University of Missouri – Columbia
Sinclair Farm Phase 3
Final Status Report

NRC Broad Scope Type A
License Number: 24-00513-32

Work Performed Under:
University of Missouri – Columbia's
NRC Broad Scope Type A
Radioactive Materials
License No. 24-00513-32

June 8, 2012

Prepared by:

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South Sinclair Rd.
Columbia, MO 65201

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APPENDICES

ACRONYM LIST

ALARA	As Low As Reasonably Achievable
CFR	Code of Federal Regulations
$DCGL_{EMC}$	Derived Concentration Guideline Level – Elevated Measurement Comparison
$DCGL_W$	Derived Concentration Guideline Level – Wilcoxon Rank Sum
DQA	Data Quality Assessment
DQO	Data Quality Objective
FSS	Final Status Survey
HSA	Historical Site Assessment
LBGR	Lower Bound of the Gray Region
LSC	Liquid Scintillation Counter
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	Minimum Detectable Concentration
MU	University of Missouri-Columbia
NRC	U.S. Nuclear Regulatory Commission
NIST	National Institute of Standards and Technology
QA	Quality Assurance
RPP	Radiation Protection Program
RSO	Radiation Safety Officer
TEDE	Total Effective Dose Equivalent

1 INTRODUCTION

The University of Missouri - Columbia (MU) has decided to conduct release surveys of the Environmental Trace Laboratory Buildings 13669 and 13671 located at the Sinclair Farm Site in Columbia, Missouri. The buildings burned in 2011 such that only the floor slabs (18,129 ft^2) and foundations remain. Because these buildings were historically used for activities involving radioactive materials under the MU US Nuclear Regulatory Commission (NRC) Broad Scope Type A radioactive materials license No. 24-00513-32, MU must demonstrate that the concrete slabs meet the criteria for unrestricted use. A map of the site is provided in Appendix A. Isotopes of concern consisted of C-14, Cl-36, H-3, and Ni-63. Other short-lived beta/gamma emitters may have been utilized, but due to their short half-lives, do not need to be considered in this report.

MU procured Chase Environmental Group, Inc. (Chase) to perform MARSSIM-based surveys at the Sinclair Farm Site. These independent, third party surveys are statistically sound and support that the buildings in question meet the unrestricted release criteria for residual radioactive materials. On-site activities were conducted under the University of Missouri – Columbia's NRC Broad Scope Type A License No. 24-00513-32 and in accordance with the "*University of Missouri – Columbia, Sinclair Farm Phase 3 Radiological Survey Plan*" (Plan) dated May 24, 2012. On site activities were performed on May 29, 2012.

The Plan was developed using the guidance provided in NUREG 1757, "*Consolidated NMSS Decommissioning Guidance*" and NUREG 1575, "*Multi-Agency Radiation Survey and Site Investigation Manual*" (MARSSIM). The plan provided the approach, methods, and techniques for radiological surveys of impacted areas of the facility. Final status surveys were designed to implement the protocols and guidance provided in MARSSIM to ensure that technically defensible data was generated to demonstrate that structures met the release criteria for unrestricted use specified in 10CFR20.1402: "*Radiological criteria for unrestricted use*". The criteria are that residual radioactivity that is distinguishable from background radiation does not result in a Total Effective Dose Equivalent (TEDE) to an average member of the critical group in excess of 25 mrem per year and that the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA).

In addition, MU established conservative ALARA goals based on NUREG 1556, Volume 7, Table Q.2, *"Acceptable Surface Contamination Levels for Equipment."* Specifically, the following surface contamination limits were applied:

- 5,000 dpm/100cm^2 total surface contamination (averaged over 1m^2)
- 15,000 dpm/100cm^2 maximum total surface contamination (limited to 100 cm^2)
- 1,000 dpm/100cm^2 removable surface contamination

Facility radiological surveys did not identify residual radioactivity above ALARA goals. Therefore, no remediation was necessary and no radioactive waste was generated as a result of decommissioning activities.

This report presents sufficient data to support the conclusion that the facilities surveyed meet the NRC's release criteria. Final status surveys demonstrate that building structural surfaces

and systems included in the scope of this report are orders of magnitude below release criteria and are suitable for unrestricted release. All final status surface contamination measurements were a small fraction of the default screening values (DSVs). Based on the Building Occupancy Scenario of NRC DandD dose modeling software Version 2.1, **the Total Effective Dose Equivalent (TEDE) to an average member of the critical group would be < 0.016 mrem/year (<0.1% of the release criterion of 25 mrem/yr)** using the results of the survey unit with the highest average activity.

2 SITE DESCRIPTION AND HISTORY

2.1 Historical Site Assessments

Chase and the MU Environmental Health and Safety Department performed a Historical Site Assessment (HSA) in March and May 2011. The purpose of the historical site assessment was to determine the current status of the facility including potential, likely, or known sources of radioactive contamination by gathering data from various sources. This data included physical characteristics and location of the site as well as information found in site operating records, including radiological surveys, and operational history obtained from personnel interviews.

The reviewed records included: radioactive materials licenses, license applications, amendment requests, radiological surveys, radionuclide receipt and distribution records, incident reports, and facility renovation records.

2.2 Site Description

2.2.1 Ownership

The site is owned by MU.

2.2.2 Potential Contaminants

Based on information provided by MU, the nuclides of concern are C-14, Cl-36 and H-3. A Ni-63 electron capture device was used in a gas chromatograph at the facility. MU noticed indications of leakage and the source was disposed. As part of the response to the leaking sealed source, MU surveyed all lab fixtures in the area with no elevated activity identified. Other short-lived (half-life <120 days) beta-gamma emitters and low activity sealed sources may have also been used at the facility, but are not of concern for decommissioning.

2.2.3 Impacted Facility Descriptions

The MU Sinclair Research Farm, located on 543 acres at South Sinclair Road in Columbia, Missouri was historically used for radioactive materials research, incineration, land disposal, and radioactive materials storage. During Phase 1 and 2 surveys completed by Chase in May and December 2011, five barns (buildings 13641, 13646, 13648, 13650, and 13667), a small clinic (building 13661), three laboratory buildings (13617, 13618, and 13663), and two vivarium buildings (1320, 1330) were surveyed and released. For Phase 3, two concrete floor slabs with a total area of 18,129ft^2 associated with buildings 13669 and 13671 located on the east side of South Sinclair Road are considered impacted.

2.2.4 Impacted Systems

All building floor drains are directed into a lagoon near the barns. No other systems remain as a result of the 2011 fire.

3 FACILITY RELEASE CRITERIA

The radiological release criteria of NRC 10 CFR 20 Subpart E for unrestricted use were used for decommissioning the concrete slabs. Specifically, the concrete slabs were surveyed in accordance with the guidance contained in MARSSIM to demonstrate compliance with the criteria of 10 CFR 20.1402: *"Radiological criteria for unrestricted use: A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of the critical group that does not exceed 25 mrem (0.25 mSv) per year, including that from groundwater sources of drinking water, and the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA). Determination of the levels which are ALARA must take into account consideration of any detriments, such as deaths from transportation accidents, expected to potentially result from decontamination and waste disposal."*

4 DERIVED CONCENTRATION GUIDELINE LEVELS (DCGLs)

The NRC has published default screening values (DSVs) in NUREG 1757, Volume 1, Appendix B for commonly used radionuclides. The DSVs are the average concentrations of residual radioactivity that would equate to 25 mrem/yr to an average member of the critical group using default parameter values in the DandD dose modeling software. Structural surface DSVs for the nuclides of concern are presented in Table 4-1.

Table 4-1: NRC Screening Values

Isotope	Half-Life (yr)	Half-Life < 120 days?	Radiation Type	Default Screening Value ($dpm/100cm^2$)
C-14	5.7E+03	NO	Weak Beta	3.7E+06
Cl-36	3.0E+05	NO	Beta	5.0E+05
H-3	1.2E+01	NO	Weak Beta	1.2E+08
Ni-63	1.0E+02	NO	Weak Beta	1.8E+06

DSVs are the basis for developing Derived Concentration Guideline Levels for building structural surfaces. The DCGL is the radionuclide-specific surface area concentration that could result in a dose equal to the release criterion. $DCGL_W$ is the concentration limit if the residual activity is essentially evenly distributed over a large area. For this project, $DCGL_W$ is equal to the DSV. An important assumption of the dose model is that removable contamination is <10% of total contamination. Smear surveys were taken to verify this assumption and compared to a removable DCGL equal to 10% of the total DCGL.

Based on history, usage, etc., C-14, Cl-36, H-3 and Ni-63 were the nuclides of concern for all areas. Dose calculations are conservatively based on the limiting nuclide, Cl-36.

Because H-3 and Ni-63 cannot be efficiently detected by direct methods, they were evaluated by removable contamination measurements only. Considering the extremely conservative ALARA goals, we can ensure the H-3 and Ni-63 dose contribution is an insignificant component of the total calculated dose.

5 ALARA GOALS

ALARA goals were established for all impacted surfaces based on the release criteria for equipment and materials specified in NUREG 1556, Volume 7, Table Q.2, "*Acceptable Surface Contamination Levels for Equipment*." Specifically, the following surface contamination limits were applied:

- 5,000 dpm/100cm^2 total surface contamination (averaged over 1m^2)
- 15,000 dpm/100cm^2 maximum total surface contamination (limited to 100 cm^2)
- 1,000 dpm/100cm^2 removable surface contamination

Because of the conservatism of the ALARA goals, these criteria were applied to gross measurements and the unity rule was not applied. However, the number of measurements required by MARSSIM to demonstrate compliance with the release criteria was calculated using DCGLs.

Data Quality Objectives (DQOs) were designed to ensure instrument detection sensitivities were below the ALARA goals.

6 ALARA ANALYSIS

Due to the low doses associated with residual radioactivity at or below the ALARA goals, an explicit quantitative ALARA analysis was not required per NUREG 1757, Volume 2, Appendix N.

7 PROJECT MANAGEMENT AND ORGANIZATION

Work was performed under the MU NRC Broad Scope Type A License No. 24-00513-32, under the supervision of the MU Radiation Safety Officer (RSO) and Radiation Safety Committee (RSC). Chase designated a Project Manager to interface and inform MU personnel of all project operations.

8 PROJECT TRAINING

MU provided Chase personnel with site-specific Contractor HSE/Site Orientation Training. Chase provided training for project-specific programs, plans, and procedures.

8.1 MU Required Training

MU provided radiological training to Chase personnel per MU license requirements.

8.2 Project Specific Training

Prior to project start-up, personnel attended an initial project-specific training session conducted by the PM. The training session included the following items:

- Review of the Project Work Plan
- Discussion regarding the scope of work and planned work activities
- Review of chemical, physical, and radiological hazards associated with the project
- Discussion of posting requirements
- Types and use of available personal protective equipment
- Project security control and operational work zones
- Emergency response and site evacuation procedures
- Project communications
- General safe work practices
- Data quality and chain of custody procedures, and
- Review of applicable regulatory standards as applied to project operations

8.3 General Safety Briefings

General safety meetings were held by the PM at the beginning of the work shift. The purpose of the meeting was to discuss project status, potential problem areas, general safety concerns, and to reiterate DWP requirements.

9 RADIATION PROTECTION

Radiological work was performed according to the Plan and in accordance with the MU radioactive materials license Radiation Protection Program (RPP).

10 ENVIRONMENTAL MONITORING PROGRAM

Due to the small quantities of materials present at the facility, an environmental monitoring program was not required.

11 RADIOACTIVE WASTE MANAGEMENT

There was no radioactive waste generated from project activities.

12 QUALITY ASSURANCE PROGRAM

Due to the limited scope of the planned activities, project-specific quality requirements were included in the Plan, and were supported by the Chase corporate Quality Assurance (QA) program and met the guidelines of MARSSIM Section 9. QA criteria were applied in a graded manner to achieve a balance between the rigor of application of quality assurance measures and the scale, cost, and complexity of the work involved.

13 SURVEY INSTRUMENTATION

13.1 Instrument Calibration

Radiation detection instruments were calibrated at least annually with National Institute of Standards and Technology (NIST) traceable sources and to radiation emission types and energies that provided detection capabilities similar to the isotopes of concern. Field instruments had an efficiency determined by a licensed calibration facility using NIST traceable sources. Calibration records for field instruments are provided in Appendix B. Calibration records for the liquid scintillation counter are maintained by MU.

13.2 Datalogging

Beta-gamma surface scans were performed using datalogging instrumentation. While scanning, in addition to the surveyor listening to the audible output, integrated counts were recorded. Logged data was downloaded and processed using data management software to perform data analyses and reporting. Reporting includes graphical (4-plot) presentation, as well as summary statistics functions.

13.3 Functional Checks

Instrument functional checks were performed at least daily when in use. The background, source check, and field measurement count times for radiation detection instrumentation were specified by procedure to ensure measurements were statistically valid. Background readings were taken as part of the daily instrument check and compared with the acceptance range for instrument and site conditions.

13.4 Counting Times and Minimum Detectable Concentrations (MDCs)

Minimum counting times for background determinations and measurement of total and removable contamination were chosen to provide MDCs that met the Data Quality Objectives (DQOs) specified in the plan. MARSSIM equations relative to building surfaces have been modified to convert to units of dpm/100cm^2. Count times and scanning rates were determined using the following equations:

13.4.1 Static Counting MDC

Static counting MDC at a 95% confidence level was calculated using the following equation, which is an expansion of NUREG 1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions", Table 3.1 (Strom & Stansbury, 1992):

$$MDC_{static} = \frac{3 + 3.29\sqrt{B_R \cdot t_S \cdot (1 + \frac{t_S}{t_B})}}{t_S \cdot E_{tot} \cdot \frac{A}{100}}$$

Where:

MDC_{static} = minimum detectable concentration (dpm/100cm^2)

B_R = background count rate (counts per minute)

t_B = background count time (minutes)
t_S = sample count time (minutes)
E_{tot} = total detector efficiency for radionuclide emission of interest (cpm/dpm)
A = detector probe area (cm^2)

A typical static MDC calculation for the Ludlum Model 43-37 gas flow proportional detector is shown below:

$$MDC_{STATIC} = \frac{3 + 3.29\sqrt{(1500)(0.1)\left(1 + \frac{0.1}{0.1}\right)}}{(0.1)(0.16)\frac{582}{100}} = 644 \text{ dpm/100cm}^2$$

13.4.2 Ratemeter Scanning MDC

Scanning MDC at a 95% confidence level was calculated using the following equation, which is a combination of MARSSIM equations 6-8, 6-9, and 6-10:

$$MDC_{scan} = \frac{d'\sqrt{b_i}\left(\frac{60}{i}\right)}{\sqrt{p} \cdot E_{tot} \cdot \frac{A}{100 cm^2}}$$

Where:
MDC_{scan} = minimum detectable concentration (dpm/100cm^2)
d' = desired performance variable (1.38)
b_i = background counts during the residence interval (counts)
i = residence interval (seconds)
p = surveyor efficiency (0.5)
E_{tot} = total detector efficiency for radionuclide emission of interest (cpm/dpm)
A = detector probe area (cm^2)

A typical MDC_{scan} calculation for the Ludlum 43-37 gas flow proportional detector is shown below:

$$i = 13.3\text{cm} \cdot \frac{\text{inch}}{2.54\text{cm}} \cdot \frac{\text{sec}}{20\text{inch}} \cdot = 0.26\text{sec}$$

$$b_i = 0.26 \text{ sec} \cdot \frac{1{,}500 \text{ counts}}{\text{minute}} \cdot \frac{\text{minute}}{60 \text{ sec}} = 6.5 \text{ counts}$$

$$MDC_{SCAN} = \frac{1.38\sqrt{6.5}\left(\frac{60}{0.26}\right)}{\left(\sqrt{0.5}\right)(0.16)\left(\frac{582}{100}\right)} = 1233 \text{ dpm/100cm}^2$$

13.4.3 Smear Counting MDC

Smear counting MDC at a 95% confidence level was calculated using the following equation, which is an expansion of NUREG 1507, Table 3.1 (Strom & Stansbury, 1992):

$$MDC_{SMEAR} = \frac{3 + 3.29\sqrt{B_R \cdot t_s \cdot \left(1 + \frac{t_s}{t_b}\right)}}{t_s \cdot E}$$

Where:

MDC_{smear}	=	minimum detectable concentration (dpm/100cm^2)
B_R	=	background count rate (counts per minute)
t_b	=	background count time (minutes)
t_s	=	sample count time (minutes)
E_{tot}	=	instrument efficiency for radionuclide emission of interest (cpm/dpm)

13.4.4 Uncertainty

The uncertainty for each measurement was calculated using equation 6-15 from MARSSIM:

$$\sigma = 1.96\sqrt{\frac{C_{s+b}}{T_{s+b}^{\ 2}} + \frac{C_b}{T_b^{\ 2}}}$$

Where:

σ	=	uncertainty
1.96	=	multiplier to achieve a 95% confidence level
C_{s+b}	=	gross sample counts
T_{s+b}	=	sample count time (min.)
C_b	=	gross background counts
T_b	=	background count time (min.)

Uncertainties presented with total surface activity results are additionally corrected for detection efficiency and probe area for presentation in the same units as total surface activity results.

13.5 Instrumentation Specifications

The instrumentation used for facility decommissioning surveys is summarized in the following tables. Table 13-1 lists the standard features of each instrument such as probe size and efficiency. Table 13-2 lists the typical operational parameters such as scan rate, count time, and the associated Minimum Detectable Concentrations (MDC).

Table 13-1: Instrumentation Specifications

Detector Model	Detector Type	Detector Area (cm^2)	Meter Model	Window Thickness (mg/cm^2)	Typical Efficiency
Ludlum 43-68	Gas Flow Proportional	126	Ludlum 2241-3	0.8	15% (C-14)
Ludlum 43-37 Floor Monitor	Gas Flow Proportional	582	Ludlum 2241-3	0.8	15% (C-14)
Packard TriCarb (or Equivalent)	Liquid Scintillation	N/A	N/A	N/A	60% (H-3) 80% (C-14) 90% (CH3, >256 keV)

Table 13-2: Typical Instrument Operating Parameters and Sensitivities

Measurement Type	Detector Model	Max. Scan Rate (in/sec)	Count Time (sec)	Background (cpm)	MDC ($dpm/100cm^2$)
Surface Scans	Ludlum 43-68	10	N/A	500	3,039 (C-14)
Surface Scans	Ludlum 43-37	20	N/A	1,000	1,070 (C-14)
Total Surface Activity	Ludlum 43-68	N/A	6	500	1,899 (C-14)
Total Surface Activity	Ludlum 43-37	N/A	6	1,000	567 (C-14)
Removable Activity	Packard TriCarb	N/A	60	25 (H-3) 15 (C-14) 16 (CH3)	44 (H-3) 26 (C-14) 24 (CH3)

13.6 Efficiency Determination

The Investigation Levels/ALARA goals were conservatively based on the release criteria for equipment and materials specified in NUREG 1556, Volume 7, Table Q.2, *"Acceptable Surface Contamination Levels for Equipment"* in which activities are determined using 4π instrument efficiency. MARSSIM uses ISO-7503-1 methodology that takes into account the texture of the surface and the 2π detector efficiency. Instrument efficiencies are conservatively based on C-14 because it was the most commonly used nuclide at the facility. Under MARSSIM, the default surface efficiency for beta emitters with maximum energies less than 400 KeV is conservatively set at 0.25, resulting in a total efficiency of approximately half of the 4π efficiency. To reconcile this incongruity and to aid in data management, the 4π C-14 calibration efficiency was used to determine field measurement activities. This methodology was chosen because:

- Application of the ISO-7503-1 surface efficiency would significantly impact final status survey time and data quality while providing no benefit. The impact would be in the form of slower scanning times and magnification of the variability of the natural background radioactivity present in some building materials.
- NUREG 1507 research indicates that ISO-7503-1 surface efficiencies for low energy beta emitters are overly conservative for typical decommissioning conditions and surface efficiencies closer to 0.5 are warranted.
- NUREG 1556, Volume 7, Table Q.2, criteria are not dose-based resulting in extreme over-conservatism for low energy beta emitters.
- Dose calculations are conservatively based on the limiting nuclide (Cl-36) that had limited, if any usage at the site. Cl-36 has a higher ISO-7503-1 detection efficiency than the 4-pi C-14 detection efficiency, so this method is conservative.

14 CHARACTERIZATION SURVEYS

Radiological characterization was designed to identify areas of elevated activity that required remediation. Characterization consisted primarily of surface scans and smears for building structural surfaces and removable activity measurements on system internal surfaces. Characterization surveys were designed to meet the same data quality objectives as final status surveys such that characterization data was used as final status data where possible. No areas of elevated activity were identified during characterization surveys.

14.1 Building Structural Surfaces

The survey protocol for building surfaces consisted of performing the scanning portion of the final status survey protocol specified in section 15.5. The purpose of scanning was to identify locations of elevated activity. No elevated activity was detected during scans or removable activity measurements.

14.2 Building Drains

The characterization survey protocol for building drains consisted of a removable contamination measurement of internal surfaces. One hundred percent of accessible drain system openings were surveyed. Chase used convenient accessible locations to obtain measurements. The small geometry of the openings made direct measurements impossible, so only removable activity measurements were made. Because it was impossible to differentiate drain openings from other openings, all openings were assumed to be drains and were surveyed.

15 DESIGN AND PERFORMANCE OF FINAL STATUS SURVEYS

Final status surveys (FSS) demonstrated that residual radioactivity in each survey unit satisfied the predetermined criteria for release. The FSS was conducted by performing the appropriate combination of scan surveys, total activity measurements, and removable activity measurements as discussed further in this section. All final status surveys were performed according to written instructions. Survey data was documented on survey maps and/or associated data information sheets. Characterization and remedial action survey data was used as FSS data to the maximum extent possible.

15.1 Background Determination

Reference background areas or paired background comparisons were not necessary for this survey design. Material and ambient background levels were not significant in comparison to the DCGLs. Ambient background was determined for each survey to calculate the actual survey MDCs and associated counting errors.

For total surface activity measurements, ambient background levels were generally determined by performing a six-second timed count with the probe at waist level and away from survey unit surfaces. Ambient background was subtracted from each total activity gross measurement. Material background, the contribution from naturally-occurring radioactivity in the concrete slabs, was not accounted for (subtracted) since it was a small fraction of the DCGL.

The liquid scintillation counter was set up to report results in net dpm in each channel (background subtraction on).

15.2 Data Quality Objectives (DQO)

The Data Quality Objective process as described in MARSSIM was used throughout the design and implementation of decommissioning surveys. The following is a list of the DQOs for the survey design:

- Static measurements of structural surfaces were taken to achieve an MDC_{static} of less than the ALARA goal of 5,000 dpm/100cm^2
- Scanning of structural surfaces was conducted at a rate to achieve an MDC_{scan} of less than the ALARA goal of 5,000 dpm/100cm^2
- Removable contamination measurements were counted to achieve an MDC_{smear} of less than 200 dpm/100cm^2 in each LSC channel.
- Individual measurements were made to a 95% confidence interval.
- Decision error probability rates were set at 0.05 for both α and β.
- The null hypothesis (H_0) and atlernative hypothesis (H_A) were that of NUREG 1505 scenario A:
  - H_0 was that the survey unit does not meet the release criteria
  - H_A was that the survey unit meets the release criteria
- Quality assurance surveys (duplicative measurements on building structural surfaces) were conducted at a rate of 5%.
- Characterization surveys were conducted under the same quality assurance criteria as FSSs such that the data may be used as FSS data to the maximum extent possible.

15.3 Area Classifications

Based on the facility operational history and previous survey results, facility areas were classified as impacted areas or non-impacted areas.

15.3.1 Non-Impacted Areas

Non-impacted areas are areas without residual radioactivity from licensed activities and were not surveyed during final status surveys. Surface and

subsurface soils of outside grounds were considered non impacted based on historical operations.

15.3.2 Impacted Areas

Impacted areas are those areas that had potential residual radioactivity from licensed activities. All areas with a history of containing radioactive materials were considered impacted. There were no Class 1 or Class 3 areas. Based on the release criteria and historical operations provided by MU, all areas with a history of radioactive materials usage were conservatively classified as Class 2. Class 2 areas are areas that meet the following criteria: (1) impacted; (2) low potential for delivering a dose above the release criterion; and (3) little or no potential for small areas of elevated activity.

15.4 Survey Units

A survey unit is a geographical area of specified size and shape for which a separate decision was made whether or not that area met the release criteria. Survey units were homogeneous in construction, contamination potential, and contamination distribution.

The number of discrete sampling locations needed to determine if a uniform level of residual radioactivity existed within a survey unit did not depend on the survey unit size. However, the sampling density reflected the potential for small elevated areas of residual radioactivity. Survey units were sized according to the potential for small elevated areas of residual radioactivity. Recommended maximum survey unit sizes for building structures, based on floor area, is Class 1: up to 100 m^2 , Class 2: 100 m^2 to 1000 m^2 and Class 3: no limit.

Each survey unit is assigned a unique identification number consisting of the building number followed by a dash and then a four character alpha-numeric code consisting of the elevation, classification, and a two-digit identifier as follows:

Survey Unit Designations
Building Number[1] – Elevation/Classification/Numerical Identifier
The default numeric identifier is 01

Elevations:
1=1st Floor

Example:
669-1201 is the concrete slab associated with building 13669, first floor, class 2

Survey units are presented in the table below.

[1] Because all the building numbers are five digits long and start with 13, only last three digits were used as the building number.

Table 15-1: Building Structural Survey Units

Building	Class	Survey Unit Number	Floor Area (GSF)
13669	2	1201	7,814
13671	2	1201	10,315

Due to the limited size of the impacted areas, building drain surveys were grouped together as one survey unit. The Code ETR (Environmental Trace Research) was used to identify the building number. All drains from both buildings are included in survey unit ETR-DR01.

15.5 Surface Scans

Scanning was used to identify locations that exceed the investigation level. Scan surveys were conducted by moving the detector probe at a distance of about $^1/_8$ inch from the surface at the prescribed scan rate and listening for an increase in the audible response. While scanning, in addition to the surveyor listening to the audible output, integrated counts were recorded every second by datalogging instrumentation. Table 15-2 summarizes the percentage of accessible structural surfaces scanned based on classification.

Table 15-2: Scan Survey Area Coverage by Classification

Surface	Class 2
Floors	50%

Areas where floor tile was intact were scanned 100%. No elevated activity was detected during scan surveys.

15.6 Total Surface Activity Measurements

Total surface activity (static) measurements were taken at each identified sample location. Scaler count times were determined to achieve the detection sensitivities stated in the DQOs. Field measurements were converted to an activity concentration using the following equation:

$$\text{Activity}(\text{dpm}/100\text{cm}^2) = \frac{cpm_{sample} - cpm_{background}}{E_{total} \cdot \frac{A}{100cm^2}}$$

Where:

cpm_{sample} = sample count rate in counts per minute
$cpm_{background}$ = background count rate in counts per minute
E_{tot} = total detector efficiency for radionuclide emission of interest (includes combination of instrument efficiency and surface efficiency)
A = Active area of the detector in cm^2

Static measurements for total surface activity were performed by conducting a six-second timed count on the surface to be measured. Static measurements were used for survey

unit statistical analyses and to determine compliance with release criteria. Due to small geometry, system internals were inaccessible and no direct measurements were performed.

15.7 Determination of the Number of Samples Required for the Sign Test

The minimum number of samples required for the Sign Test was calculated using equations in Section 5 of MARSSIM. A conservative estimate of the standard deviation of total surface activity measurements (1,000 dpm/100cm^2) was used for calculations. The Lower Bound Gray Region was set at one half of the DCGL. The calculation performed to determine the required number of samples in accessible areas is provided below.

15.7.1 Determination of the Relative Shift

The number of required samples depended on the ratio involving the activity level measured relative to the variability in the concentration. This ratio is called the Relative Shift, Δ/σ_S and is defined in MARSSIM as:

$$\Delta / \sigma_S = \frac{DCGL - LBGR}{\sigma_S}$$

Where:

DCGL = derived concentration guideline level
LBGR = concentration at the lower bound of the gray region(LBGR). The LBGR is the average concentration to which the survey unit should be cleaned in order to have an acceptable probability of passing the test
σ_S = an estimate of the standard deviation of the residual radioactivity in the survey unit

The actual calculation is provided below:

$$\Delta / \sigma_S = \frac{5.0E5 \text{ dpm/100cm}^2 - 2.5E5 \text{ dpm/100cm}^2}{1{,}000 \text{ dpm/100cm}^2} = 250$$

Since MARRSIM Table 5.5 does not include relative shifts above 3 and the number of samples required decreases with an increasing relative shift, the relative shift was conservatively set at 3.

15.7.2 Determination of Acceptable Decision Errors

A decision error is the probability of making an error in the decision on a survey unit by passing a unit that should fail (α decision error) or failing a unit that should pass (β decision error). MARSSIM uses the terminology α and β decision errors; this is the same as the more common terminology of Type I and Type II errors, respectively. The applicable decision errors (Type I Type II errors) were

selected in accordance with the established Data Quality Objectives at 0.05 for Type I errors and 0.05 for Type II errors.

15.7.3 Determination of Number of Samples

For the purposes of the final status survey it was assumed that the contaminant was not present in background at significant levels compared to the DCGLs. Therefore, material-specific background was not subtracted from the total surface activity measurements. Using this methodology, the Sign Test was chosen for the statistical evaluation of survey data.

The number of total surface activity measurements for a particular survey unit, employing the Sign Test, was determined from MARSSIM Table 5.5, which is based on the following equation (MARSSIM equation 5-2):

$$N = \frac{\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2}{4\left(SignP - 0.5\right)^2}$$

Where:

N	= number of samples needed in the survey unit
$Z_{1-\alpha}$	= percentile represented by the decision error α
$Z_{1-\beta}$	= percentile represented by the decision error β
SignP	= estimated probability that a random measurement will be less than the DCGL when the survey unit median is actually at the LBGR

Note: SignP is determined from MARSSIM Table 5.4

MARSSIM recommends increasing the calculated number of measurements by 20% to ensure sufficient power of the statistical tests and to allow for possible data losses. MARSSIM Table 5.5 values include this additional 20%. The following calculations were made to determine this number:

$$N = \frac{\left(1.645 + 1.645\right)^2}{4\left(0.998650 - 0.5\right)^2} = 11$$

$Z_{1-\alpha}$ and $Z_{1-\beta}$ are equal to 1.645 using the error rate of 0.05 from MARSSIM Table 5.2. SignP is equal to 0.998650 from MARSSIM Table 5.4. Adding an additional 20% to account for data losses resulted in a value of 14.

Therefore, the determined number of samples per survey unit for the final status surveys was **14**.

15.8 Determination of Sample Locations

Determination of Class 2 survey unit sample locations was accomplished by first determining sample spacing and then systematically plotting the sample locations from a

randomly generated start location. The random starting point of the grid provided an unbiased method for obtaining measurement locations to be used in the statistical tests. A square grid was used in this survey design. The use of a systematic grid allowed the decision-maker to draw conclusions about the size of the potential areas of elevated activity based on the area between measurement locations.

Sampling locations were established in a unique pattern beginning with the random start location and the determined sample spacing. After determining the number of samples needed in the survey unit, sample spacing is determined from MARSSIM equation 5-8:

$$L = \sqrt{\frac{A}{N}} \text{ for a square grid}$$

Where:

L = sample spacing interval
A = the survey unit area
N = number of samples needed in the survey unit

Maps were generated of the survey unit's permanent horizontal surfaces included in the statistical tests. A random starting point was determined using computer-generated random numbers coinciding with the x and y coordinates of the total survey unit. A grid was plotted across the survey unit surfaces based on the random start location and the determined sample spacing. A measurement location was plotted at each intersection of the grid plot. Final Status sample location maps are presented in Appendix C.

15.9 Removable Contamination Measurements

Removable contamination measurements were collected by wiping an area of approximately 100 cm^2 using paper smears or cotton swabs. The smears/swabs were counted to achieve the detection sensitivities stated in the DQOs. The liquid scintillation counter (LSC) was setup for triple channel counting as follows:

Channel 1 (^3H):	2 – 18.6 keV
Channel 2 (^{14}C):	18.6 – 256 keV
Channel 3 (all others):	> 256 keV

Removable contamination measurements (smears) were collected on building structural surfaces at each sample location. Additionally, removable contamination measurements were collected for building system internals. An area of approximately 100cm^2 was wiped. LSC results are reported in net dpm/100cm^2 (with background subtraction on).

15.10 Surveys of Building Mechanical System Internals

Surveys of drain systems were required. Survey design for these systems is out of the scope of MARSSIM. For the purpose of identifying potential residual contamination within drains; scans and removable contamination surveys were taken at system inlets to

the extent possible due to geometric considerations. 100% of accessible drain openings were sampled.

15.11 Investigation Levels

Investigation levels were used to flag locations that required special attention and further investigation to ensure areas were properly classified and adequate surveys were performed. Investigation levels are summarized in the table below.

Table 15-3: Survey Investigation Levels

Survey Unit Classification	Flag Static Measurement Result When: (dpm/100cm^2)	Flag Scanning Measurement Result When: (dpm/100cm^2)	Flag Removable Measurement Result When: (dpm/100cm^2 in any channel)
All	>5,000	>5,000	>200

16 SURVEY DOCUMENTATION AND DATA MANAGEMENT

16.1 Survey Packages

Each survey unit was surveyed under a survey package approved by the Project Manager and specifying the survey protocol to be followed. The survey package contained the following elements to ensure the DQOs were met:

- Survey protocol instructions such as the number of samples, sample spacing, sample locations, areas to be scanned, etc.
- Random number generations to determine survey locations
- Instrumentation to be used
- Scan rates, static count times, and/or minimum sample volumes
- Scaled survey unit maps
- Checklists for the survey technician

16.2 Location Codes

To ensure proper data management and organization, each static and removable activity measurement location was assigned a unique alpha-numeric location code consisting of a sequence of identifiers to indicate specific information about that location, such as the building, survey unit, structural surface, structural material, and a numerically sequenced location number within the survey unit. This system was used so that survey data could be properly entered and organized in the Final Status Survey Database. A breakdown of the location code and specific code components are provided in the table below.

Table 16-1: Location Code Description

A unique location code was assigned to each individual survey location to ensure proper data management of the survey results. The following format was used to ensure consistency throughout the final status survey process: **BBB-RRRR-SS-M-LLL** Where:		
BBB:	=	Building Code. This field represents the building number. (3 characters)
RRRR:	=	Survey Unit Number. This is the assigned survey unit number. (4 characters)
SS:	=	Structural Surface Code. This field represents the structural surface such as floor, wall, ceiling, etc. (2 characters) F1 = Floor D2 = Floor Drains D4 = Other Drains
M:	=	Structural Material Code. This field represents the type of structural material on which a particular measurement is taken. (1 character) C = Concrete V = Vinyl Tile
LLL:	=	Numerical Identifier. This field represents the survey location number. The field "001" means survey point location number 1. Numerical identifiers are unique within a survey unit. (3-characters)

17 DATA QUALITY ASSESSMENT (DQA) AND INTERPRETATION OF SURVEY RESULTS

The statistical guidance contained in Section 8 of MARSSIM was used to determine if areas were acceptable for unrestricted release, and whether additional surveys or sample measurements were needed.

17.1 Data Validation

Field data was reviewed and validated to ensure:

- Completeness of forms.
- The type of survey was correctly assigned to the survey unit.
- The MDCs for measurements met the established data quality objectives.
- Independent calculations were performed for a representative sample of data sheets and survey areas.

- Instrument calibrations and daily functional checks were performed accurately and at the required frequency.

Additionally, all final status survey data was entered into the Final Status Survey Database. This provided the means to sort survey data, verify activity calculations, and to compute the associated MDC and counting errors. Once data entry for a survey unit was complete, a verification report was printed and compared to original data sheets to ensure correct data entry.

The final status database reports for building structural surfaces and systems are provided in Appendices E and F, respectively.

17.2 Preliminary Data Review

A preliminary data review was performed for each survey unit to identify any patterns, relationships or potential anomalies. Additionally, measurement data was reviewed and compared with the DCGLs and investigation levels to identify areas of elevated activity and confirm the correct classification of survey units.

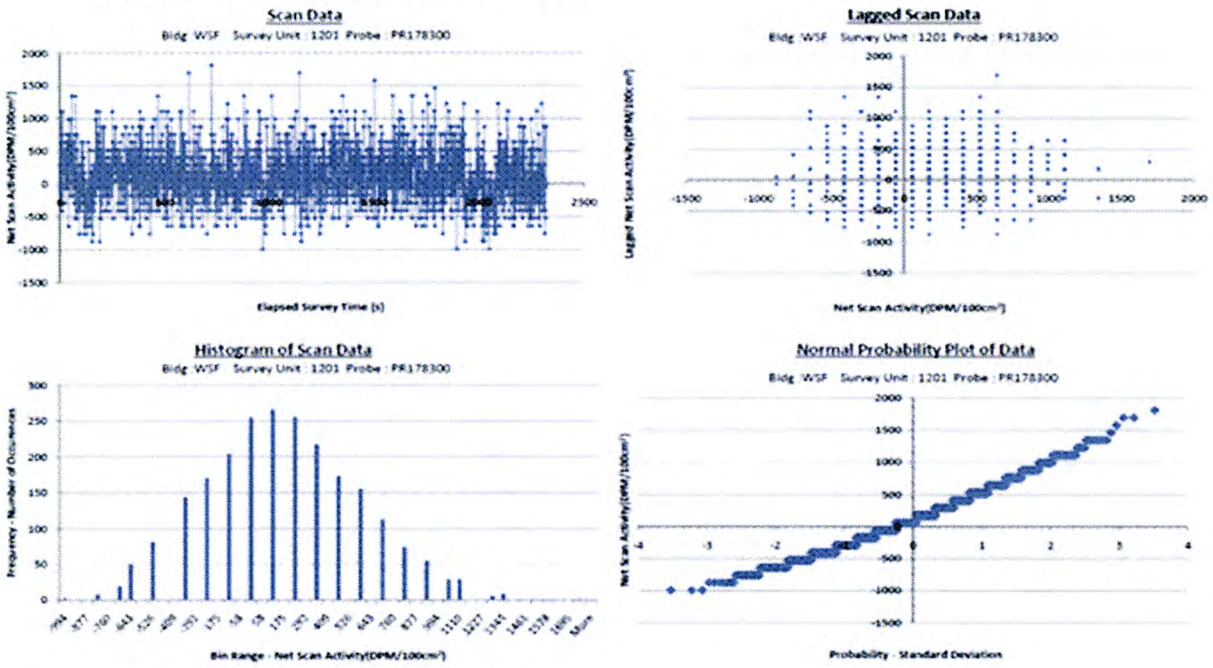
The following preliminary data reviews were performed for each survey unit:

- Calculations of the survey unit mean median, maximum, minimum, and standard deviation for each type of reading.
- Comparison of the actual standard deviation to the assumed standard deviation used for calculating the number of measurements to ensure a sufficient number of samples was obtained.
- Comparison of survey data with applicable investigation levels.
- Review of graphical outputs

The data management software produced 4-plot graphical output of scan data to enhance data visualization. A 4-plot consists of the following:

- A **run sequence plot** presents logged data in chronological order, providing a time history of the survey data.
- A **lag plot** checks whether a data set or time series is random or not. Random data should not exhibit any identifiable structure in the lag plot.
- A **histogram plot** graphically summarizes the distribution of a univariate data set, showing center (i.e., the location) of the data, spread (i.e., the scale) of the data, skewness of the data, presence of outliers, and presence of multiple modes.
- A **probability plot** is a goodness-of-fit test used to verify the distributional model. The normal probability plot is a graphical technique for assessing whether or not a data set is approximately normally distributed. The data is plotted against a theoretical normal distribution in such a way that the points should form an approximate straight line. Departures from this straight line indicate departures from normality.

An example 4-plot is provided below.



17.3 Review of 4 Plots

A 4-Plot was produced for each survey instrument used within each survey unit. Survey unit 4-Plot graphs can be found in Appendix D.

One anomaly was noted in survey unit 671-1201. A spike is apparent in the histogram. This is because the results can only occur at discrete multiples of a conversion factor used to convert net counts from the data logger into disintegrations per minute per 100cm^2(dpm/100cm^2). The histograms are created using a function that automatically chooses bin ranges based upon the range of data obtained. Since the bin range spacing is independent of the spacing of the plotted data, sometimes the bin can span more than one plotted value (or could contain no values as in the histogram for survey unit 669-1201). This appears as a spike compared to the other bins with only one plotted value per bin.

17.4 Data Summary Tables

Static measurement and smear data are presented below. The total activity results had a slight positive bias, likely due to the naturally occurring radioactivity in concrete floors.

Table 17-1: Structural Surfaces Total Beta Surface Activity (Static Measurements)

Survey Unit	# of Sample Locations	Mean	MDC	Standard Deviation	Min.	Max.	Any Result Exceeding Investigation Level of 5,000?
		(dpm/100 cm^2)					
669-1201	18	314	518	233	-187	648	NO
671-1201	13	144	518	267	-318	626	NO

Table 17-2: Building Structural Surfaces Removable ^{3}H Summary

Survey Unit	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Any Result Exceeding Investigation Level of 200?
		(dpm/100 cm^2)				
669-1201	18	10	6	0	26	NO
671-1201	13	13	7	3	24	NO

Table 17-3: Building Structural Surfaces Removable ^{14}C Summary

Survey Unit	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Any Result Exceeding Investigation Level of 200?
		(dpm/100 cm^2)				
669-1201	18	8	7	0	22	NO
671-1201	13	7	6	0	18	NO

Table 17-4: Building Structural Surfaces Removable Channel 3 Summary

Survey Unit	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Any Result Exceeding Investigation Level of 200?
		(dpm/100 cm^2)				
669-1201	18	1	2	0	6	NO
671-1201	13	1	2	0	8	NO

Table 17-5: Building Drains Removable ^{3}H Summary

Survey Unit	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Any Result Exceeding Investigation Level of 200?
		(dpm/100 cm^2)				
ETR-DR01	117	18	10	0	75	NO

Table 17-6: Building Drains Removable ^{14}C Summary

Survey Unit	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Any Result Exceeding Investigation Level of 200?
		(dpm/100 cm^2)				
617-DR01	117	7	7	0	27	NO

Table 17-7: Building Drains Removable Channel 3 Summary

Survey Unit	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Any Result Exceeding Investigation Level of 200?
		(dpm/100 cm^2)				
617-DR01	117	2	3	0	14	NO

17.5 Determining Compliance for Building Structural Surfaces and Structures Post Remediation

Removable contamination measurements were compared directly to the applicable investigation levels and DCGLs. No contingency was established for elevated removable contamination. All removable contamination measurements collected during the final status surveys were less than the applicable investigation level and significantly less than the removable DCGL, so compliance is determined based on total activity measurements.

All total surface activity measurements were compared directly to the DCGL and investigation levels to determine if an area required further surveillance. All total surface activity measurement collected at MARSSIM-calculated locations were less than the investigation levels and significantly less than the DCGL.

The Sign test is not performed in this survey design because the total activity DCGL is used as a maximum. If all measurements are less than the DCGL, performance of the Sign test is not necessary because the survey units will pass the Sign test. Therefore, the null hypothesis can be rejected and the survey units meet the release criteria and are suitable for release for unrestricted use.

The standard deviation for each survey unit was less than the standard deviation used for preliminary calculation of the minimum number of samples required for the Sign test. Therefore, 11 measurements are required for each survey unit.

The results of the data quality assessment and calculations of the dose from each structural surface survey unit are presented in the table below.

Table 17-8: Structural Surfaces Total Beta Surface Activity Dose Calculations

Survey Unit	Standard Deviation (dpm/100 cm^2)	# of Samples	Mean (dpm/100 cm^2)	Calculated Annual TEDE[2] (mrem/yr)
669-1201	233	18	314	0.016
671-1201	267	13	144	0.007
			Maximum:	**0.016**

17.6 Mechanical System Survey Data Analysis

Results of drain system removable activity measurements were compared directly with the investigation level and removable DCGL. Direct measurements were not possible due to the small geometry of the drain internals. All removable activity measurements were less than the investigation level and removable DCGL, therefore the system meets the release criterion and are suitable for release.

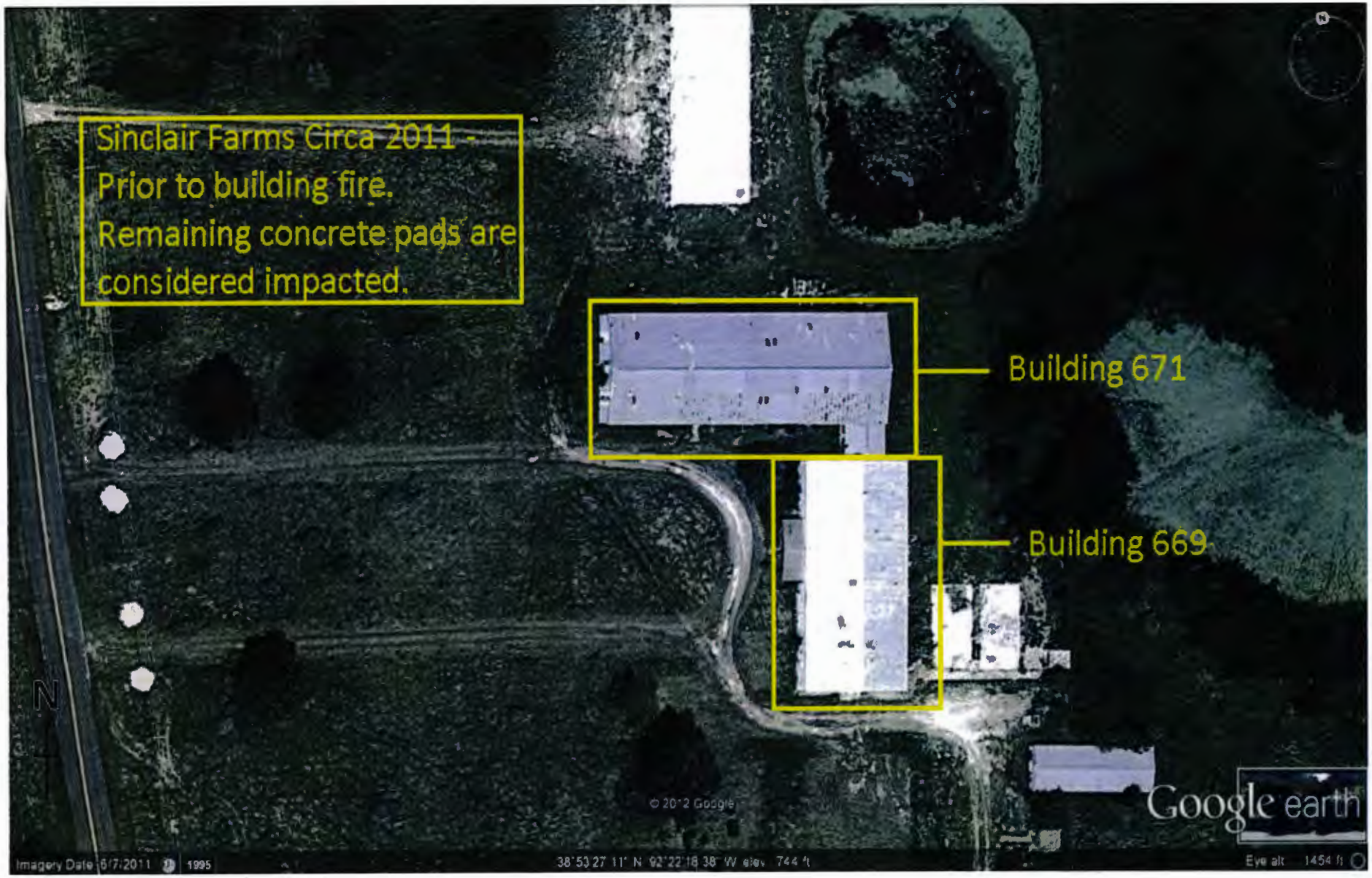
18 QUALITY ASSURANCE SURVEYS

Quality Assurance (QA) measurements were performed during phase one and two of the Sinclair farm project. Surveys were conducted according to the quality assurance requirements of the plan requiring duplication of the final status survey protocol for building structural surfaces at a rate of 5% to include scans, static measurements, and smears. This was accomplished by re-surveying survey unit 041-1201 during phase one, and 663-1201 during phase two. The total scan and removable percentages during these phases exceeded the 5% project requirement. Additional measurements were not collected during Phase 3 because Phase 3 involved a very limited area and final status surveys were directly observed by the Project Manager and Field Service Manager.

[2] The TEDE shown is calculated by multiplying 25 mrem/yr by the ratio of the mean total surface activity to the Cl-36 DCGL of 5.0E5 dpm/100cm^2.

19 REFERENCES

- NRC Regulations
- The University of Missouri - Columbia US Nuclear Regulatory Commission Broad Scope Type A radioactive materials license No. 24-00513-32
- NUREG-1575, Revision 1, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)," August 2000
- NUREG 1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions," June 1998
- NUREG 1757, Volume 1, Revision 2, "Consolidated NMSS Decommissioning Guidance, Decommissioning Process for Materials Licensees," September, 2006
- NUREG 1757, Volume 2, Revision 1, "Consolidated NMSS Decommissioning Guidance, Characterization, Survey, and Determination of Radiological Criteria," September, 2006
- "Decommissioning Health Physics, A Handbook for MARSSIM Users," Abelquist, 2001
- "Handbook of Health Physics and Radiological Health", 3rd Edition, 1998
- ISO-7503-1, "Evaluation of Surface Contamination – Part 1: Beta Emitters and Alpha Emitters." 1988
- NUREG 1556, Volume 7, Table Q.2, "Acceptable Surface Contamination Levels for Equipment," December 1999
- University of Missouri – Columbia Sinclair Farm Phase 1 Final Status Report
- University of Missouri – Columbia Sinclair Farm Phase 2 Final Status Report


Sinclair Farms Circa 2011 -
Prior to building fire.
Remaining concrete pads are
considered impacted.
Building 671
Building 669
N
© 2012 Google
Google earth
Imagery Date 6/7/2011
1995
38°53'27.11" N 92°22'18.38" W elev 744 ft
Eye alt 1454 ft

GRIFFIN INSTRUMENTS

CALIBRATION CERTIFICATE FOR 2241-3 SERIAL# 267138

Owner: CHASE ENV

DATE: 02/22/12 LOCATION: Griffin Inst

TECH: Joanne Glenn DATE LAST CAL EXPIRES: 05/02/12

Reason For Calibration: (•) Due For Calibration ( ) Repair (See Remarks)
( ) Other (See Remarks) ( ) Due and Repair (See Remarks)

NIST TRACEABLE EQUIPMENT USED DURING CALIBRATION

MODEL: 500-2 SERIAL #: 284951 CAL. DUE: 12/28/12

MODEL: SERIAL #: CAL. DUE:

[x] Fast/Slow Switch working properly [x] Audio Response [ ] Geotropism CABLE LENGTH 5'

CONDITION: Sat

NEW BATTERIES: ( ) Yes (•) No BATTERY CHECK: Sat

AF HV (V) #1:	1675	AL HV (V) #1:	A.F.	AF I.S. (mV) #1:	4	AL I.S. (mV) #1:	A.F.
AF HV (V) #2:	1800	AL HV (V) #2:	A.F.	AF I.S. (mV) #2:	4	AL I.S. (mV) #2 :	A.F.
AF HV (V) #3:	1250	AL HV (V) #3:	A.F.	AF I.S. (mV) #3:	4	AL I.S. (mV) #3:	A.F.
AF HV (V) #4:	1260	AL HV (V) #4:	A.F.	AF I.S. (mV) #4:	4	AL I.S. (mV) #4:	A.F.

RATE CPM	AS FOUND		% ERROR	AS LEFT	% ERROR
250	250		0.0%	A.F.	
2500	2494		0.2%	A.F.	
25K	25.004	K	0.0%	A.F.	
250K	249.750	K	0.1%	A.F.	

Is the As Found Data Within 2% of the Set Point?:
(•) Yes ( ) No

DETECTOR 1:		DETECTOR 2:		DETECTOR 3:		DETECTOR 4:	
AF 1-6	AL 1-6	AF 1-6	AL 1-6	AF 1-6	AL 1-6	AF 1-6	AL 1-6
0000 S-6	A.F.	0000 S-6	A.F.	0000 S-6	A.F.	0000 S-6	A.F.
0100 -2	A.F.	0100 -2	A.F.	0100 -2	A.F.	0100 -2	A.F.
c/	A.F.	c/	A.F.	c/	A.F.	c/	A.F.
m	A.F.	m	A.F.	m	A.F.	m	A.F.
1	A.F.	1	A.F.	1	A.F.	1	A.F.
000s	A.F.	000s	A.F.	000s	A.F.	000s	A.F.

REMARKS: Det 1, 43-68, #PR285699, beta; Det 2, 43-37, #PR286832, beta; Det 3, 43-68, #PR285699, alpha; Det 4, 43-37, #PR286832, alpha.

Does Instrument Meet Final Acceptance Criteria?: (•) Yes ( ) No

Calibration Sticker Attached?: (•) Yes ( ) No

Date Instrument is Due For Next Calibration: 02/22/13

INSTRUMENT MARRIED WITH #

Performed/Reviewed by: Joanne Glenn JG Date: 2/22/2012 Entered by: JG Initials

Calibrations performed to ANSI N323A-1997 standards.

GRIFFIN INSTRUMENTS

CALIBRATION CERTIFICATE FOR 43-37 PROBE # PR286832

Owner: CHASE ENV

DATE: 02/22/12 LOCATION: Griffin Inst
TECH: Joanne Glenn DATE LAST CAL EXPIRES: 05/02/12

REASON FOR CALIBRATION:

(●) Due For Calibration ( ) Repair (See Remarks) ( ) Other (See Remarks) ( ) Due and Repair

CABLE LENGTH: 10' INPUT SENSITIVITY: 4 mV

NIST TRACEABLE EQUIPMENT AND STANDARDS USED DURING CALIBRATION

MODEL: 2241-3 SERIAL #: 267138 CAL. DUE: 02/22/13

NIST TRACEABLE SOURCES USED

Source Number	Isotope	4 pi Activity	Assay Date	2 pi Activity
00TC470-0654	Tc99 SS	17,300 dpm	06/15/09	10,800 cpm
94TH470-1593	Th230	16,700 dpm	06/16/09	8,170 cpm
2696-00	Pu239	18,500 dpm	12/02/09	9,370 cpm
2697-00	Sr90	12,200 dpm	03/01/00	8,530 cpm
PX 726	C14	48,780 dpm	01/21/08	18,660 cpm

Condition: (●) Sat ( ) Unsat

Efficiencies from last cal.:

Pu: 23.34% Th: 22.28% Sr: 41.16%
Tc ss: 27.55% C14: 15.31% Tc Ni:

As Found (AF) Efficiencies:

HV / Vernier:	Tc-99 Source Response Nickel (CPM):			Pu-239 Source Response (CPM):			Background (CPM):		Tc-99 Source Response Stainless Steel (CPM):		
	A ch.	B ch.	Net Eff.	A ch.	B ch.	Net Eff.	A ch.	B ch.	A ch.	B ch.	Net Eff.
1250 a / 1600 b				4521		24.39%	9	1113		6059	28.59%

Net A to B Xtalk: <10%	B to A Xtalk: <1%

	Pu239	Tc99 Ni	Tc99 ss	Th-230	Sr90	C-14
AF CPM:	4521		6059	3590	4849	8746
AF 4 pi eff:	24.39%		28.59%	21.44%	40.80%	15.65%
AF 2 pi eff:	*48.15%*		*45.80%*	*43.83%*	*58.35%*	*40.91%*

Is as found efficiency within 20% of the efficiency from the last cal? (●) Yes ( ) No (See Remarks)

Note: If the as found data is within 10% of the last calibration and the B-A Xtalk is <1% and the A-B Xtalk is <10%, then the technician may N/A the plateau section and go directly to remarks.

GRIFFIN INSTRUMENTS

PROBE #: **PR286832**
Date: 02/22/12

PLATEAU AND SET POINT DATA

HV / Vernier:	Tc-99 Source Response SS (CPM):			Pu-239 Source Response (CPM):			Background (CPM):		Net A to B Xtalk: <10%	B to A Xtalk: <1%
	A ch.	B ch.	Net Eff.	A ch.	B ch.	Net Eff.	A ch.	B ch.		
N/A										

Alpha / Beta Bkg (cpm) 9 1113

HV / Vernier		Pu-239	Tc-99 Ni	Tc-99 SS	Th-230	C-14	Sr-90
1250 a / 1800 b	CPM:	4521		6059	3590	8746	4849
	4 pi AL Efficiencies:	24.39%		28.59%	21.44%	15.65%	40.80%
	2 pi AL Efficiencies:	*48.15%*		*45.80%*	*43.83%*	*40.91%*	*58.35%*

REMARKS: Det 2, beta; Det 4, alpha.

Does Instrument Meet Final Acceptance Criteria?: (●) Yes ( ) No

Calibration Sticker Attached?: (●) Yes ( ) No

Date Instrument is Due For Next Calibration: 02/22/13

INSTRUMENT MARRIED WITH 2241-3 # 267138

Performed/Reviewed by: Joanne Glenn JG Date: 2/22/2012 Entered by: JG Initials

2 pi efficiencies denoted in italics.

Calibrations performed to ANSI N323A-1997 standards.

GRIFFIN INSTRUMENTS

CALIBRATION CERTIFICATE FOR 2241-3 SERIAL# 253356

Owner: CHASE ENV

DATE: 02/17/12 LOCATION: Griffin Inst

TECH: Joanne Glenn DATE LAST CAL EXPIRES: 04/06/12

Reason For Calibration: (●) Due For Calibration ( ) Repair (See Remarks)
( ) Other (See Remarks) ( ) Due and Repair (See Remarks)

NIST TRACEABLE EQUIPMENT USED DURING CALIBRATION

MODEL: 500-2 SERIAL #: 284951 CAL. DUE: 12/28/12

MODEL: SERIAL #: CAL DUE:

[x] Fast/Slow Switch working properly [x] Audio Response [ ] Geotropism CABLE LENGTH 5'

CONDITION: Sat

NEW BATTERIES: ( ) Yes (●) No BATTERY CHECK: Sat

AF HV (V) #1:	1620	AL HV (V) #1:	1650	AF I.S. (mV) #1:	4	AL I.S. (mV) #1:	A.F.
AF HV (V) #2:	1770	AL HV (V) #2:	1800	AF I.S. (mV) #2:	4	AL I.S. (mV) #2 :	A.F.
AF HV (V) #3:	1178	AL HV (V) #3:	1200	AF I.S. (mV) #3:	4	AL I.S. (mV) #3:	A.F.
AF HV (V) #4:	1230	AL HV (V) #4:	1250	AF I.S. (mV) #4:	4	AL I.S. (mV) #4:	A.F.

RATE CPM	AS FOUND		% ERROR	AS LEFT	% ERROR
250	250		0.0%	A.F.	
2500	2494		0.2%	A.F.	
25K	24.941	K	0.2%	A.F.	
250K	249.424	K	0.2%	A.F.	

Is the As Found Data Within 2% of the Set Point?:
(●) Yes ( ) No

DETECTOR 1:		DETECTOR 2:		DETECTOR 3:		DETECTOR 4:	
AF 1-6	AL 1-6	AF 1-6	AL 1-6	AF 1-6	AL 1-6	AF 1-6	AL 1-6
0000 S-6	A.F.	0000 S-6	A.F.	0000 S-6	A.F.	0000 S-6	A.F.
0100 -2	A.F.	0100 -2	A.F.	0100 -2	A.F.	0100 -2	A.F.
c/	A.F.	c/	A.F.	c/	A.F.	c/	A.F.
m	A.F.	m	A.F.	m	A.F.	m	A.F.
1	A.F.	1	A.F.	1	A.F.	1	A.F.
000s	A.F.	000s	A.F.	000s	A.F.	000s	A.F.

REMARKS:

Does Instrument Meet Final Acceptance Criteria?: (●) Yes ( ) No

Calibration Sticker Attached?: (●) Yes ( ) No

Date Instrument is Due For Next Calibration: 02/17/13

INSTRUMENT MARRIED WITH #

Performed/Reviewed by: Joanne Glenn Date: 2/17/2012 Entered by: ____ Initials

Calibrations performed to ANSI N323A-1997 standards.

GRIFFIN INSTRUMENTS

CALIBRATION CERTIFICATE FOR 43-37 PROBE # PR281040

Owner: CHASE ENV

DATE: 02/17/12 LOCATION: Griffin Inst

TECH: Joanne Glenn DATE LAST CAL EXPIRES: 04/06/12

REASON FOR CALIBRATION:

○ Due For Calibration ○ Repair (See Remarks) ○ Other (See Remarks) ◉ Due and Repair

CABLE LENGTH: 10' INPUT SENSITIVITY: 4 mV

NIST TRACEABLE EQUIPMENT AND STANDARDS USED DURING CALIBRATION

MODEL: 2241-3 SERIAL #: 253356 CAL. DUE: 02/17/13

NIST TRACEABLE SOURCES USED

Source Number	Isotope	4 pi Activity	Assay Date	2 pi Activity
00TC470-0654	Tc99 SS	17,300 dpm	06/15/09	10,800 cpm
94TH470-1593	Th230	16,700 dpm	08/16/09	8,170 cpm
2696-00	Pu239	18,500 dpm	12/02/09	9,370 cpm
2697-00	Sr90	12,200 dpm	03/01/00	6,530 cpm
PX 726	C14	48,780 dpm	01/21/08	18,660 cpm

Condition: ◉ Sat ○ Unsat

Efficiencies from last cal.:

Pu: 23.68% Th: 21.60% Sr: 39.36%

Tc ss: 26.02% C14: 15.22% Tc Ni:

As Found (AF) Efficiencies:

HV / Vernier:	Tc-99 Source Response Nickel (CPM):			Pu-239 Source Response (CPM):			Background (CPM):		Tc-99 Source Response Stainless Steel (CPM):		
	A ch.	B ch.	Net Eff.	A ch.	B ch.	Net Eff.	A ch.	B ch.	A ch.	B ch.	Net Eff.
1250 a / 1800 b				4122		22.25%	6	1107		5506	25.43%

Net A to B Xtalk: <10%	B to A Xtalk: <1%

	Pu239	Tc99 Ni	Tc99 ss	Th-230	Sr90	C-14
AF CPM:	4122		5506	3477	4555	7986
AF 4 pi eff:	22.25%		25.43%	20.78%	37.66%	14.10%
AF 2 pi eff:	*43.93%*		*40.73%*	*42.48%*	*53.86%*	*36.86%*

Is as found efficiency within 20% of the efficiency from the last cal? ◉ Yes ○ No (See Remarks)

Note: If the as found data is within 10% of the last calibration and the B-A Xtalk is <1% and the A-B Xtalk is <10%; then the technician may N/A the plateau section and go directly to remarks.

GRIFFIN INSTRUMENTS

PROBE #: **PR281040**
Date: 02/17/12

PLATEAU AND SET POINT DATA

HV / Vernier:	Tc-99 Source Response SS (CPM):			Pu-239 Source Response (CPM):			Background (CPM):		Net A to B Xtalk: <10%	B to A Xtalk: <1%
	A ch.	B ch.	Net Eff.	A ch.	B ch.	Net Eff.	A ch.	B ch.		
N/A										

Alpha / Beta Bkg (cpm) 6 1107

HV / Vernier		Pu-239	Tc-99 Ni	Tc-99 SS	Th-230	C-14	Sr-90
1250 a / 1800 b	CPM:	4122		5506	3477	7985	4555
	4 pi AL Efficiencies:	22.25%		25.43%	20.78%	14.10%	37.66%
	2 pi AL Efficiencies:	*43.93%*		*40.73%*	*42.48%*	*36.86%*	*53.86%*

REMARKS: Replaced mylar due to hole.

Does Instrument Meet Final Acceptance Criteria?: (●) Yes ( ) No

Calibration Sticker Attached?: (●) Yes ( ) No

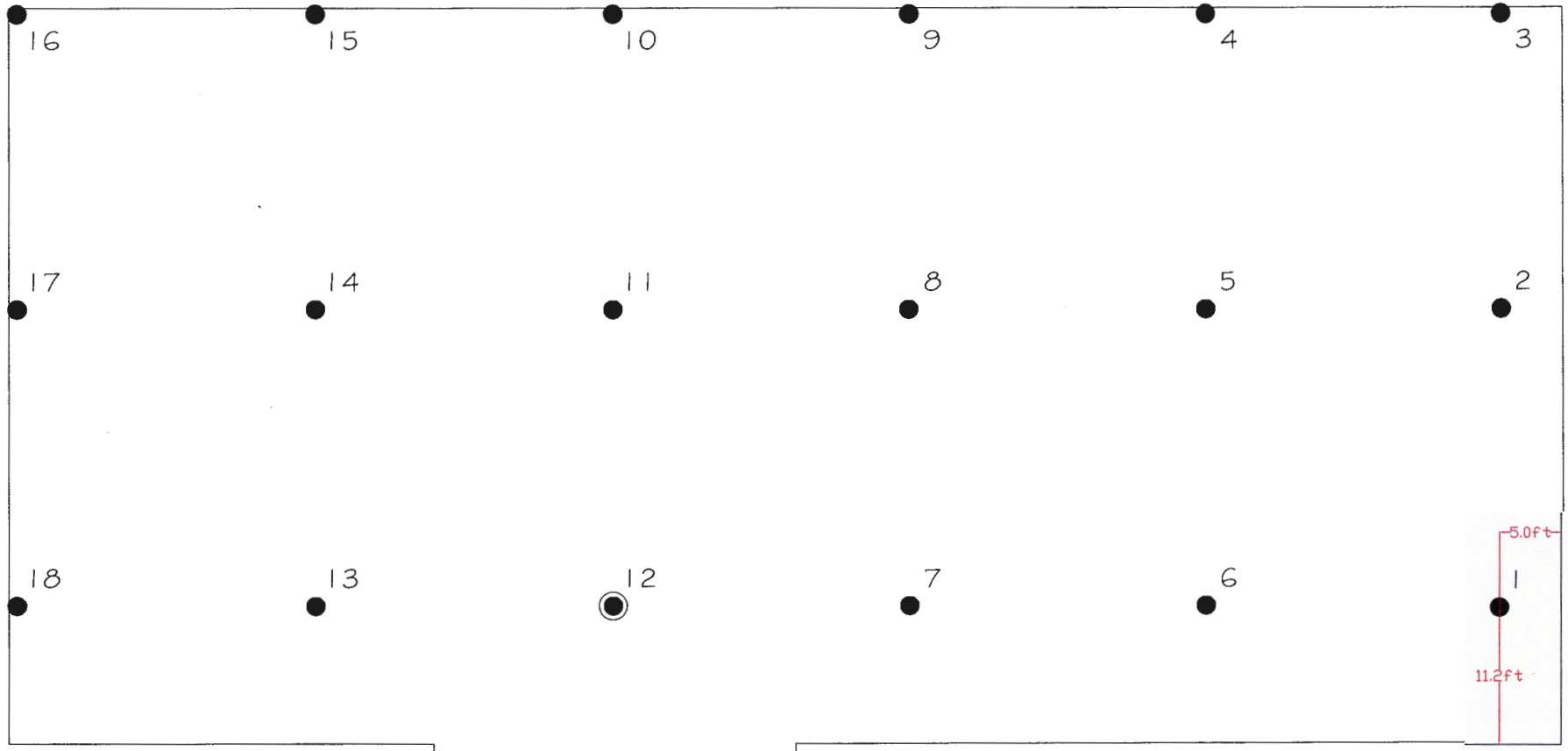
Date Instrument Is Due For Next Calibration: 02/17/13

INSTRUMENT MARRIED WITH 2241-3 # 253356

Performed/Reviewed by: Joanne Glenn Date: 2/17/2012 Entered by: ____ Initials

2 pi efficiencies denoted in italics.

Calibrations performed to ANSI N323A-1997 standards.

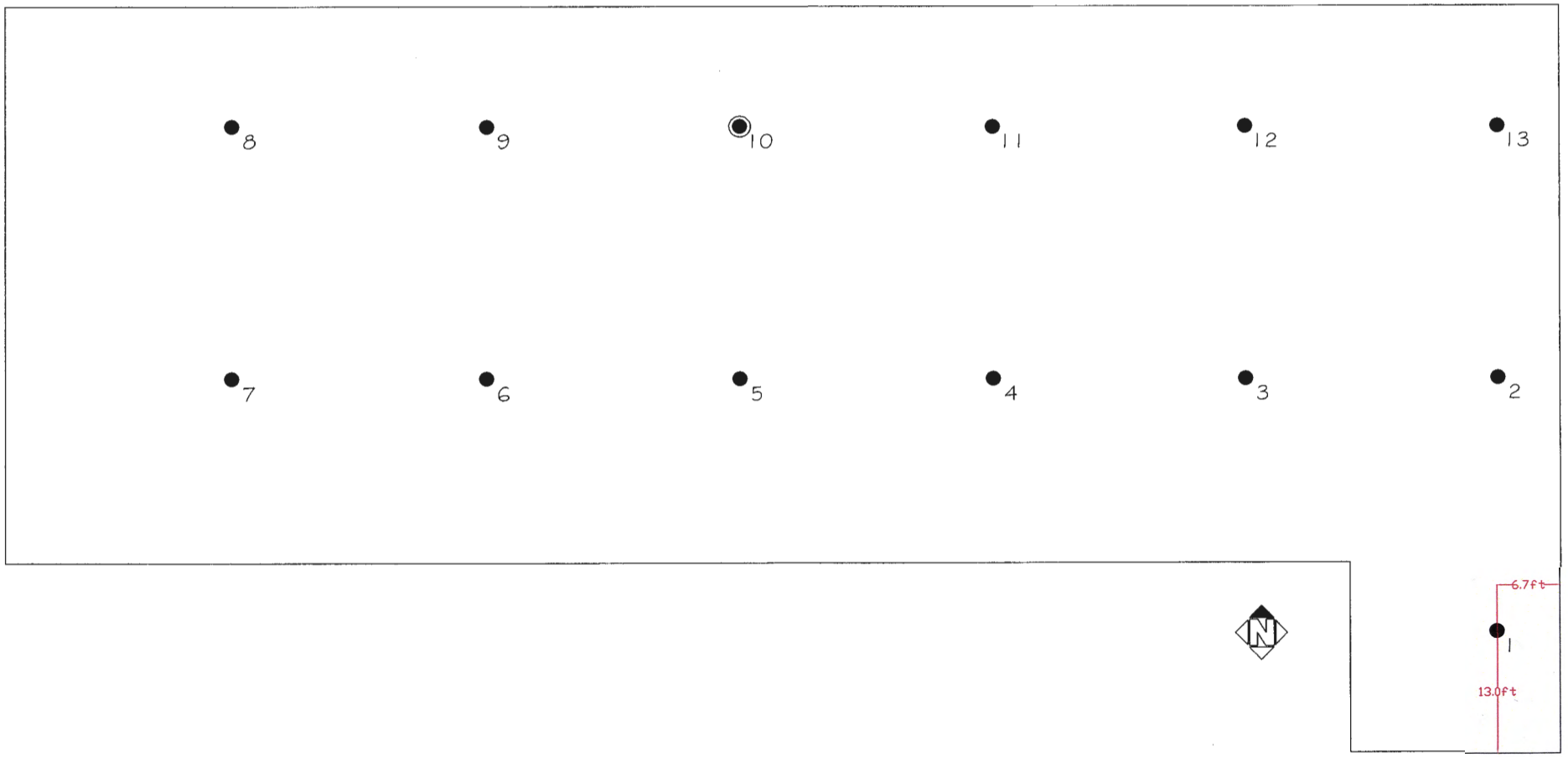


Random Start Location

Spacing = 24ft

University of Missouri
Sinclair Farms Phase 3
Final Status Survey Report

Building: 669	Survey Unit: 1201	Page C.1 of C.2



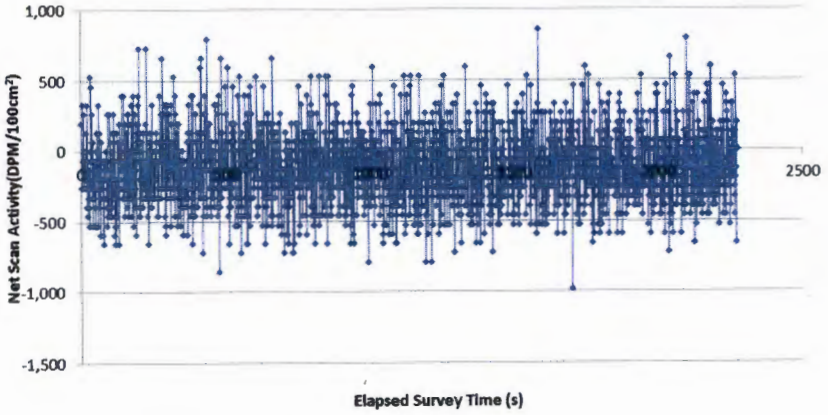
Random Start Location

Spacing = 27ft

Mizzou University of Missouri - Columbia	University of Missouri Sinclair Farms Phase 3 Final Status Survey Report	CHASE Environmental Group
Building: 671	Survey Unit: 1201	Page: C.2 of C.2

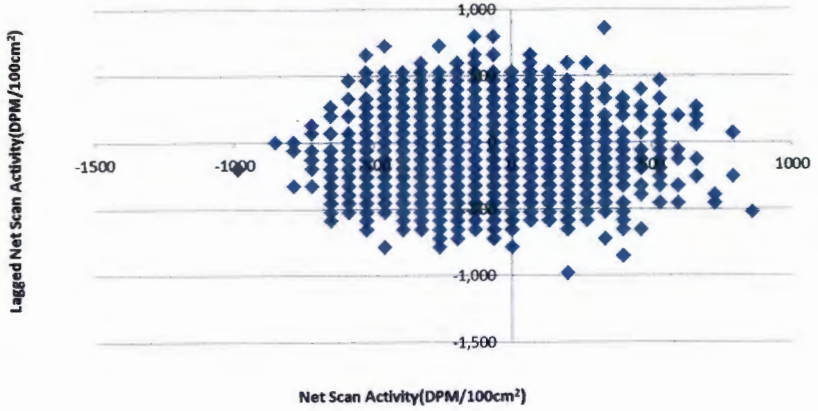
Scan Data

Bldg :669 Survey Unit : 1201 Probe : PR286832



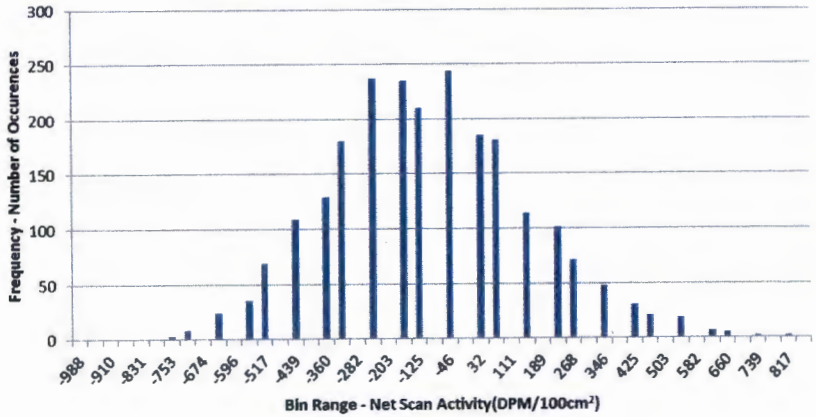
Lagged Scan Data

Bldg :669 Survey Unit : 1201 Probe : PR286832



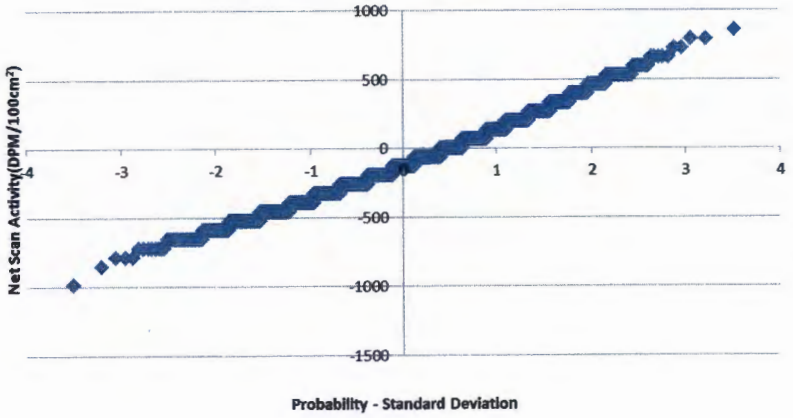
Histogram of Scan Data

Bldg :669 Survey Unit : 1201 Probe : PR286832



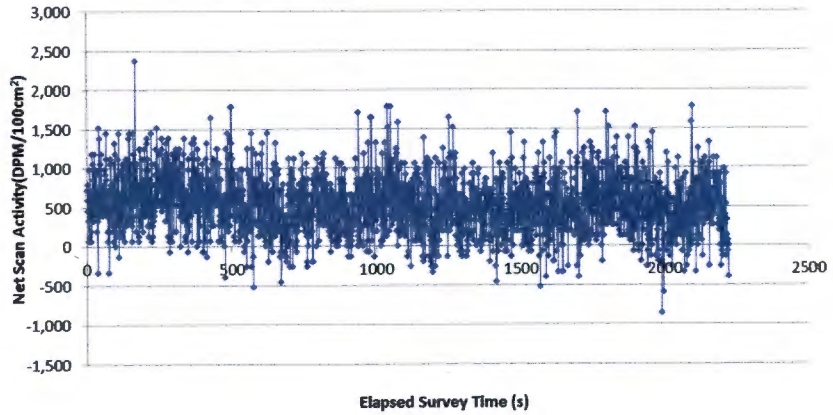
Normal Probability Plot of Data

Bldg :669 Survey Unit : 1201 Probe : PR286832



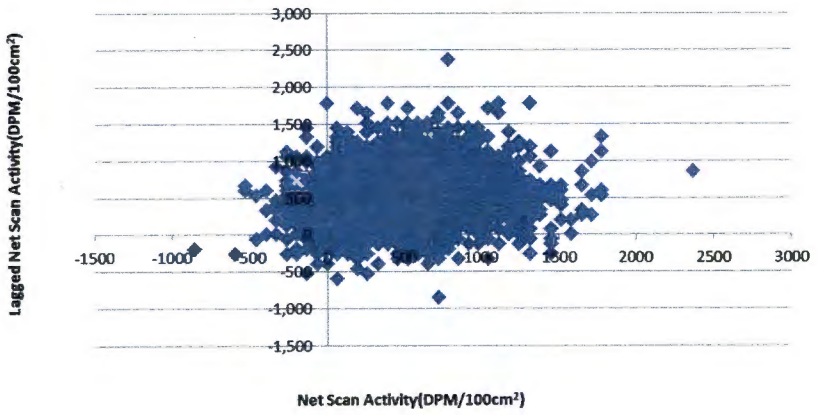
Scan Data

Bldg :671 Survey Unit : 1201 Probe : PR286832



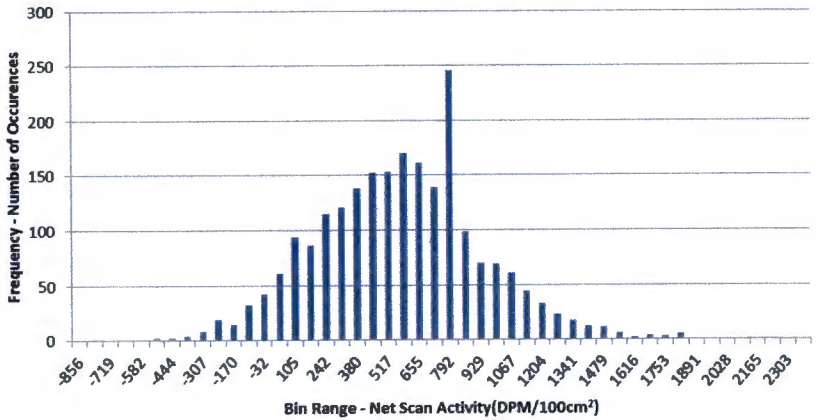
Lagged Scan Data

Bldg :671 Survey Unit : 1201 Probe : PR286832



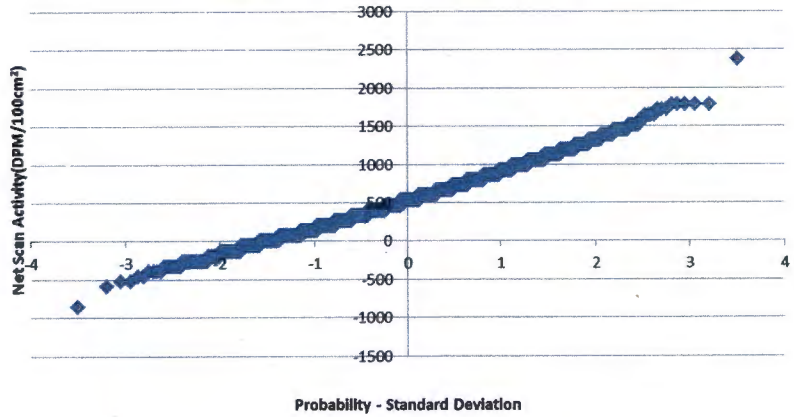
Histogram of Scan Data

Bldg :671 Survey Unit : 1201 Probe : PR286832



Normal Probability Plot of Data

Bldg :671 Survey Unit : 1201 Probe : PR286832



Structural Surfaces Survey Results

Building 669 Survey Unit 1201 Class 2

Location Code	Total Activity Measurements		Removable Activity Measurements					
			Channel 1		Channel 2		Channel 3	
	Activty	MDC	Activity	MDC	Activity	MDC	Activity	MDC
669-1201-F1-C-001	**582** ± 328	518	14 ± 9	44	9 ± 7	26	0 ± 0	24
669-1201-F1-C-002	329 ± 312	518	4 ± 5	44	2 ± 3	26	0 ± 0	24
669-1201-F1-C-003	44 ± 292	518	8 ± 7	44	1 ± 2	26	0 ± 0	24
669-1201-F1-T-004	66 ± 293	518	10 ± 8	44	22 ± 10	26	0 ± 0	24
669-1201-F1-T-005	351 ± 313	518	26 ± 13	44	17 ± 9	26	0 ± 0	24
669-1201-F1-C-006	**648** ± 333	518	3 ± 4	44	5 ± 5	26	0 ± 0	24
669-1201-F1-C-007	494 ± 323	518	10 ± 8	44	20 ± 10	26	0 ± 0	24
669-1201-F1-C-008	**571** ± 328	518	10 ± 8	44	2 ± 3	26	4 ± 4	24
669-1201-F1-T-009	176 ± 301	518	13 ± 9	44	10 ± 7	26	0 ± 0	24
669-1201-F1-C-010	209 ± 304	518	4 ± 5	44	3 ± 4	26	6 ± 5	24
669-1201-F1-C-011	**560** ± 327	518	5 ± 6	44	8 ± 6	26	0 ± 0	24
669-1201-F1-C-012	351 ± 313	518	7 ± 7	44	11 ± 7	26	1 ± 2	24
669-1201-F1-T-013	-187 ± 275	518	17 ± 10	44	0 ± 0	26	0 ± 0	24
669-1201-F1-C-014	231 ± 305	518	11 ± 8	44	15 ± 8	26	4 ± 4	24
669-1201-F1-C-015	**626** ± 331	518	14 ± 9	44	12 ± 8	26	0 ± 0	24
669-1201-F1-T-016	198 ± 303	518	14 ± 9	44	2 ± 3	26	0 ± 0	24
669-1201-F1-C-017	99 ± 296	518	1 ± 3	44	4 ± 4	26	0 ± 0	24
669-1201-F1-C-018	296 ± 310	518	0 ± 0	44	9 ± 7	26	0 ± 0	24
Summary for Survey Unit # 1201 (18 detail records)								
Average	314		10		8		1	
Minimum	-187		0		0		0	
Maximum	648		26		22		6	
Standard Deviation	233		6		7		2	
Summary for Building # 669 (18 detail records)								
Avg	314		10		8		1	
Min	-187		0		0		0	
Max	648		26		22		6	

Notes: All total activity results reported in net dpm/100cm^2. All removable activity results reported in net dpm/100cm^2. Results above MDC are in bold print. Results above investigation levels are in red print.

Structural Surfaces Survey Results

Building 671 Survey Unit 1201 Class 2

Location Code	Total Activity Measurements		Removable Activity Measurements					
			Channel 1		Channel 2		Channel 3	
	Activty	MDC	Activity	MDC	Activity	MDC	Activity	MDC
671-1201-F1-C-001	373 ± 315	518	5 ± 6	44	15 ± 8	26	1 ± 2	24
671-1201-F1-C-002	**626** ± 331	518	12 ± 9	44	9 ± 7	26	0 ± 0	24
671-1201-F1-C-003	242 ± 306	518	11 ± 8	44	9 ± 7	26	0 ± 0	24
671-1201-F1-C-004	198 ± 303	518	20 ± 11	44	0 ± 0	26	0 ± 0	24
671-1201-F1-C-005	44 ± 292	518	19 ± 11	44	3 ± 4	26	0 ± 0	24
671-1201-F1-C-006	220 ± 304	518	24 ± 12	44	0 ± 0	26	8 ± 6	24
671-1201-F1-T-007	-187 ± 275	518	3 ± 4	44	9 ± 7	26	0 ± 0	24
671-1201-F1-C-008	22 ± 290	518	19 ± 11	44	10 ± 7	26	0 ± 0	24
671-1201-F1-T-009	-143 ± 278	518	8 ± 7	44	18 ± 9	26	4 ± 4	24
671-1201-F1-T-010	-318 ± 264	518	4 ± 5	44	12 ± 8	26	0 ± 0	24
671-1201-F1-C-011	450 ± 320	518	21 ± 12	44	6 ± 5	26	0 ± 0	24
671-1201-F1-C-012	66 ± 293	518	13 ± 9	44	0 ± 0	26	0 ± 0	24
671-1201-F1-C-013	285 ± 309	518	5 ± 6	44	2 ± 3	26	0 ± 0	24
Summary for Survey Unit # 1201 (13 detail records)								
Average	144		13		7		1	
Minimum	-318		3		0		0	
Maximum	626		24		18		8	
Standard Deviation	267		7		6		2	
Summary for Building # 671 (13 detail records)								
Avg	144		13		7		1	
Min	-318		3		0		0	
Max	626		24		18		8	

Notes: All total activity results reported in net dpm/100cm^2. All removable activity results reported in net dpm/100cm^2. Results above MDC are in bold print. Results above investigation levels are in red print.

Building Drains Survey Results

Building ETR Survey Unit DR01 Class

Location Code	Total Activity Measurements		Removable Activity Measurements					
			Channel 1		Channel 2		Channel 3	
	Activty	MDC	Activity	MDC	Activity	MDC	Activity	MDC
ETR-DR01-D4-M-001	±		11 ± 8	44	2 ± 3	26	0 ± 0	24
ETR-DR01-D4-M-002	±		12 ± 9	44	12 ± 8	26	6 ± 5	24
ETR-DR01-D4-M-003	±		**75** ± 22	44	0 ± 0	26	4 ± 4	24
ETR-DR01-D2-M-004	±		7 ± 7	44	5 ± 5	26	12 ± 7	24
ETR-DR01-D4-M-005	±		15 ± 10	44	25 ± 11	26	4 ± 4	24
ETR-DR01-D4-M-006	±		17 ± 10	44	0 ± 0	26	0 ± 0	24
ETR-DR01-D4-M-007	±		30 ± 14	44	8 ± 6	26	0 ± 0	24
ETR-DR01-D4-M-008	±		30 ± 14	44	10 ± 7	26	0 ± 0	24
ETR-DR01-D4-M-009	±		17 ± 10	44	12 ± 8	26	6 ± 5	24
ETR-DR01-D4-M-010	±		10 ± 8	44	14 ± 8	26	3 ± 3	24
ETR-DR01-D4-M-011	±		18 ± 11	44	4 ± 4	26	0 ± 0	24
ETR-DR01-D2-M-012	±		17 ± 10	44	2 ± 3	26	6 ± 5	24
ETR-DR01-D2-M-013	±		22 ± 12	44	17 ± 9	26	0 ± 0	24
ETR-DR01-D2-M-014	±		7 ± 7	44	5 ± 5	26	0 ± 0	24
ETR-DR01-D2-M-015	±		20 ± 11	44	9 ± 7	26	0 ± 0	24
ETR-DR01-D4-M-016	±		5 ± 6	44	0 ± 0	26	8 ± 6	24
ETR-DR01-D2-M-017	±		12 ± 9	44	2 ± 3	26	0 ± 0	24
ETR-DR01-D2-M-018	±		16 ± 10	44	4 ± 4	26	0 ± 0	24
ETR-DR01-D4-M-019	±		21 ± 12	44	7 ± 6	26	14 ± 8	24
ETR-DR01-D2-M-020	±		28 ± 13	44	2 ± 3	26	0 ± 0	24
ETR-DR01-D2-M-021	±		18 ± 11	44	2 ± 3	26	0 ± 0	24
ETR-DR01-D2-M-022	±		33 ± 15	44	7 ± 6	26	0 ± 0	24
ETR-DR01-D2-M-023	±		32 ± 14	44	5 ± 5	26	0 ± 0	24
ETR-DR01-D4-M-024	±		33 ± 15	44	2 ± 3	26	0 ± 0	24

Note: All total activity results reported in net dpm/100cm^2. All removable activity results reported in net dpm/100cm^2. Results above MDC are in bold print. Results above investigation levels are in red print.

Building Drains Survey Results

Building ETR Survey Unit DR01 Class

Location Code	Total Activity Measurements			Removable Activity Measurements					
				Channel 1		Channel 2		Channel 3	
	Activty	±	MDC	Activity	MDC	Activity	MDC	Activity	MDC
ETR-DR01-D4-M-025		±		39 ± 16	44	10 ± 7	26	3 ± 3	24
ETR-DR01-D4-M-026		±		29 ± 14	44	0 ± 0	26	0 ± 0	24
ETR-DR01-D4-M-027		±		24 ± 12	44	22 ± 10	26	0 ± 0	24
ETR-DR01-D2-M-028		±		24 ± 12	44	17 ± 9	26	6 ± 5	24
ETR-DR01-D2-M-029		±		19 ± 11	44	14 ± 8	26	1 ± 2	24
ETR-DR01-D2-M-030		±		17 ± 10	44	17 ± 9	26	4 ± 4	24
ETR-DR01-D4-M-031		±		7 ± 7	44	0 ± 0	26	1 ± 2	24
ETR-DR01-D2-M-032		±		28 ± 13	44	7 ± 6	26	0 ± 0	24
ETR-DR01-D4-M-033		±		25 ± 13	44	0 ± 0	26	0 ± 0	24
ETR-DR01-D4-M-034		±		24 ± 12	44	4 ± 4	26	0 ± 0	24
ETR-DR01-D2-M-035		±		28 ± 13	44	2 ± 3	26	0 ± 0	24
ETR-DR01-D2-M-036		±		11 ± 8	44	0 ± 0	26	11 ± 7	24
ETR-DR01-D4-M-037		±		40 ± 16	44	17 ± 9	26	0 ± 0	24
ETR-DR01-D4-M-038		±		26 ± 13	44	10 ± 7	26	1 ± 2	24
ETR-DR01-D4-M-039		±		32 ± 14	44	4 ± 4	26	0 ± 0	24
ETR-DR01-D4-M-040		±		19 ± 11	44	0 ± 0	26	0 ± 0	24
ETR-DR01-D4-M-041		±		15 ± 10	44	0 ± 0	26	0 ± 0	24
ETR-DR01-D2-M-042		±		19 ± 11	44	0 ± 0	26	4 ± 4	24
ETR-DR01-D4-M-043		±		4 ± 5	44	15 ± 8	26	3 ± 3	24
ETR-DR01-D4-M-044		±		15 ± 10	44	5 ± 5	26	0 ± 0	24
ETR-DR01-D2-M-045		±		20 ± 11	44	12 ± 8	26	4 ± 4	24
ETR-DR01-D4-M-046		±		21 ± 12	44	0 ± 0	26	0 ± 0	24
ETR-DR01-D4-M-047		±		15 ± 10	44	4 ± 4	26	0 ± 0	24
ETR-DR01-D4-M-048		±		17 ± 10	44	0 ± 0	26	0 ± 0	24

Note: All total activity results reported in net dpm/100cm^2. All removable activity results reported in net dpm/100cm^2. Results above MDC are in bold print. Results above investigation levels are in red print.

Building Drains Survey Results

Building ETR Survey Unit DR01 Class

Location Code	Total Activity Measurements		Removable Activity Measurements					
			Channel 1		Channel 2		Channel 3	
	Activty	MDC	Activity	MDC	Activity	MDC	Activity	MDC
ETR-DR01-D2-M-049	±		14 ± 9	44	8 ± 6	26	14 ± 8	24
ETR-DR01-D4-M-050	±		15 ± 10	44	12 ± 8	26	0 ± 0	24
ETR-DR01-D4-M-051	±		29 ± 14	44	0 ± 0	26	0 ± 0	24
ETR-DR01-D4-M-052	±		24 ± 12	44	9 ± 7	26	0 ± 0	24
ETR-DR01-D4-M-053	±		16 ± 10	44	6 ± 5	26	0 ± 0	24
ETR-DR01-D4-M-054	±		18 ± 11	44	10 ± 7	26	3 ± 3	24
ETR-DR01-D4-M-055	±		18 ± 11	44	3 ± 4	26	6 ± 5	24
ETR-DR01-D4-M-056	±		23 ± 12	44	14 ± 8	26	1 ± 2	24
ETR-DR01-D4-M-057	±		23 ± 12	44	5 ± 5	26	0 ± 0	24
ETR-DR01-D2-M-058	±		19 ± 11	44	23 ± 11	26	0 ± 0	24
ETR-DR01-D2-M-059	±		17 ± 10	44	10 ± 7	26	0 ± 0	24
ETR-DR01-D2-M-060	±		12 ± 9	44	18 ± 9	26	1 ± 2	24
ETR-DR01-D4-M-061	±		12 ± 9	44	5 ± 5	26	0 ± 0	24
ETR-DR01-D4-M-062	±		14 ± 9	44	7 ± 6	26	0 ± 0	24
ETR-DR01-D4-M-063	±		2 ± 4	44	10 ± 7	26	1 ± 2	24
ETR-DR01-D4-M-064	±		20 ± 11	44	0 ± 0	26	0 ± 0	24
ETR-DR01-D4-M-065	±		9 ± 8	44	8 ± 6	26	1 ± 2	24
ETR-DR01-D4-M-066	±		14 ± 9	44	20 ± 10	26	0 ± 0	24
ETR-DR01-D4-M-067	±		5 ± 6	44	0 ± 0	26	8 ± 6	24
ETR-DR01-D4-M-068	±		25 ± 13	44	0 ± 0	26	0 ± 0	24
ETR-DR01-D4-M-069	±		17 ± 10	44	6 ± 5	26	0 ± 0	24
ETR-DR01-D4-M-070	±		20 ± 11	44	6 ± 5	26	0 ± 0	24
ETR-DR01-D2-M-071	±		23 ± 12	44	15 ± 8	26	0 ± 0	24
ETR-DR01-D2-M-072	±		23 ± 12	44	6 ± 5	26	0 ± 0	24

Note: All total activity results reported in net dpm/100cm^2. All removable activity results reported in net dpm/100cm^2. Results above MDC are in bold print. Results above investigation levels are in red print.

Building Drains Survey Results

Building ETR Survey Unit DR01 Class

Location Code	Total Activity Measurements		Removable Activity Measurements					
			Channel 1		Channel 2		Channel 3	
	Activty	MDC	Activity	MDC	Activity	MDC	Activity	MDC
ETR-DR01-D2-M-073	±		10 ± 8	44	5 ± 5	26	6 ± 5	24
ETR-DR01-D2-M-074	±		6 ± 6	44	5 ± 5	26	0 ± 0	24
ETR-DR01-D4-M-075	±		22 ± 12	44	7 ± 6	26	1 ± 2	24
ETR-DR01-D4-M-076	±		17 ± 10	44	10 ± 7	26	0 ± 0	24
ETR-DR01-D4-M-077	±		18 ± 11	44	0 ± 0	26	0 ± 0	24
ETR-DR01-D2-M-078	±		5 ± 6	44	2 ± 3	26	0 ± 0	24
ETR-DR01-D2-M-079	±		19 ± 11	44	2 ± 3	26	0 ± 0	24
ETR-DR01-D2-M-080	±		12 ± 9	44	0 ± 0	26	0 ± 0	24
ETR-DR01-D4-M-081	±		20 ± 11	44	0 ± 0	26	0 ± 0	24
ETR-DR01-D4-M-082	±		21 ± 12	44	0 ± 0	26	3 ± 3	24
ETR-DR01-D4-M-083	±		15 ± 10	44	17 ± 9	26	0 ± 0	24
ETR-DR01-D4-M-084	±		18 ± 11	44	0 ± 0	26	1 ± 2	24
ETR-DR01-D4-M-085	±		34 ± 15	44	5 ± 5	26	0 ± 0	24
ETR-DR01-D4-M-086	±		31 ± 14	44	7 ± 6	26	0 ± 0	24
ETR-DR01-D2-M-087	±		7 ± 7	44	0 ± 0	26	4 ± 4	24
ETR-DR01-D4-M-088	±		21 ± 12	44	12 ± 8	26	0 ± 0	24
ETR-DR01-D4-M-089	±		27 ± 13	44	2 ± 3	26	1 ± 2	24
ETR-DR01-D4-M-090	±		9 ± 8	44	3 ± 4	26	0 ± 0	24
ETR-DR01-D4-M-091	±		12 ± 9	44	9 ± 7	26	0 ± 0	24
ETR-DR01-D4-M-092	±		15 ± 10	44	10 ± 7	26	0 ± 0	24
ETR-DR01-D2-M-093	±		24 ± 12	44	10 ± 7	26	4 ± 4	24
ETR-DR01-D2-M-094	±		10 ± 8	44	22 ± 10	26	0 ± 0	24
ETR-DR01-D4-M-095	±		15 ± 10	44	**27** ± 11	26	6 ± 5	24
ETR-DR01-D2-M-096	±		16 ± 10	44	16 ± 9	26	0 ± 0	24

Note: All total activity results reported in net dpm/100cm^2. All removable activity results reported in net dpm/100cm^2. Results above MDC are in bold print. Results above investigation levels are in red print.

Building Drains Survey Results

Building ETR Survey Unit DR01 Class

Location Code	Total Activity Measurements		Removable Activity Measurements					
			Channel 1		Channel 2		Channel 3	
	Activty	MDC	Activity	MDC	Activity	MDC	Activity	MDC
ETR-DR01-D4-M-097	±		14 ± 9	44	3 ± 4	26	1 ± 2	24
ETR-DR01-D4-M-098	±		7 ± 7	44	5 ± 5	26	0 ± 0	24
ETR-DR01-D4-M-099	±		13 ± 9	44	5 ± 5	26	0 ± 0	24
ETR-DR01-D2-M-100	±		6 ± 6	44	16 ± 9	26	0 ± 0	24
ETR-DR01-D4-M-101	±		12 ± 9	44	7 ± 6	26	0 ± 0	24
ETR-DR01-D4-M-102	±		7 ± 7	44	5 ± 5	26	1 ± 2	24
ETR-DR01-D2-M-103	±		15 ± 10	44	23 ± 11	26	0 ± 0	24
ETR-DR01-D2-M-104	±		2 ± 4	44	9 ± 7	26	0 ± 0	24
ETR-DR01-D2-M-105	±		22 ± 12	44	0 ± 0	26	0 ± 0	24
ETR-DR01-D4-M-106	±		14 ± 9	44	15 ± 8	26	0 ± 0	24
ETR-DR01-D2-M-107	±		14 ± 9	44	0 ± 0	26	0 ± 0	24
ETR-DR01-D2-M-108	±		8 ± 7	44	2 ± 3	26	3 ± 3	24
ETR-DR01-D4-M-109	±		20 ± 11	44	0 ± 0	26	1 ± 2	24
ETR-DR01-D4-M-110	±		4 ± 5	44	5 ± 5	26	0 ± 0	24
ETR-DR01-D4-M-111	±		8 ± 7	44	4 ± 4	26	1 ± 2	24
ETR-DR01-D2-M-112	±		9 ± 8	44	10 ± 7	26	3 ± 3	24
ETR-DR01-D2-M-113	±		0 ± 0	44	7 ± 6	26	6 ± 5	24
ETR-DR01-D2-M-114	±		10 ± 8	44	26 ± 11	26	0 ± 0	24
ETR-DR01-D4-M-115	±		12 ± 9	44	10 ± 7	26	0 ± 0	24
ETR-DR01-D2-M-116	±		7 ± 7	44	0 ± 0	26	0 ± 0	24
ETR-DR01-D2-M-117	±		5 ± 6	44	4 ± 4	26	0 ± 0	24
Summary for Survey Unit # DR01 (117 detail records)								
Average			18		7		2	
Minimum			0		0		0	
Maximum			75		27		14	
Standard Deviation			10		7		3	

Note: All total activity results reported in net dpm/100cm^2. All removable activity results reported in net dpm/100cm^2. Results above MDC are in bold print. Results above investigation levels are in red print.

Building Drains Survey Results

Summary for Building # ETR (117 detail records)			
Avg	18	7	2
Min	0	0	0
Max	75	27	14

Note: All total activity results reported in net dpm/100cm^2. All removable activity results reported in net dpm/100cm^2. Results above MDC are in bold print. Results above investigation levels are in red print.