level (Alarm Setpoint)	20,000 cpm (Background + 4,000 cpm)	N/A
Design DCGL_{EMC}	1.62E7 pCi/m ² or 360,000 dpm/100 cm ²	1.62E7 pCi/m ² or 360,000 dpm/100 cm ²

Attachment 3

Investigation Table

TABLE 3-1

INVESTIGATION RESULTS TABLE

Grid	Co-60 (pCi/m ²)	Cs-137 (pCi/m ²)	Co-60 Minus SU Mean (pCi/m ²)	Cs-137 Minus SU Mean (pCi/m ²)	Cobalt Activity (Unitized)	Cesium Activity (Unitized)	DCGL _{EMC} Comparison Fraction
54	9.68E+04 ± 50.93%	5.12E+05 ± 48.11%	N/A	N/A	N/A	N/A	< DCGL
55	< 1.08E+05	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
58	6.75E+05 ± 13.10%	2.95E+05 ± 52.50%	N/A	N/A	N/A	N/A	< DCGL
72	< 1.38E+05	6.35E+05 ± 31.61%	N/A	N/A	N/A	N/A	< DCGL
82	7.32E+05 ± 13.50%	2.14E+05 ± 107.98%	N/A	N/A	N/A	N/A	< DCGL
88	< 1.14E+05	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
89	< 1.24E+05	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
102	2.60E+05 ± 24.90%	8.72E+05 ± 37.97%	N/A	N/A	N/A	N/A	< DCGL
103	< 1.42E+05	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
126	< 1.20E+05	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
134	< 2.03E+05	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
141	< 1.39E+05	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
142	< 1.38E+05	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
145	< 1.43E+05	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
146	< 1.98E+05	0.00E+00	N/A	N/A	N/A	N/A	< DCGL

Grid	Co-60 (pCi/m ²)	Cs-137 (pCi/m ²)	Co-60 Minus SU Mean (pCi/m ²)	Cs-137 Minus SU Mean (pCi/m ²)	Cobalt Activity (Unitized)	Cesium Activity (Unitized)	DCGL _{EMC} Comparison Fraction
148	4.04E+05 ± 17.79%	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
149	<1.47E+05	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
150	<1.56E+05	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
151	3.72E+05 ± 16.33%	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
153	3.80E+05 ± 19.17%	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
156	<1.66E+05	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
157	1.52E+05 ± 30.16%	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
158	<2.21E+05	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
160	7.05E+04 ± 51.09%	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
161	2.99E+05 ± 20.02%	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
164	3.68E+05 ± 18.36%	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
180	3.47E+05 ± 19.30%	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
186	<5.46E+05	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
187	<4.17E+05	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
191	<1.88E+05	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
195	4.81E+05 ± 14.30%	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
196	3.29E+05 ± 20.22%	0.00E+00	N/A	N/A	N/A	N/A	< DCGL

Grid	Co-60 (pCi/m ²)	Cs-137 (pCi/m ²)	Co-60 Minus SU Mean (pCi/m ²)	Cs-137 Minus SU Mean (pCi/m ²)	Cobalt Activity (Unitized)	Cesium Activity (Unitized)	DCGL _{EMC} Comparison Fraction
198	3.50E+05 ± 17.66%	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
199	<1.26E+05	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
201	4.34E+05 ± 17.27%	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
202	3.55E+05 ± 26.11%	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
203	3.80E+05 ± 22.50%	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
204	2.86E+05 ± 24.30%	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
207	1.56E+06 ± 10.08%	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
209	1.19E+06 ± 10.94%	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
210	3.09E+05 ± 15.47%	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
212	4.14E+05 ± 18.45%	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
214	5.35E+05 ± 8.48%	6.65E+04 ± 51.94%	N/A	N/A	N/A	N/A	< DCGL
216	1.34E+05 ± 34.09%	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
218	1.91E+06 ± 9.64%	0.00E+00	1.59E+06	N/A	0.0279	N/A	0.028
219	9.32E+05 ± 7.24%	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
221	1.46E+06 ± 11.92%	0.00E+00	N/A	N/A	N/A	N/A	< DCGL
226	4.37E+05 ± 15.34%	1.55E+05 ± 64.32%	N/A	N/A	N/A	N/A	< DCGL
227	2.61E+05 ± 28.96%	0.00E+00	N/A	N/A	N/A	N/A	< DCGL

Grid	Co-60 (pCi/m ²)	Cs-137 (pCi/m ²)	Co-60 Minus SU Mean (pCi/m ²)	Cs-137 Minus SU Mean (pCi/m ²)	Cobalt Activity (Unitized)	Cesium Activity (Unitized)	DCGL _{EMC} Comparison Fraction
228	1.72E+06 ± 10.06%	0.00E+00	1.40E+06	N/A	0.025	N/A	0.025
229	4.73E+06 ± 8.88%	0.00E+00	4.41E+06	N/A	0.078	N/A	0.078
FR0400051R005	5.62E+05 ± 22.87%	2.25E+06 ± 35.91%	2.42E+05	2.20E+06	0.004	0.039	0.043
FR0400051R014	4.50E+05 ± 43.91%	1.97E+06 ± 86.34%	1.30E+05	1.92E+06	0.002	0.034	0.036
FR0400051R015	2.85E+05 ± 43.32%	1.54E+07 ± 13.56%	-3.50E+04	1.53E+07	0	0.271	0.271
FR0400051R018	< 5.35E+05	8.61E+06 ± 29.99%	2.15E+05	8.56E+06	0.004	0.151	0.154
FR0400051R024	3.57E+05 ± 59.01%	2.29E+06 ± 49.32%	3.70E+04	2.24E+06	0.001	0.039	0.040
FR0400051R049	1.81E+06 ± 6.69%	0.00E+00	1.49E+06	N/A	0.026	N/A	0.026
		SU Mean Elevated Areas Total	0.239 0.701 0.930				0.701

NOTES

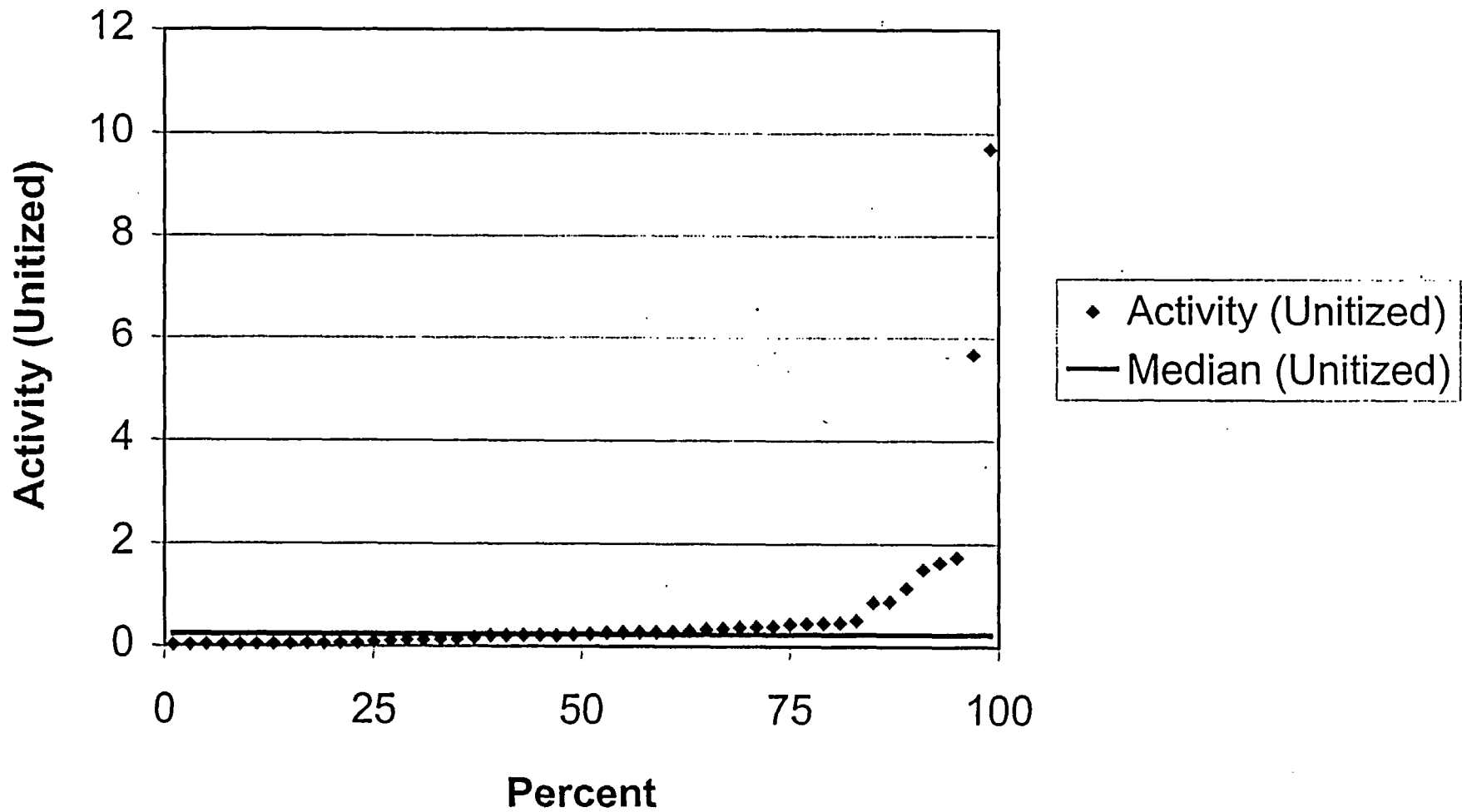
1. "<" indicates MDA value for non-detect Co-60 results.
2. Non-detect Cs-137 results shown as 0.00E+00 as discussed in Section E.
3. The Co-60 and Cs-137 mean values were calculated using Table 2 values except that the values for the six directs shown in Table 3-1 were excluded.
4. A conservative area factor (AF) of 35 was used based on a scan grid area of 9 m².
5. The unitized elevated activity was calculated as follows: (Investigation Result – SU Mean) / (AF)DCGL

Attachment 4
Statistical Data

Survey Package FR0400 Unit 5 Soil Sign Test Summary

Evaluation Input Values		Comments
Survey Package:	FR0400	Forebay
Survey Unit:	05	
Evaluator:	DR	
DCGL _w :	1.00E+00	
DCGL _{emc} :	1.00E+01	
LBGR:	5.00E-01	
Sigma:	2.58E-02	(0.31 pCi/g / 12 pCi/g)
Type I error:	0.05	
Type II error:	0.05	
Nuclide:	UNITY	
Soil Type:	N/A	
Calculated Values		Comments
Z _{1-α} :	1.645	
Z _{1-β} :	1.645	
Sign p:	0.99865	
Calculated Relative Shift:	19.3	
Relative Shift Used:	3.0	Uses 3.0 if Relative Shift is >3
N-Value:	11	
N-Value+20%:	14	
Sample Data Values		Comments
Number of Samples:	50	
Median:	2.24E-01	
Mean:	6.28E-01	
Net Sample Standard Deviation:	1.56E+00	
Total Standard Deviation:	1.56E+00	SRSS
Maximum:	9.68E+00	
Sign Test Results		Comments
Adjusted N Value:	50	
S+ Value:	44	
Critical Value:	31	
Sign test results:	Pass	
Criteria Satisfaction		Comments
Sufficient samples collected:	Pass	
Maximum value <DCGL _w :	Investigate	See Sections D&E of Release Record
Median value <DCGL _w :	Pass	
Mean value <DCGL _w :	Pass	
Maximum value <DCGL _{emc} :	Pass	
Total Standard Deviation <=Sigma:	Investigate	See Section F of Release Record
Criteria comparison results:	Investigate	See Section I of Release Record
Final Status		Comments
The survey unit passes all conditions:	Investigate	The SU passes

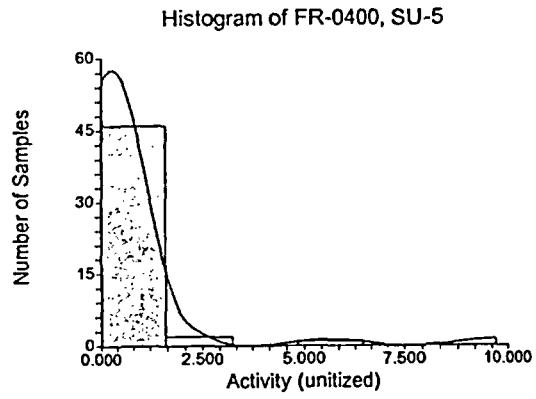
FR-0400 SU-5 Quantile Plot



One-Sample T-Test Report

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Variable C2

Plots Section



One-Sample T-Test Power Analysis

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Chart Section

