



ZION STATION RESTORATION PROJECT FINAL STATUS SURVEY RELEASE RECORD

NORTH YARD STORM DRAIN BURIED PIPING SURVEY UNIT 00150A/B & C



FSS RELEASE RECORD
NORTH YARD STORM DRAIN BURIED PIPING
SURVEY UNIT 00150A/B & C



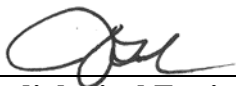

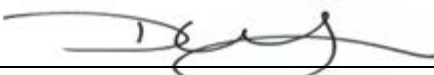
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TABLE OF CONTENTS

1. EXECUTIVE SUMMARY	6
2. SURVEY UNIT DESCRIPTION	7
3. CLASSIFICATION BASIS	7
4. DATA QUALITY OBJECTIVES	8
5. SURVEY DESIGN	11
6. SURVEY IMPLEMENTATION.....	16
7. SURVEY RESULTS.....	17
8. QUALITY CONTROL	20
9. INVESTIGATIONS AND RESULTS	20
10. REMEDIATION AND RESULTS.....	20
11. CHANGES FROM THE SURVEY PLAN	20
12. DATA QUALITY ASSESSMENT.....	20
13. ANOMALIES.....	21
14. CONCLUSION	21
15. REFERENCES	21
16. ATTACHMENTS.....	22
ATTACHMENT 1 - SURVEY UNIT 00150A/B & C - STORM DRAIN PIPING DRAWING	23
ATTACHMENT 2 - SAMPLE DATA.....	25
ATTACHMENT 3 - SIGN TEST	35
ATTACHMENT 4 - QC DATA ASSESSMENT	40

LIST OF TABLES

Table 1 - Dose Significant Radionuclides and Mixture.....	10
Table 2 - Base Case and Operational DCGLs for Buried Pipe.....	11
Table 3 - Surrogate Ratios	11
Table 4 - Normalized Mixture for Gamma-Emitting ROC	13
Table 5 - Synopsis of Survey Design	15
Table 6 - Instruments and Detectors	17
Table 7 - North Yard Storm Drain Buried Pipe - Statistical Quantities	19

LIST OF ACRONYMS AND ABBREVIATIONS

ALARA	As Low As Reasonably Achievable
AMCG	Average Member of the Critical Group
BcDCGL	Base Case Derived Concentration Guideline Level
BcSOF	Base Case Sum of Fractions
C/LT	Characterization/License Termination
DQO	Data Quality Objective
DCGL	Derived Concentration Guideline Level
FOV	Field of View
FSS	Final Status Survey
HTD	Hard-to-Detect
ID	Internal Diameter
LTP	License Termination Plan
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	Minimum Detectable Concentration
NaI	Sodium Iodide
NORM	Naturally Occurring Radioactive Material
OD	Outside Diameter
OpDCGL	Operational Derived Concentration Guideline Level
OpSOF	Operational Sum of Fractions

FSS RELEASE RECORD
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QAPP	Quality Assurance Project Plan
QC	Quality Control
RE	Radiological Engineer
ROC	Radionuclides of Concern
SOF	Sum of Fractions
TEDE	Total Effective Dose Equivalent
TSD	Technical Support Document
UCL	Upper Confidence Level
ZNPS	Zion Nuclear Power Station
ZSRP	Zion Station Restoration Project

1. EXECUTIVE SUMMARY

This Final Status Survey (FSS) Release Record for survey unit 00150A/B and C “North Yard Storm Drain Buried Piping,” has been generated for the Zion Station Restoration Project (ZSRP) in accordance with ZionSolutions procedure ZS-LT-300-001-005, “*Final Status Survey Data Reporting*” (Reference 1) and satisfies the requirements of Section 5.11 of the “*Zion Station Restoration Project License Termination Plan*” (LTP) (Reference 2).

Three (3) FSS packages (package nos. S2-00150A-F, S2-00150B-F and S2-00150C-F) were developed in accordance with ZionSolutions procedure ZS-LT-300-001-001, “*Final Status Survey Package Development*” (Reference 3), the ZSRP LTP, and guidance from NUREG-1575, “*Multi-Agency Radiation Survey and Site Investigation Manual*” (MARSSIM) (Reference 4).

FSS was conducted to demonstrate that the concentrations of residual radioactivity are equal to or below site-specific Derived Concentration Guideline Levels (DCGL) corresponding to the dose criterion in 10 CFR 20.1402 “Radiological Criteria for Unrestricted Use”. The North Yard Storm Drain buried piping was classified as MARSSIM Class 2.

The North Yard Storm Drain buried piping consists of various length of buried storm water pipe with varying Internal Diameters (ID) including approximately 135 linear feet (41.1 meters) of 6-inch ID pipe, approximately 550 linear feet (168 meters) of 8-inch ID pipe, approximately 119 linear feet (36.2 meters) of 12-inch ID pipe, approximately 115 linear feet (35.1 meters) of 15-inch ID pipe, and approximately 363 linear feet (110.6 meters) of 16-inch ID buried pipe. This totaled approximately 1,282 linear feet of pipe. Of the total of 1,282 linear feet of pipe buried pipe, it was decided to remove and replace (with clean pipe) the 363 feet of 16-inch ID pipe. This reduced the overall length of pipe to undergo FSS from 1,282 linear feet to 919 linear feet.

The initial surveys of the North Yard Storm Drain ID buried piping was performed using a Ludlum Model 2350-1 Data Logger paired with a Ludlum Model 44-157 sodium iodide (NaI) gamma detector. To minimize the contribution of background radiation on the dose calculation for the survey unit, these surveys were re-performed and subsequent FSS was performed with the Ludlum Model 2350-1 Data Logger paired with a Ludlum Model 44-10 NaI gamma detector calibrated to the Cs-137 energy window. The evaluation performed in this release record is based on the survey data collected using the Ludlum Model 44-10 calibrated to the Cs-137 energy window.

One-minute static measurements were taken to quantify the activity in the pipe. Each measurement had a calculated Field of View (FOV) based on the ID of the pipe surveyed (FOV area of 1.57 ft² for a 6-inch ID pipe, 2.09 ft² for an 8-inch ID pipe, 3.14 ft² for a 12-inch ID pipe and 3.93 ft² for a 15-inch ID pipe). The total length of the piping of this survey unit was 919 linear feet.

For the FSS of the North Yard Storm Drain buried piping, 272 readings were obtained. All of the readings were below a Sum of Fractions (SOF) of 1.0 for the Operational DCGLs for Buried Pipe (OpDCGL_{BP}), with a mean Operational SOF (OpSOF) of 0.107. The mean Base Case SOF (BcSOF), when compared to the Base Case DCGLs for Buried Pipe (BcDCGL_{BP}), was 0.027, which results in the dose for this survey unit of 0.683 mrem/yr.

2. SURVEY UNIT DESCRIPTION

Section A of survey unit 00150A consisted of the buried 6-inch ID storm drain pipe that runs from the north end of the electrical switchyard to the open drainage ditch located in the southern portions of open land survey areas 10212 and 10213, flowing west to east into Lake Michigan. A second header is also located along the site access road in open land survey area 10214. This header ties into the west/east header under the site parking lot. The storm drain system itself consisted of 6-inch ID smooth wall steel pipe that was approximately 135 linear feet in length. This equated to an internal surface area of approximately 212 ft².

Section B of survey unit 00150B, consisted of the buried 8-inch ID PVC storm drain that was located along the access road north of the Protected Area and was approximately 515 linear feet in length, which equated to a surface area of 1,079 ft². This piping connected Catch Basin (CB)-1 to CB-6.

Section C of survey unit 00150C, consisted of the buried 8-inch, 12-inch and 15-inch ID piping that was located along the side of the access road north of the Protected Area. The pipe was in three sections that totaled approximately 269 linear feet of pipe. A description of each pipe section is as follows:

- The 8-inch ID PVC pipe ran from CB-7 to a capped off section of pipe. This section was approximately 35 linear feet in length, which equated to a surface area of 73 ft².
- The 12-inch ID smooth steel wall piping ran from CB-6 to CB-7. This section of pipe was approximately 119 linear feet in length, which equated to a surface area of 374 ft².
- The 15-inch corrugated steel piping ran from the West Ditch to CB-7. This section of pipe was approximately 115 linear feet in length, which equated to a surface area of 452 ft².

3. CLASSIFICATION BASIS

On May 7, 2019, as part of an FSS surveillance performed on the north portion of the Switchyard open land survey unit (10205) in accordance with ZionSolutions procedure ZS-LT-300-001-003, *“Isolation and Control for Final Status Survey”* (Reference 5), Characterization/License Termination (C/LT) Technicians collected sediment samples from the bottom of manhole access points to the Switchyard storm drain. Both storm drain systems were initially classified as non-impacted based on information taken from the *“Zion Station Historical Site Assessment”* (Reference 6). In the sediment sample collected from the west

access point (L2-10214C-RJGS-001-SM), both Cs-137 and Co-60 were positively detected at concentrations of 2.22E+00 pCi/g and 1.80E-01 pCi/g respectively. Consequently, the discovery prompted a change of classification in accordance with ZionSolutions procedure ZS-LT-300-001-002, “*Survey Unit Classification*” (Reference 7). This storm drain, which had previously been classified as “non-impacted”, was reclassified as a MARSSIM Class 2 buried pipe and subject to compliance demonstration as required by LTP Chapter 5, section 5.7.1.9.

License Termination Plan Chapter 5, section 5 states,

“The list of buried piping, penetrations and embedded piping to remain is provided in ZionSolutions TSD 14-016, “*Description of Embedded Pipe [sic, “Piping”], Penetrations, and Buried Pipe to Remain in Zion End State*” (Reference 5-8). The list of end-state embedded pipe, buried pipe and penetrations presented in Attachment F to TSD 14-016 is intended to be a bounding end-state condition. No pipe that is not listed in Attachment F will be added to the end-state condition however, pipe can be removed from the list and disposed of as waste.”

Technical Support Document (TSD) 14-016 is Reference 8 in this Release Record. Since this section of storm drain (approximately 1,282 feet of piping) was previously classified as non-impacted, it was not included in Attachment F of TSD 14-016, identifying it as impacted buried piping that will remain. Section 5 of the LTP Revision 2 stated that no additional piping will be added to the impacted piping list as identified in Attachment F of TSD 14-016. It has been determined that leaving the storm drain piping does not adversely impact the release of the impacted area. Therefore, the LTP and TSD have been revised to reflect the acceptability of the pipe reclassification. ZionSolutions notified the NRC in June 2019 of the storm drain piping reclassification. A figure showing the location of the storm drain piping is included in Attachment 1.

A Radiological Engineer (RE) and a C/LT Supervisor performed a visual inspection and walk-down of the survey unit on June 17, 2019 prior to performing FSS. The purpose of the walk-down was to assess the physical condition of the survey unit, evaluate access points and travel paths and identify potentially hazardous conditions. A final classification assessment was performed in accordance with procedure ZS-LT-300-001-002 as part of the survey design for FSS. The assessment confirmed that survey unit 00150A/B & C was correctly classified as MARSSIM Class 2.

4. DATA QUALITY OBJECTIVES

Final Status Survey planning and design hinges on coherence with the Data Quality Objective (DQO) process to ensure, through compliance with explicitly defined inputs and boundaries, that the primary objective of the survey is satisfied. The DQO process is described in the ZSRP

LTP in accordance with MARSSIM. The appropriate design for a given survey is developed using the DQO process as outlined in Appendix D of MARSSIM.

The DQO process incorporated hypothesis testing and probabilistic sampling distributions to control decision errors during data analysis. Hypothesis testing is a process based on the scientific method that compares a baseline condition to an alternate condition. The baseline condition is technically known as the null hypothesis. Hypothesis testing rests on the premise that the null hypothesis is true and that sufficient evidence must be provided for rejection. In designing the survey plan, the underlying assumption, or null hypothesis was that residual activity in the survey unit exceeded the release criteria. Rejection of the null hypothesis would indicate that residual activity within the survey unit does not exceed the release criteria, therefore the survey unit would satisfy the primary objective of the FSS sample plan.

The primary objective of the FSS sample plan is to demonstrate that the level of residual radioactivity in survey unit 00150A/B & C does not exceed the release criteria specified in the LTP and that the potential dose from residual radioactivity is As Low As Reasonably Achievable (ALARA).

The residual radioactivity in buried piping located below the 588 foot grade that will remain and be subjected to FSS is discussed in LTP Chapter 2, section 2.3.3.7 and TSD 14-016. The dose assessment methods and resulting DCGLs for buried piping are described in detail in TSD 14-015, *“Buried Pipe Dose Modeling & DCGLs”* (Reference 9) and LTP Chapter 6, section 6.12.

ZionSolutions TSD 11-001, *“Technical Support Document for Potential Radionuclides of Concern During the Decommissioning of the Zion Station”* (Reference 10) established the basis for an initial suite of potential Radionuclides of Concern (ROC) for the decommissioning of the Zion Nuclear Power Station (ZNPS). LTP Chapter 2 provides detailed characterization data that described contamination levels in the Containments and Auxiliary Building, which were the primary source of radioactive contaminants. ZionSolutions TSD 14-019, *“Radionuclides of Concern for Soil and Basement Fill Model Source Terms”* (Reference 11) evaluates the results of the concrete core analysis data from the Containments and Auxiliary Building and refines the initial suite of potential ROC by evaluating the dose significance of each radionuclide.

The final ROC for the decommissioning of Zion are Co-60, Cs-134 and Cs-137 (as well as Eu-152 and Eu-154 for Containment), which are gamma emitters, and Ni-63 and Sr-90 (as well as H-3 for Containment), which are Hard-to-Detect (HTD) radionuclides. LTP section 5.1 states that HTD concentrations will be inferred using a surrogate approach and the maximum ratios from LTP Chapter 5, Table 5-15 unless area-specific ratios as determined by actual survey data are used in lieu of the maximum ratios.

LTP Chapter 6, section 6.5.2 discusses the process used to derive the ROC for the decommissioning of the ZNPS, including the elimination of insignificant dose contributors from the initial suite consistent with the guidance in Section 3.3 of NUREG-1757. Based upon the analysis of the Auxiliary Building mixture in TSD 14-019, Table 19, it was determined that Co-60, Ni-63, Sr-90, Cs-134 and Cs-137 accounted for 99.5% of all dose in the contaminated concrete mixes. Table 1 presents the ROC for the decommissioning of Auxiliary Building structural surfaces and the normalized mixture fractions based on the radionuclide mixture. In accordance with LTP Chapter 5, section 5.1, it was determined that the suite of ROC and radionuclide mixture derived for the Auxiliary Building concrete was considered as a reasonably conservative mixture to apply to soils and buried piping for FSS planning and implementation.

Table 1 - Dose Significant Radionuclides and Mixture

Radionuclide	% of Total Activity (normalized)⁽¹⁾
Co-60	0.92%
Cs-134	0.01%
Cs-137	75.32%
Ni-63	23.71%
Sr-90	0.05%

(1) Based on maximum percent of total activity from Table 20 of TSD 14-019, normalized to one for the dose significant radionuclides.

At ZNPS, compliance is demonstrated through the summation of dose from four distinct source terms for the end-state (basements, soils, buried pipe and groundwater). Each radionuclide-specific BcDCGL is equivalent to the level of residual radioactivity (above background levels) that could, when considered independently, result in a Total Effective Dose Equivalent (TEDE) of 25 mrem per year to an Average Member of the Critical Group (AMCG). To ensure that the summation of dose from each source term is 25 mrem/year or less after all FSS is completed, the BcDCGLs are reduced based on an expected, or *a priori*, fraction of the 25 mrem/year dose limit from each source term. The reduced DCGLs, or “Operational” DCGLs can be related to the BcDCGLs as an expected fraction of dose based on an *a priori* assessment of what the expected dose should be based on the results of site characterization, process knowledge and the extent of planned remediation. The OpDCGL is then used as the DCGL for the FSS design of the survey unit (e.g. calculation of surrogate DCGLs, investigations levels, etc.). Details of the OpDCGLs derived for each dose component and the basis for the applied *a priori* dose fractions are provided in ZionSolutions TSD 17-004, “Operational Derived Concentration Guideline Levels for Final Status Survey” (Reference 12).

The Base Case and Operational DCGLs for Buried Pipe are listed in Tables 5-9 and 5-10 of the LTP, and are reproduced in Table 2.

Table 2 - Base Case and Operational DCGLs for Buried Pipe

Radionuclide	Base Case Buried Pipe DCGL dpm/100cm²	Operational Buried Pipe DCGL dpm/100cm²
Co-60	2.64E+04	6.76E+03
Cs-134	4.54E+04	1.16E+04
Cs-137	1.01E+05	2.59E+04
Ni-63	4.89E+07	1.25E+07
Sr-90	4.50E+04	1.15E+04

5. SURVEY DESIGN

The level of effort associated with planning a survey is based on the complexity of the survey and nature of the hazards. Guidance for preparing FSS plans is provided in procedure ZS-LT-300-001-001.

The DQO process determined that Co-60, Ni-63, Sr-90, Cs-134 and Cs-137 would be the ROC in survey unit 00150A/B & C. During FSS, concentrations for HTD ROC Ni-63 and Sr-90 were inferred using a surrogate approach. Cs-137 was the principle surrogate radionuclide for Sr-90 and Co-60 was the principle surrogate radionuclide for Ni-63. The mean, maximum and 95% Upper Confidence Level (UCL) of the surrogate ratios for concrete core samples taken in the Auxiliary Building basement were calculated in ZionSolutions TSD 14-019 and are presented in Table 3. The maximum ratios were used in the surrogate calculations during this FSS. The results of the surrogate calculations are listed in Table 4.

Table 3 - Surrogate Ratios

Ratios	Auxiliary Building		
	Mean	Max	95%UCL
Ni-63/Co-60	44.143	180.450	154.632
Sr-90/Cs-137	0.001	0.002	0.002

The equation for calculating a surrogate DCGL is as follows:

Equation 1

$$Surrogate_{DCGL} = \frac{1}{\left[\left(\frac{1}{DCGL_{Sur}}\right) + \left(\frac{R_2}{DCGL_2}\right) + \left(\frac{R_3}{DCGL_3}\right) + \dots + \left(\frac{R_n}{DCGL_n}\right)\right]}$$

Where: $DCGL_{Sur}$ = Surrogate radionuclide DCGL
 $DCGL_{2,3\dots n}$ = DCGL for radionuclides to be represented by the surrogate
 R_n = Ratio of concentration (or nuclide mixture fraction) of radionuclide “n” to surrogate radionuclide

Using the OpDCGLs for buried pipe presented in Table 2 and the maximum ratios from Table 3, the following surrogate calculations for buried pipe were performed:

Equation 2

$$Surrogate\ OpDCGL_{(Cs-137)} = \frac{1}{\left[\left(\frac{1}{2.59E4_{(Cs-137)}}\right) + \left(\frac{0.002}{1.15E4_{(Sr-90)}}\right)\right]} = 2.58E4\ dpm/100\ cm^2$$

The surrogate OpDCGL for buried pipe that was used for Cs-137 in this survey unit is 2.58E+04 dpm/100cm².

Equation 3

$$Surrogate\ OpDCGL_{(Co-60)} = \frac{1}{\left[\left(\frac{1}{6.76E3_{(Co-60)}}\right) + \left(\frac{180.45}{1.25E7_{(Ni-63)}}\right)\right]} = 6.16E3\ dpm/100cm^2$$

The surrogate OpDCGL for buried pipe that was used for Co-60 in this survey unit is 6.16E+03 dpm/100 cm².

An adjusted gross gamma Operational DCGL was also calculated by applying the normalized gamma mixture for the three gamma-emitting ROC to the surrogate Co-60 OpDCGL, the surrogate Cs-137 OpDCGL and the OpDCGL for Cs-134 from Table 2.

The normalized values are:

Table 4 - Normalized Mixture for Gamma-Emitting ROC

Radionuclide	Auxiliary Building % of Total Activity (normalized)
Co-60	1.21%
Cs-134	0.01%
Cs-137	98.78%

The equation for performing a gross activity calculation is as follows:

Equation 4

$$\text{Gross Activity DCGL} = \frac{1}{\frac{f_1}{DCGL_1} + \frac{f_2}{DCGL_2} + \dots + \frac{f_n}{DCGL_n}}$$

The equation for the gross gamma activity calculation is as follows:

Equation 5

$$\text{Gross Activity DCGL} = \frac{1}{\frac{.9878}{2.58E4} + \frac{.0121}{6.16E3} + \frac{.0001}{1.16E4}} = 2.48E4 \text{ dpm}/100\text{cm}^2$$

The adjusted gross gamma OpDCGL for buried pipe is 2.48E+04 dpm/100 cm².

For the survey of pipe internal surfaces, areal coverage is achieved by the area of detection for each static measurement taken. Scanning, in the traditional context, is not applicable to the survey of pipe internal surfaces. It is conservatively assumed that one static measurement provides a full field of view over the 1-foot segment for these pipe sizes. This assumption is conservative because there is additional instrument response from contamination located in the pipe at distances outside of one (1) foot. Each foot of 6-inch ID pipe has a FOV area of 1.57 ft², each foot of 8-inch ID pipe has a FOV area of 2.09 ft², each foot of 12-inch ID pipe has a FOV area of 3.14 ft² and each foot of 15-inch ID pipe has a FOV area of 3.93 ft²; which is considered as the FOV for the measurements taken inside the pipe for this survey.

The buried North Yard Storm Drain piping was classified as MARSSIM Class 2 buried pipe. The initial survey design for the FSS of the North Yard Storm Drain buried piping was to be performed with a Ludlum Model 2350-1 Data Logger paired with a Ludlum Model 44-157 NaI gamma detector. Background was not subtracted from the readings. For this survey design, a minimum of 25% areal coverage was required. For the survey of these pipes, the pipe detector was calibrated for the specific geometry of the various diameters of the storm drain pipes.

To minimize the contribution of background radiation on the dose calculation for the survey unit, a second survey was performed with the Ludlum Model 2350-1 Data Logger paired with a Ludlum Model 44-10 NaI gamma detector calibrated to the Cs-137 energy window. The evaluations performed in this release record are based on the survey data collected using the Ludlum Model 44-10 calibrated to the Cs-137 energy window.

In compliance with ZS-LT-01, “*Quality Assurance Project Plan (for Characterization and FSS)*” (QAPP) (Reference 13), replicate measurements were required at 5% of the static measurement locations.

For the Ludlum Model 44-10 detector windowed for the Cs-137 energy, a 2nd surrogate calculation was performed, with Cs-137 as the surrogate for Co-60 and Cs-134.

Equation 6

$$Surrogate\ DCGL_{(Cs-137)} = \frac{1}{\left[\left(\frac{1}{2.58E4_{(Cs-137)}}\right) + \left(\frac{0.0001012}{1.16E4_{(Cs-134)}}\right) + \left(\frac{0.01225}{6.16E3_{(Co-60)}}\right)\right]} = 2.45E4\ dpm/100cm^2$$

The surrogate OpDCGL for buried pipe that was used for surveys with the Ludlum Model 44-10 detector windowed for the Cs-137 energy was 2.45E+04 dpm/100cm². Table 5 provides a synopsis of the survey design for survey unit 00150A/B & C.

Table 5 - Synopsis of Survey Design

FEATURE	DESIGN CRITERIA	BASIS
Survey Unit Area	2,187 ft ²	Pipe diameter (ID) x 919 linear ft (length) x π
Number of Static Measurements	272	25% areal coverage, Class 2
Measurement Spacing	As needed to obtain a sufficient number of measurements for 25% areal coverage	25% areal coverage, Class 2
DCGLs	<ul style="list-style-type: none"> Co-60 – 6.76E+03 dpm/100cm² Cs-134 – 1.16E+04 dpm/100cm² Cs-137 – 2.59E+04 dpm/100cm² Ni-63 – 1.25E+07 dpm/100cm² Sr-90 – 1.15E+04 dpm/100cm² 	OpDCGL for Buried Pipe, (LTP Chapter 5, Table 5-10)
HTD ROC Analysis	Gross Gamma DCGL adjusted for HTD based on the isotopic mixture	LTP 5.7.1.9
Measurement Investigation Level	Gross Gamma Operational DCGL Cs-137 Surrogate Operational DCGL	(LTP Chapter 5, Table 5-25)
Scan Survey Area Coverage	N/A	LTP 5.7.1.9
Quality Control (QC)	Replicate measurements will be performed on 5% of the static measurement locations	QAPP

6. SURVEY IMPLEMENTATION

Survey instructions for this FSS were incorporated into and performed in accordance with FSS Sample Plans S2-00150A-F, S2-00150B-F and S2-00150C-F, which were developed in accordance with *ZionSolutions* procedure ZS-LT-300-001-001. The FSS unit was inspected and controlled in accordance with *ZionSolutions* procedure ZS-LT-300-001-003.

Inspections of the pipe were performed with the SeeSnake prior to the start of the survey.

A background value was determined for the detector/instrument combination to be used prior to deployment. The background value was obtained at the location where the pre-use response check of the instrument was performed. The background value was primarily used to ensure that the detector had not become cross-contaminated by any previous use. Background was not subtracted from any measurement.

Daily, prior to and following use, each detector was subjected to an Operational Response Check in accordance with procedure ZS-LT-300-001-006, *"Radiation Surveys of Pipe Interiors Using Sodium/Cesium Iodide Detectors"* (Reference 14). The Daily Operational Response Check compared the background response and the response to check sources to ranges established for normal background and source response to ensure that the detector was working properly.

FSS field activities were conducted under the following three (3) FSS Sample Plans:

- S2-00150A-F included the 6-inch ID steel smooth wall piping from CB-1 to CB-8 and CB-8 to CB-9. These sections have a combined length of 135 linear feet.
- S2-00150B-F included the 8-inch ID PVC smooth wall piping from CB-1 to CB-6. This section is 515 linear feet in length.
- S2-00150C-F included three sections of pipe:
 - 8-inch ID PVC pipe runs from Catch Basin 7 south to a capped end. This section is 35 linear feet in length.
 - 12-inch ID smooth steel wall piping runs from CB-6 to CB-7. This section is 119 linear feet in length.
 - 15-inch corrugated steel piping runs from the West Ditch to CB-7. This section is 115 linear feet in length.

A "Field Log" (ZS-LT-300-001-001 Attachment 14) was used to document field activities and other information pertaining to the performance of the FSS.

FSS field activities were projected to take eight (8) working days to complete for each of the three survey plans. Daily briefings were conducted to discuss the expectations for job performance and to review safety aspects of the job. The initial survey with the Ludlum Model 44-157 detector was performed during normal working hours on June 19, 2019 on the 6-inch piping running from CB-8 to CB-9 and from CB-8 to CB-1. A survey was also performed on

the 77 foot section of 8-inch pipe from CB-1 to CB-2. The results of the survey on the 8-inch pipe indicated gross activity at concentration levels above the Action Level (OpDCGL). Investigations indicated that the elevated activity was due to Naturally Occurring Radioactive Material (NORM) that was present in the soil surrounding the buried pipe. In order to minimize the contribution of the NORM on the gross readings, the survey design was revised to allow resurvey of this pipe using a Ludlum Model 44-10 NaI detector calibrated to the energy window for Cs-137. Addendum 2 to survey plans S2-00150A-F and S2-00150B-F were written on June 25, 2019. Survey plan S2-00150C-F, written on July 1, 2019, included instructions for performing surveys with the Cs-137 windowed detector.

The surveys of the storm drain piping with the Cs-137 window commenced June 25, 2019 and completed July 23, 2019. Two hundred seventy-two (272) static measurements were obtained from within the pipe in several sections. Forty-five (45) measurements were taken in the 6-inch ID pipe (FOV of 1.57 ft²), one hundred and sixty-seven (167) measurements were taken in the 8-inch ID pipe (FOV of 2.09 ft²), thirty (30) measurements were taken in 12-inch ID pipe (FOV of 3.14 ft²) and thirty (30) measurements were taken in 15-inch ID pipe (FOV of 3.93 ft²). This corresponds to an area of 632 ft² or approximately 29% areal coverage.

The instruments and detectors used for this survey are presented in Table 6. The instrument and detector were verified to be properly calibrated prior to use.

Table 6 - Instruments and Detectors

Instrument/Detector Type	Serial #	Calibration Due Date
Ludlum 2350-1/Ludlum 44-157	304713/PR327899	12/11/19
Ludlum 2350-1/Ludlum 44-157	203445/PR372136	12/4/2019
Ludlum 2350-1/Ludlum 44-10	304713/PR372147	12/11/19

7. SURVEY RESULTS

The SOF or “unity rule” is applied to the data used for the survey planning, data evaluation and statistical tests for basement surfaces since multiple radionuclide-specific measurements will be performed or the concentrations inferred based on known relationships. The application of the unity rule serves to normalize the data to allow for an accurate comparison of the various data measurements to the release criteria. When the unity rule is applied, the DCGL_w (used for the nonparametric statistical test) becomes one (1). The BcDCGL are directly analogous to the DCGL_w as defined in MARSSIM. The use and application of the unity rule was performed in accordance with section 4.3.3 of MARSSIM.

As described in LTP Chapter 5, section 5.10.3.2, the Sign Test was used to evaluate the measured residual radioactivity against the dose criterion. The OpSOF for each measurement was used as the sum value for the Sign Test. The Sign Test then demonstrated that the mean activity for each ROC was less than the OpDCGL at a Type I decision error of 0.05.

For buried pipe, areas of elevated activity were defined as any area identified by measurement (systematic or judgmental) that exceeded the OpDCGL but was less than the BcDCGL. Any area that exceeded the BcDCGL would have required remediation. The OpSOF for a systematic or a judgmental measurement/sample(s) could exceed one (1) without remediation as long as the survey unit passed the Sign Test and, the mean OpSOF for the survey unit did not exceed one. Once the survey data set passed the Sign Test (using OpDCGLs), then the mean radionuclide activity (dpm/100cm²) for each ROC from systematic measurements along with any identified elevated areas from systematic and judgmental samples was used with the BcDCGLs to perform a mean BcSOF calculation. The dose from residual radioactivity assigned to the FSS unit is the mean BcSOF multiplied by 25 mrem/yr.

After completion of the FSS measurements in the pipe, the sample plan was reviewed to confirm the completeness of the survey and the survey data was validated in accordance with procedure ZS-LT-300-001-004, “*Final Status Survey Data Assessment*” (Reference 15). Data processing includes converting measurement data into reporting units, validating instrument applicability and sensitivity, calculating relevant statistical quantities, and verifying that all DQO have been met. In accordance with the procedure, a preliminary Data Assessment was prepared.

Since the survey was performed with a Ludlum Model 44-10 set to the Cs-137 window, the calculated gross gamma value was applied to Cs-137, and the Co-60 and Cs-134 values were inferred based on the isotopic mix from Table 1 normalized to the gamma emitting ROC. The normalized mix was Cs-137 - 98.78%, Co-60 - 1.21%, and Cs-134 - 0.01%. The surrogate ratios for the HTD nuclides listed in Table 5-15 of the LTP (Ni-63/Co-60 of 180.45; Sr-90/Cs-137 of 0.002) were then used to infer representative concentrations for HTD ROC.

The results of the data assessment for the North Yard Storm Drain buried piping are provided in Attachment 2. A statistical summary of the data is presented in Table 7. No observed individual measurement exceeded an OpSOF of one.

The data collected passed the Sign Test. The result of the Sign Test is provided in Attachment 3.

Table 7 - North Yard Storm Drain Buried Pipe - Statistical Quantities
Systematic Measurement Population - Individual Measurement Metrics

Total Number of Systematic Measurements =	272
Number of Quality Control Measurements =	18
Number of Judgmental/Investigational Measurements =	0
Total Number of Measurements =	290
Mean Systematic Measurement OpSOF =	0.107
Max Individual Systematic Measurement OpSOF =	0.276
Number of Systematic Measurements with OpSOF >One =	0

Statistical Quantities - Systematic Measurement Population

ROC	MEAN (dpm/100cm ²)	MEDIAN (dpm/100cm ²)	MAX (dpm/100cm ²)	MIN (dpm/100cm ²)	STD. DEV. (dpm/100cm ²)	BcDCGL (dpm/100cm ²)	BcSOF	Avg Dose per ROC (mrem/yr)
Gross Gamma	2.61E+03	2.36E+03	6.77E+03	1.52E+03	7.93E+02	N/A	N/A	N/A
Co-60 ⁽²⁾	3.19E+01	2.88E+01	8.27E+01	1.86E+01	9.68E+00	2.64E+04	0.00121	0.030
Cs-134 ⁽²⁾	3.47E-01	3.13E-01	8.98E-01	2.02E-01	1.05E-01	4.54E+04	0.00001	0.000
Cs-137	2.61E+03	2.36E+03	6.77E+03	1.52E+03	7.93E+02	1.01E+05	0.02587	0.647
Ni-63 ⁽¹⁾	5.76E+03	5.20E+03	1.49E+04	3.35E+03	1.75E+03	4.89E+07	0.00012	0.003
Sr-90 ⁽¹⁾	5.23E+00	4.72E+00	1.35E+01	3.04E+00	1.59E+00	4.50E+04	0.00012	0.003

(1) Concentrations for Ni-63 and Sr-90 are inferred

(2) Concentrations for Co-60 and Cs-134 are scaled off of the measured concentration of Cs-137 using the normalized gamma mixture from Table 4

MEAN BcSOF ASSIGNED TO SURVEY UNIT (SYSTEMATIC AVG.) = 0.027

DOSE ASSIGNED TO SURVEY UNIT (SYSTEMATIC AVG.) = 0.683 mrem/yr

8. QUALITY CONTROL

In compliance with ZS-LT-01, replicate measurements were performed on 5% of the survey locations chosen at random. Eighteen (18) replicate measurements were taken. Using the acceptance criteria specified in section 4.1.2 of ZS-LT-01, there was acceptable agreement between the replicate measurements and the original measurement in sixteen (16) of the eighteen (18) comparisons. Two (2) QC measurements did not fall within 20% of the original measurement. For the 8-inch ID pipe between CB-4 and CB-5, the 20 foot measurement was approximately 32% less than the original measurement. For the 12-inch ID pipe out of CB-7, the 8 foot measurement was approximately 31% less than the original measurement. All measurements were well below 50% of the DCGL and the instrument and detector passed the post-use response check. No further action was deemed necessary. Refer to Attachment 4 for quality control analysis results.

9. INVESTIGATIONS AND RESULTS

No investigations were performed in Survey Unit 00150A/B & C.

10. REMEDIATION AND RESULTS

No remediation was performed in this survey unit.

11. CHANGES FROM THE SURVEY PLAN

The detector selected for the survey during the survey design (Ludlum Model 44-157) was unable to obtain satisfactory results due to high background readings. A Ludlum Model 44-10 detector was subsequently calibrated for the Cs-137 energy window operating mode and was used to successfully collect the measurements required.

12. DATA QUALITY ASSESSMENT

The DQO sample design and data were reviewed in accordance with *ZionSolutions* procedure ZS-LT-300-001-004, "Final Status Survey Data Assessment". The sample design and data were reviewed for completeness, accuracy, and consistency. Documentation was complete and legible. The FSS unit was properly classified as Class 2. All measurement results were individually reviewed and validated. The number of measurements was sufficient to meet the requirement of 25% areal coverage of accessible surfaces. The instrumentation used to perform the FSS were in calibration, capable of detecting the activity with an adequate Minimum Detectable Concentration (MDC) and successfully response checked prior to and following use. An adequate number of replicate measurements were taken and the results meet the acceptance criteria as specified in the QAPP for completeness and consistency.

13. ANOMALIES

No anomalies were observed during the performance or analyses of the survey.

14. CONCLUSION

Two hundred seventy-two (272) static measurements were taken in the North Yard Storm Drain buried pipe. The total length of pipe was 919.00 linear feet. Forty-five (45) measurements were taken in 6-inch ID pipe (FOV of 1.57 ft²), one hundred sixty-seven (167) measurements were taken in the 8-inch ID pipe (FOV of 2.09 ft²), thirty (30) measurements were taken in 12-inch ID pipe (FOV of 3.14 ft²) and thirty (30) measurements were taken in 15-inch ID pipe (FOV of 3.93 ft²). This corresponds to a total area surveyed of 631.8 ft², or approximately 28% areal coverage. Consequently, the 25% areal survey coverage required by the survey design was met.

All of the measurements were below an OpSOF of one, when compared to the OpDCGL_{BP}. The results meet the requirement for a Class 2 survey unit, with a Mean OpSOF of 0.107. The sample data passed the Sign Test. The null hypothesis was rejected.

The mean BcSOF for this survey unit is 0.027. The dose contribution from survey unit 00150A/B & C “North Yard Storm Drain Buried Piping” is 0.683 mrem/yr TEDE, based on the average concentration of the ROC in samples used for non-parametric statistical sampling.

Survey unit 00150A/B & C “North Yard Storm Drain Buried Piping” is acceptable for unrestricted release.

15. REFERENCES

1. *ZionSolutions* procedure ZS-LT-300-001-005, Final Status Survey Data Reporting
2. Zion Station Restoration Project License Termination Plan
3. *ZionSolutions* procedure ZS-LT-300-001-001, Final Status Survey Package Development
4. NUREG-1575, Multi-Agency Radiation Survey and Site Investigation Manual
5. *ZionSolutions* procedure ZS-LT-300-001-003, Isolation and Control for Final Status Survey
6. Zion Station Historical Site Assessment
7. *ZionSolutions* procedure ZS-LT-300-001-002, Survey Unit Classification
8. *ZionSolutions* TSD 14-016, Description of Embedded Piping, Penetrations, and Buried Pipe to Remain in Zion End State
9. *ZionSolutions* TSD 14-015, Buried Pipe Dose Modeling & DCGLs

10. *ZionSolutions* TSD 11-001, Technical Support Document for Potential Radionuclides of Concern During the Decommissioning of the Zion Station
11. *ZionSolutions* TSD 14-019, Radionuclides of Concern for Soil and Basement Fill Model Source Terms
12. *ZionSolutions* TSD 17-004, Operational Derived Concentration Guideline Levels for Final Status Survey
13. *ZionSolutions* procedure ZS-LT-01, Quality Assurance Project Plan (for Characterization and FSS)
14. *ZionSolutions* procedure ZS-LT-300-001-006, Radiation Surveys of Pipe Interiors Using Sodium/Cesium Iodide Detectors
15. *ZionSolutions* procedure ZS-LT-300-001-004, Final Status Survey Data Assessment

16. ATTACHMENTS

1. Attachment 1 – Survey Unit 00150A/B & C - Storm Drain Piping Drawing
2. Attachment 2 – Sample Data
3. Attachment 3 – Sign Test
4. Attachment 4 – QC Data Assessment

ATTACHMENT 1
SURVEY UNIT 00150A/B & C
STORM DRAIN PIPING DRAWING

Survey Unit 00150A/B & C - Storm Drain Piping Drawing

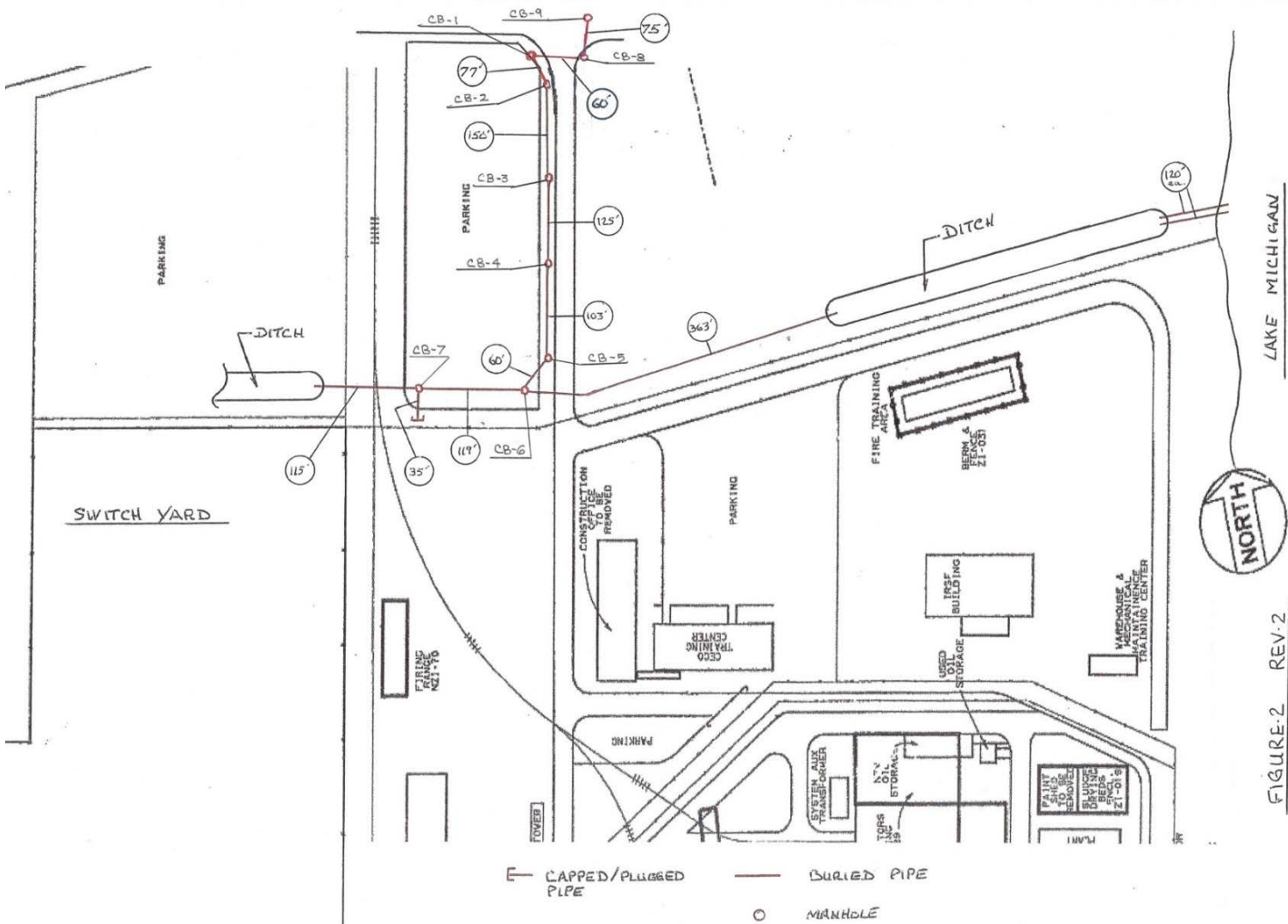


FIGURE-2 REV.2

ATTACHMENT 2

SAMPLE DATA

FSS RELEASE RECORD
NORTH YARD STORM DRAIN BURIED PIPING
SURVEY UNIT 00150A/B & C



North Yard Storm Drain Buried Pipe FSS Measurements

PIPE	PIPE ID	POSITION	FEET INTO PIPE	GROSS GAMMA ACTIVITY (dpm/100cm ²)	Co-60 (dpm/100cm ²)	Cs-134 (dpm/100cm ²)	Cs-137 (dpm/100cm ²)	Ni-63 (dpm/100cm ²)	Sr-90 (dpm/100cm ²)	OpSOF
CB-8 to CB-9	6	Zero	2	2.29E+03	2.80E+01	3.04E-01	2.29E+03	5.05E+03	4.58E+00	0.093
	6	1	4	2.88E+03	3.52E+01	3.83E-01	2.88E+03	6.36E+03	5.77E+00	0.118
	6	2	6	2.22E+03	2.72E+01	2.95E-01	2.22E+03	4.90E+03	4.45E+00	0.091
	6	3	8	1.70E+03	2.07E+01	2.25E-01	1.70E+03	3.74E+03	3.39E+00	0.069
	6	4	10	1.83E+03	2.23E+01	2.43E-01	1.83E+03	4.03E+03	3.66E+00	0.075
	6	5	12	2.40E+03	2.93E+01	3.19E-01	2.40E+03	5.29E+03	4.80E+00	0.098
	6	6	14	1.87E+03	2.29E+01	2.48E-01	1.87E+03	4.13E+03	3.74E+00	0.076
	6	7	16	2.27E+03	2.77E+01	3.01E-01	2.27E+03	5.00E+03	4.54E+00	0.092
	6	8	18	3.17E+03	3.87E+01	4.21E-01	3.17E+03	6.99E+03	6.34E+00	0.129
	6	9	20	3.17E+03	3.87E+01	4.21E-01	3.17E+03	6.99E+03	6.34E+00	0.129
	6	10	22	2.53E+03	3.09E+01	3.36E-01	2.53E+03	5.58E+03	5.06E+00	0.103
	6	11	24	2.88E+03	3.52E+01	3.83E-01	2.88E+03	6.36E+03	5.77E+00	0.118
	6	12	26	2.75E+03	3.36E+01	3.65E-01	2.75E+03	6.07E+03	5.50E+00	0.112
	6	13	28	2.53E+03	3.09E+01	3.36E-01	2.53E+03	5.58E+03	5.06E+00	0.103
	6	14	30	2.36E+03	2.88E+01	3.13E-01	2.36E+03	5.19E+03	4.71E+00	0.096
	6	15	32	2.29E+03	2.80E+01	3.04E-01	2.29E+03	5.05E+03	4.58E+00	0.093
	6	16	34	2.03E+03	2.47E+01	2.69E-01	2.03E+03	4.46E+03	4.05E+00	0.083
	6	17	36	2.64E+03	3.23E+01	3.51E-01	2.64E+03	5.82E+03	5.28E+00	0.108
	6	18	38	2.75E+03	3.36E+01	3.65E-01	2.75E+03	6.07E+03	5.50E+00	0.112
	6	19	40	2.07E+03	2.53E+01	2.75E-01	2.07E+03	4.56E+03	4.14E+00	0.084
	6	20	42	2.07E+03	2.53E+01	2.75E-01	2.07E+03	4.56E+03	4.14E+00	0.084
	6	21	44	1.83E+03	2.23E+01	2.43E-01	1.83E+03	4.03E+03	3.66E+00	0.075
	6	22	46	2.33E+03	2.85E+01	3.10E-01	2.33E+03	5.14E+03	4.67E+00	0.095
	6	23	48	2.14E+03	2.61E+01	2.84E-01	2.14E+03	4.71E+03	4.27E+00	0.087
	6	24	50	2.20E+03	2.69E+01	2.92E-01	2.20E+03	4.85E+03	4.40E+00	0.090
CB-8 to CB-1	6	25	2	2.31E+03	2.82E+01	3.07E-01	2.31E+03	5.10E+03	4.62E+00	0.094
	6	26	4	1.98E+03	2.42E+01	2.63E-01	1.98E+03	4.37E+03	3.96E+00	0.081
	6	27	6	2.18E+03	2.66E+01	2.89E-01	2.18E+03	4.80E+03	4.36E+00	0.089
	6	28	8	2.09E+03	2.56E+01	2.78E-01	2.09E+03	4.61E+03	4.18E+00	0.085
	6	29	10	2.07E+03	2.53E+01	2.75E-01	2.07E+03	4.56E+03	4.14E+00	0.084
	6	30	12	1.98E+03	2.42E+01	2.63E-01	1.98E+03	4.37E+03	3.96E+00	0.081

FSS RELEASE RECORD
NORTH YARD STORM DRAIN BURIED PIPING
SURVEY UNIT 00150A/B & C



North Yard Storm Drain Buried Pipe FSS Measurements (continued)

PIPE	PIPE ID	POSITION	FEET INTO PIPE	GROSS GAMMA ACTIVITY (dpm/100cm ²)	Co-60 (dpm/100cm ²)	Cs-134 (dpm/100cm ²)	Cs-137 (dpm/100cm ²)	Ni-63 (dpm/100cm ²)	Sr-90 (dpm/100cm ²)	OpSOF
CB-8 to CB-1	6	31	14	2.16E+03	2.64E+01	2.86E-01	2.16E+03	4.76E+03	4.32E+00	0.088
	6	32	16	2.58E+03	3.15E+01	3.42E-01	2.58E+03	5.68E+03	5.15E+00	0.105
	6	33	18	2.80E+03	3.42E+01	3.71E-01	2.80E+03	6.16E+03	5.59E+00	0.114
	6	34	20	1.85E+03	2.26E+01	2.46E-01	1.85E+03	4.08E+03	3.70E+00	0.075
	6	35	22	1.52E+03	1.86E+01	2.02E-01	1.52E+03	3.35E+03	3.04E+00	0.062
	6	36	24	1.94E+03	2.37E+01	2.57E-01	1.94E+03	4.27E+03	3.88E+00	0.079
	6	37	26	1.74E+03	2.12E+01	2.31E-01	1.74E+03	3.83E+03	3.48E+00	0.071
	6	38	28	2.07E+03	2.53E+01	2.75E-01	2.07E+03	4.56E+03	4.14E+00	0.084
	6	39	30	2.25E+03	2.74E+01	2.98E-01	2.25E+03	4.95E+03	4.49E+00	0.092
	6	40	32	2.33E+03	2.85E+01	3.10E-01	2.33E+03	5.14E+03	4.67E+00	0.095
	6	41	34	2.47E+03	3.01E+01	3.27E-01	2.47E+03	5.44E+03	4.93E+00	0.101
	6	42	36	1.74E+03	2.12E+01	2.31E-01	1.74E+03	3.83E+03	3.48E+00	0.071
	6	43	38	1.74E+03	2.12E+01	2.31E-01	1.74E+03	3.83E+03	3.48E+00	0.071
	6	44	40	1.85E+03	2.26E+01	2.46E-01	1.85E+03	4.08E+03	3.70E+00	0.075
CB-1 to CB-2	8	Zero	2	2.66E+03	3.25E+01	3.54E-01	2.66E+03	5.87E+03	5.33E+00	0.109
	8	1	4	2.73E+03	3.34E+01	3.63E-01	2.73E+03	6.03E+03	5.47E+00	0.112
	8	2	6	2.19E+03	2.68E+01	2.91E-01	2.19E+03	4.83E+03	4.39E+00	0.089
	8	3	8	2.12E+03	2.59E+01	2.82E-01	2.12E+03	4.68E+03	4.24E+00	0.087
	8	4	10	2.59E+03	3.17E+01	3.44E-01	2.59E+03	5.72E+03	5.19E+00	0.106
	8	5	12	2.55E+03	3.11E+01	3.38E-01	2.55E+03	5.61E+03	5.09E+00	0.104
	8	6	14	2.40E+03	2.94E+01	3.19E-01	2.40E+03	5.30E+03	4.81E+00	0.098
	8	7	16	2.36E+03	2.88E+01	3.13E-01	2.36E+03	5.20E+03	4.72E+00	0.096
	8	8	18	2.78E+03	3.40E+01	3.69E-01	2.78E+03	6.13E+03	5.56E+00	0.113
	8	9	20	2.81E+03	3.43E+01	3.73E-01	2.81E+03	6.18E+03	5.61E+00	0.114
	8	10	22	2.62E+03	3.20E+01	3.47E-01	2.62E+03	5.77E+03	5.23E+00	0.107
	8	11	24	3.30E+03	4.03E+01	4.38E-01	3.30E+03	7.28E+03	6.60E+00	0.135
	8	12	26	2.73E+03	3.34E+01	3.63E-01	2.73E+03	6.03E+03	5.47E+00	0.112
	8	13	28	2.62E+03	3.20E+01	3.47E-01	2.62E+03	5.77E+03	5.23E+00	0.107
	8	14	30	3.32E+03	4.06E+01	4.41E-01	3.32E+03	7.33E+03	6.65E+00	0.136
	8	15	32	2.88E+03	3.51E+01	3.82E-01	2.88E+03	6.34E+03	5.75E+00	0.117

FSS RELEASE RECORD
NORTH YARD STORM DRAIN BURIED PIPING
SURVEY UNIT 00150A/B & C



North Yard Storm Drain Buried Pipe FSS Measurements (continued)

PIPE	PIPE ID	POSITION	FEET INTO PIPE	GROSS GAMMA ACTIVITY (dpm/100cm ²)	Co-60 (dpm/100cm ²)	Cs-134 (dpm/100cm ²)	Cs-137 (dpm/100cm ²)	Ni-63 (dpm/100cm ²)	Sr-90 (dpm/100cm ²)	OpSOF
CB-1 to CB-2	8	16	34	3.16E+03	3.86E+01	4.19E-01	3.16E+03	6.96E+03	6.32E+00	0.129
	8	17	36	2.88E+03	3.51E+01	3.82E-01	2.88E+03	6.34E+03	5.75E+00	0.117
	8	18	38	3.32E+03	4.06E+01	4.41E-01	3.32E+03	7.33E+03	6.65E+00	0.136
	8	19	40	2.88E+03	3.51E+01	3.82E-01	2.88E+03	6.34E+03	5.75E+00	0.117
	8	20	42	3.28E+03	4.00E+01	4.35E-01	3.28E+03	7.22E+03	6.55E+00	0.134
	8	21	44	3.23E+03	3.94E+01	4.28E-01	3.23E+03	7.11E+03	6.45E+00	0.132
CB-2 to CB-3	8	Zero	2	2.81E+03	3.43E+01	3.73E-01	2.81E+03	6.18E+03	5.61E+00	0.114
	8	1	4	2.62E+03	3.20E+01	3.47E-01	2.62E+03	5.77E+03	5.23E+00	0.107
	8	2	6	2.55E+03	3.11E+01	3.38E-01	2.55E+03	5.61E+03	5.09E+00	0.104
	8	3	8	2.29E+03	2.79E+01	3.04E-01	2.29E+03	5.04E+03	4.57E+00	0.093
	8	4	10	2.31E+03	2.82E+01	3.07E-01	2.31E+03	5.09E+03	4.62E+00	0.094
	8	5	12	2.52E+03	3.08E+01	3.35E-01	2.52E+03	5.56E+03	5.05E+00	0.103
	8	6	14	2.19E+03	2.68E+01	2.91E-01	2.19E+03	4.83E+03	4.39E+00	0.089
	8	7	16	2.17E+03	2.65E+01	2.88E-01	2.17E+03	4.78E+03	4.34E+00	0.088
	8	8	18	2.76E+03	3.37E+01	3.66E-01	2.76E+03	6.08E+03	5.52E+00	0.112
	8	9	20	2.22E+03	2.71E+01	2.94E-01	2.22E+03	4.88E+03	4.43E+00	0.090
	8	10	22	3.14E+03	3.83E+01	4.16E-01	3.14E+03	6.91E+03	6.27E+00	0.128
	8	11	24	2.40E+03	2.94E+01	3.19E-01	2.40E+03	5.30E+03	4.81E+00	0.098
	8	12	26	2.78E+03	3.40E+01	3.69E-01	2.78E+03	6.13E+03	5.56E+00	0.113
	8	13	28	2.19E+03	2.68E+01	2.91E-01	2.19E+03	4.83E+03	4.39E+00	0.089
	8	14	30	2.29E+03	2.79E+01	3.04E-01	2.29E+03	5.04E+03	4.57E+00	0.093
	8	15	32	1.84E+03	2.25E+01	2.44E-01	1.84E+03	4.05E+03	3.68E+00	0.075
	8	16	34	2.33E+03	2.85E+01	3.10E-01	2.33E+03	5.14E+03	4.67E+00	0.095
	8	17	36	2.69E+03	3.28E+01	3.57E-01	2.69E+03	5.92E+03	5.38E+00	0.110
	8	18	38	2.03E+03	2.48E+01	2.69E-01	2.03E+03	4.47E+03	4.06E+00	0.083
	8	19	40	2.81E+03	3.43E+01	3.73E-01	2.81E+03	6.18E+03	5.61E+00	0.114
	8	20	2	2.48E+03	3.02E+01	3.29E-01	2.48E+03	5.46E+03	4.95E+00	0.101
	8	21	4	2.78E+03	3.40E+01	3.69E-01	2.78E+03	6.13E+03	5.56E+00	0.113
	8	22	6	2.45E+03	3.00E+01	3.26E-01	2.45E+03	5.40E+03	4.90E+00	0.100
	8	23	8	2.36E+03	2.88E+01	3.13E-01	2.36E+03	5.20E+03	4.72E+00	0.096
	8	24	10	2.76E+03	3.37E+01	3.66E-01	2.76E+03	6.08E+03	5.52E+00	0.112

FSS RELEASE RECORD
NORTH YARD STORM DRAIN BURIED PIPING
SURVEY UNIT 00150A/B & C



North Yard Storm Drain Buried Pipe FSS Measurements (continued)

PIPE	PIPE ID	POSITION	FEET INTO PIPE	GROSS GAMMA ACTIVITY (dpm/100cm ²)	Co-60 (dpm/100cm ²)	Cs-134 (dpm/100cm ²)	Cs-137 (dpm/100cm ²)	Ni-63 (dpm/100cm ²)	Sr-90 (dpm/100cm ²)	OpSOF
CB-2 to CB-3	8	25	12	2.55E+03	3.11E+01	3.38E-01	2.55E+03	5.61E+03	5.09E+00	0.104
	8	26	14	2.05E+03	2.51E+01	2.72E-01	2.05E+03	4.52E+03	4.10E+00	0.084
	8	27	16	2.22E+03	2.71E+01	2.94E-01	2.22E+03	4.88E+03	4.43E+00	0.090
	8	28	18	2.24E+03	2.74E+01	2.97E-01	2.24E+03	4.94E+03	4.48E+00	0.091
	8	29	20	2.22E+03	2.71E+01	2.94E-01	2.22E+03	4.88E+03	4.43E+00	0.090
	8	30	22	2.00E+03	2.45E+01	2.66E-01	2.00E+03	4.42E+03	4.01E+00	0.082
	8	31	24	1.93E+03	2.36E+01	2.57E-01	1.93E+03	4.26E+03	3.87E+00	0.079
	8	32	26	2.19E+03	2.68E+01	2.91E-01	2.19E+03	4.83E+03	4.39E+00	0.089
	8	33	28	2.36E+03	2.88E+01	3.13E-01	2.36E+03	5.20E+03	4.72E+00	0.096
	8	34	30	2.03E+03	2.48E+01	2.69E-01	2.03E+03	4.47E+03	4.06E+00	0.083
	8	35	32	2.15E+03	2.62E+01	2.85E-01	2.15E+03	4.73E+03	4.29E+00	0.087
	8	36	34	1.82E+03	2.22E+01	2.41E-01	1.82E+03	4.00E+03	3.63E+00	0.074
	8	37	36	2.26E+03	2.76E+01	3.01E-01	2.26E+03	4.99E+03	4.53E+00	0.092
	8	38	38	2.26E+03	2.76E+01	3.01E-01	2.26E+03	4.99E+03	4.53E+00	0.092
	8	39	40	2.31E+03	2.82E+01	3.07E-01	2.31E+03	5.09E+03	4.62E+00	0.094
CB-3 to CB-4	8	Zero	2	2.50E+03	3.05E+01	3.32E-01	2.50E+03	5.51E+03	5.00E+00	0.102
	8	1	4	2.36E+03	2.88E+01	3.13E-01	2.36E+03	5.20E+03	4.72E+00	0.096
	8	2	6	2.31E+03	2.82E+01	3.07E-01	2.31E+03	5.09E+03	4.62E+00	0.094
	8	3	8	1.96E+03	2.39E+01	2.60E-01	1.96E+03	4.31E+03	3.91E+00	0.080
	8	4	10	1.96E+03	2.39E+01	2.60E-01	1.96E+03	4.31E+03	3.91E+00	0.080
	8	5	12	1.77E+03	2.16E+01	2.35E-01	1.77E+03	3.90E+03	3.54E+00	0.072
	8	6	14	2.24E+03	2.74E+01	2.97E-01	2.24E+03	4.94E+03	4.48E+00	0.091
	8	7	16	1.82E+03	2.22E+01	2.41E-01	1.82E+03	4.00E+03	3.63E+00	0.074
	8	8	18	2.19E+03	2.68E+01	2.91E-01	2.19E+03	4.83E+03	4.39E+00	0.089
	8	9	20	2.17E+03	2.65E+01	2.88E-01	2.17E+03	4.78E+03	4.34E+00	0.088
	8	10	22	2.22E+03	2.71E+01	2.94E-01	2.22E+03	4.88E+03	4.43E+00	0.090
	8	11	24	2.12E+03	2.59E+01	2.82E-01	2.12E+03	4.68E+03	4.24E+00	0.087
	8	12	26	1.67E+03	2.04E+01	2.22E-01	1.67E+03	3.69E+03	3.35E+00	0.068
	8	13	28	2.31E+03	2.82E+01	3.07E-01	2.31E+03	5.09E+03	4.62E+00	0.094
	8	14	30	1.93E+03	2.36E+01	2.57E-01	1.93E+03	4.26E+03	3.87E+00	0.079
	8	15	32	2.45E+03	3.00E+01	3.26E-01	2.45E+03	5.40E+03	4.90E+00	0.100

FSS RELEASE RECORD
NORTH YARD STORM DRAIN BURIED PIPING
SURVEY UNIT 00150A/B & C



North Yard Storm Drain Buried Pipe FSS Measurements (continued)

PIPE	PIPE ID	POSITION	FEET INTO PIPE	GROSS GAMMA ACTIVITY (dpm/100cm ²)	Co-60 (dpm/100cm ²)	Cs-134 (dpm/100cm ²)	Cs-137 (dpm/100cm ²)	Ni-63 (dpm/100cm ²)	Sr-90 (dpm/100cm ²)	OpSOF
CB-3 to CB-4	8	16	34	1.58E+03	1.93E+01	2.10E-01	1.58E+03	3.48E+03	3.16E+00	0.064
	8	17	36	2.10E+03	2.56E+01	2.79E-01	2.10E+03	4.63E+03	4.20E+00	0.086
	8	18	38	2.57E+03	3.14E+01	3.41E-01	2.57E+03	5.66E+03	5.14E+00	0.105
	8	19	40	2.73E+03	3.34E+01	3.63E-01	2.73E+03	6.03E+03	5.47E+00	0.112
	8	20	2	2.69E+03	3.28E+01	3.57E-01	2.69E+03	5.92E+03	5.38E+00	0.110
	8	21	4	1.86E+03	2.28E+01	2.47E-01	1.86E+03	4.11E+03	3.73E+00	0.076
	8	22	6	2.36E+03	2.88E+01	3.13E-01	2.36E+03	5.20E+03	4.72E+00	0.096
	8	23	8	2.26E+03	2.76E+01	3.01E-01	2.26E+03	4.99E+03	4.53E+00	0.092
	8	24	10	2.15E+03	2.62E+01	2.85E-01	2.15E+03	4.73E+03	4.29E+00	0.087
	8	25	12	2.40E+03	2.94E+01	3.19E-01	2.40E+03	5.30E+03	4.81E+00	0.098
	8	26	14	2.69E+03	3.28E+01	3.57E-01	2.69E+03	5.92E+03	5.38E+00	0.110
	8	27	16	2.07E+03	2.53E+01	2.75E-01	2.07E+03	4.57E+03	4.15E+00	0.085
	8	28	18	2.45E+03	3.00E+01	3.26E-01	2.45E+03	5.40E+03	4.90E+00	0.100
	8	29	20	2.22E+03	2.71E+01	2.94E-01	2.22E+03	4.88E+03	4.43E+00	0.090
	8	30	22	2.15E+03	2.62E+01	2.85E-01	2.15E+03	4.73E+03	4.29E+00	0.087
	8	31	24	2.48E+03	3.02E+01	3.29E-01	2.48E+03	5.46E+03	4.95E+00	0.101
	8	32	26	2.03E+03	2.48E+01	2.69E-01	2.03E+03	4.47E+03	4.06E+00	0.083
	8	33	28	2.19E+03	2.68E+01	2.91E-01	2.19E+03	4.83E+03	4.39E+00	0.089
	8	34	30	2.05E+03	2.51E+01	2.72E-01	2.05E+03	4.52E+03	4.10E+00	0.084
	8	35	32	2.12E+03	2.59E+01	2.82E-01	2.12E+03	4.68E+03	4.24E+00	0.087
	8	36	34	1.91E+03	2.33E+01	2.54E-01	1.91E+03	4.21E+03	3.82E+00	0.078
	8	37	36	2.48E+03	3.02E+01	3.29E-01	2.48E+03	5.46E+03	4.95E+00	0.101
	8	38	38	2.26E+03	2.76E+01	3.01E-01	2.26E+03	4.99E+03	4.53E+00	0.092
	8	39	40	2.31E+03	2.82E+01	3.07E-01	2.31E+03	5.09E+03	4.62E+00	0.094
CB-4 to CB-5	8	Zero	2	1.86E+03	2.28E+01	2.47E-01	1.86E+03	4.11E+03	3.73E+00	0.076
	8	1	4	2.07E+03	2.53E+01	2.75E-01	2.07E+03	4.57E+03	4.15E+00	0.085
	8	2	6	2.50E+03	3.05E+01	3.32E-01	2.50E+03	5.51E+03	5.00E+00	0.102
	8	3	8	1.96E+03	2.39E+01	2.60E-01	1.96E+03	4.31E+03	3.91E+00	0.080
	8	4	10	2.00E+03	2.45E+01	2.66E-01	2.00E+03	4.42E+03	4.01E+00	0.082
	8	5	12	1.82E+03	2.22E+01	2.41E-01	1.82E+03	4.00E+03	3.63E+00	0.074
	8	6	14	1.91E+03	2.33E+01	2.54E-01	1.91E+03	4.21E+03	3.82E+00	0.078

FSS RELEASE RECORD
NORTH YARD STORM DRAIN BURIED PIPING
SURVEY UNIT 00150A/B & C



North Yard Storm Drain Buried Pipe FSS Measurements (continued)

PIPE	PIPE ID	POSITION	FEET INTO PIPE	GROSS GAMMA ACTIVITY (dpm/100cm ²)	Co-60 (dpm/100cm ²)	Cs-134 (dpm/100cm ²)	Cs-137 (dpm/100cm ²)	Ni-63 (dpm/100cm ²)	Sr-90 (dpm/100cm ²)	OpSOF
CB-4 to CB-5	8	7	16	2.24E+03	2.74E+01	2.97E-01	2.24E+03	4.94E+03	4.48E+00	0.091
	8	8	18	1.89E+03	2.30E+01	2.50E-01	1.89E+03	4.16E+03	3.77E+00	0.077
	8	9	20	1.79E+03	2.19E+01	2.38E-01	1.79E+03	3.95E+03	3.58E+00	0.073
	8	10	22	2.05E+03	2.51E+01	2.72E-01	2.05E+03	4.52E+03	4.10E+00	0.084
	8	11	24	2.10E+03	2.56E+01	2.79E-01	2.10E+03	4.63E+03	4.20E+00	0.086
	8	12	26	1.98E+03	2.42E+01	2.63E-01	1.98E+03	4.37E+03	3.96E+00	0.081
	8	13	28	2.36E+03	2.88E+01	3.13E-01	2.36E+03	5.20E+03	4.72E+00	0.096
	8	14	30	2.15E+03	2.62E+01	2.85E-01	2.15E+03	4.73E+03	4.29E+00	0.087
	8	15	2	1.86E+03	2.28E+01	2.47E-01	1.86E+03	4.11E+03	3.73E+00	0.076
	8	16	4	2.36E+03	2.88E+01	3.13E-01	2.36E+03	5.20E+03	4.72E+00	0.096
	8	17	6	1.67E+03	2.04E+01	2.22E-01	1.67E+03	3.69E+03	3.35E+00	0.068
	8	18	8	2.07E+03	2.53E+01	2.75E-01	2.07E+03	4.57E+03	4.15E+00	0.085
	8	19	10	2.17E+03	2.65E+01	2.88E-01	2.17E+03	4.78E+03	4.34E+00	0.088
	8	20	12	2.10E+03	2.56E+01	2.79E-01	2.10E+03	4.63E+03	4.20E+00	0.086
	8	21	14	2.12E+03	2.59E+01	2.82E-01	2.12E+03	4.68E+03	4.24E+00	0.087
	8	22	16	2.55E+03	3.11E+01	3.38E-01	2.55E+03	5.61E+03	5.09E+00	0.104
	8	23	18	2.52E+03	3.08E+01	3.35E-01	2.52E+03	5.56E+03	5.05E+00	0.103
	8	24	20	2.15E+03	2.62E+01	2.85E-01	2.15E+03	4.73E+03	4.29E+00	0.087
	8	25	22	2.48E+03	3.02E+01	3.29E-01	2.48E+03	5.46E+03	4.95E+00	0.101
	8	26	24	2.52E+03	3.08E+01	3.35E-01	2.52E+03	5.56E+03	5.05E+00	0.103
	8	27	26	1.98E+03	2.42E+01	2.63E-01	1.98E+03	4.37E+03	3.96E+00	0.081
	8	28	28	2.43E+03	2.97E+01	3.22E-01	2.43E+03	5.35E+03	4.86E+00	0.099
	8	29	30	1.79E+03	2.19E+01	2.38E-01	1.79E+03	3.95E+03	3.58E+00	0.073
CB-5 to CB-6	8	Zero	2	2.45E+03	3.00E+01	3.26E-01	2.45E+03	5.40E+03	4.90E+00	0.100
	8	1	4	2.07E+03	2.53E+01	2.75E-01	2.07E+03	4.57E+03	4.15E+00	0.085
	8	2	6	2.12E+03	2.59E+01	2.82E-01	2.12E+03	4.68E+03	4.24E+00	0.087
	8	3	8	1.84E+03	2.25E+01	2.44E-01	1.84E+03	4.05E+03	3.68E+00	0.075
	8	4	10	2.50E+03	3.05E+01	3.32E-01	2.50E+03	5.51E+03	5.00E+00	0.102
	8	5	12	1.79E+03	2.19E+01	2.38E-01	1.79E+03	3.95E+03	3.58E+00	0.073
	8	6	14	2.48E+03	3.02E+01	3.29E-01	2.48E+03	5.46E+03	4.95E+00	0.101
	8	7	16	2.05E+03	2.51E+01	2.72E-01	2.05E+03	4.52E+03	4.10E+00	0.084

FSS RELEASE RECORD
NORTH YARD STORM DRAIN BURIED PIPING
SURVEY UNIT 00150A/B & C



North Yard Storm Drain Buried Pipe FSS Measurements (continued)

PIPE	PIPE ID	POSITION	FEET INTO PIPE	GROSS GAMMA ACTIVITY (dpm/100cm ²)	Co-60 (dpm/100cm ²)	Cs-134 (dpm/100cm ²)	Cs-137 (dpm/100cm ²)	Ni-63 (dpm/100cm ²)	Sr-90 (dpm/100cm ²)	OpSOF
CB-5 to CB-6	8	8	18	1.93E+03	2.36E+01	2.57E-01	1.93E+03	4.26E+03	3.87E+00	0.079
	8	9	20	2.40E+03	2.94E+01	3.19E-01	2.40E+03	5.30E+03	4.81E+00	0.098
	8	10	22	2.48E+03	3.02E+01	3.29E-01	2.48E+03	5.46E+03	4.95E+00	0.101
	8	11	24	2.36E+03	2.88E+01	3.13E-01	2.36E+03	5.20E+03	4.72E+00	0.096
	8	12	26	2.29E+03	2.79E+01	3.04E-01	2.29E+03	5.04E+03	4.57E+00	0.093
	8	13	28	2.40E+03	2.94E+01	3.19E-01	2.40E+03	5.30E+03	4.81E+00	0.098
	8	14	30	2.15E+03	2.62E+01	2.85E-01	2.15E+03	4.73E+03	4.29E+00	0.087
	8	15	32	2.07E+03	2.53E+01	2.75E-01	2.07E+03	4.57E+03	4.15E+00	0.085
	8	16	34	2.33E+03	2.85E+01	3.10E-01	2.33E+03	5.14E+03	4.67E+00	0.095
	8	17	36	2.55E+03	3.11E+01	3.38E-01	2.55E+03	5.61E+03	5.09E+00	0.104
	8	18	38	2.17E+03	2.65E+01	2.88E-01	2.17E+03	4.78E+03	4.34E+00	0.088
	8	19	40	2.36E+03	2.88E+01	3.13E-01	2.36E+03	5.20E+03	4.72E+00	0.096
CB-7 to Capped pipe	8	Zero	1	2.15E+03	2.62E+01	2.85E-01	2.15E+03	4.73E+03	4.29E+00	0.087
	8	1	2	2.07E+03	2.53E+01	2.75E-01	2.07E+03	4.57E+03	4.15E+00	0.085
	8	2	3	2.10E+03	2.56E+01	2.79E-01	2.10E+03	4.63E+03	4.20E+00	0.086
	8	3	4	2.33E+03	2.85E+01	3.10E-01	2.33E+03	5.14E+03	4.67E+00	0.095
	8	4	5	2.33E+03	2.85E+01	3.10E-01	2.33E+03	5.14E+03	4.67E+00	0.095
	8	5	6	2.36E+03	2.88E+01	3.13E-01	2.36E+03	5.20E+03	4.72E+00	0.096
	8	6	7	1.91E+03	2.33E+01	2.54E-01	1.91E+03	4.21E+03	3.82E+00	0.078
	8	7	8	3.73E+03	4.55E+01	4.95E-01	3.73E+03	8.21E+03	7.45E+00	0.152
	8	8	9	2.62E+03	3.20E+01	3.47E-01	2.62E+03	5.77E+03	5.23E+00	0.107
	8	9	10	2.48E+03	3.02E+01	3.29E-01	2.48E+03	5.46E+03	4.95E+00	0.101
	8	10	11	2.31E+03	2.82E+01	3.07E-01	2.31E+03	5.09E+03	4.62E+00	0.094
	8	11	12	2.24E+03	2.74E+01	2.97E-01	2.24E+03	4.94E+03	4.48E+00	0.091
	8	12	13	2.05E+03	2.51E+01	2.72E-01	2.05E+03	4.52E+03	4.10E+00	0.084
	8	13	14	2.05E+03	2.51E+01	2.72E-01	2.05E+03	4.52E+03	4.10E+00	0.084
	8	14	15	2.22E+03	2.71E+01	2.94E-01	2.22E+03	4.88E+03	4.43E+00	0.090
CB-7 to CB-6	12	Zero	2	3.18E+03	3.88E+01	4.22E-01	3.18E+03	7.01E+03	6.36E+00	0.130
	12	1	4	3.05E+03	3.72E+01	4.04E-01	3.05E+03	6.71E+03	6.09E+00	0.124

FSS RELEASE RECORD
NORTH YARD STORM DRAIN BURIED PIPING
SURVEY UNIT 00150A/B & C



North Yard Storm Drain Buried Pipe FSS Measurements (continued)

PIPE	PIPE ID	POSITION	FEET INTO PIPE	GROSS GAMMA ACTIVITY (dpm/100cm ²)	Co-60 (dpm/100cm ²)	Cs-134 (dpm/100cm ²)	Cs-137 (dpm/100cm ²)	Ni-63 (dpm/100cm ²)	Sr-90 (dpm/100cm ²)	OpSOF
CB-7 to CB-6	12	2	6	3.09E+03	3.77E+01	4.10E-01	3.09E+03	6.81E+03	6.18E+00	0.126
	12	3	8	3.27E+03	3.99E+01	4.34E-01	3.27E+03	7.21E+03	6.54E+00	0.133
	12	4	10	2.91E+03	3.56E+01	3.87E-01	2.91E+03	6.42E+03	5.82E+00	0.119
	12	5	12	3.00E+03	3.67E+01	3.98E-01	3.00E+03	6.61E+03	6.00E+00	0.122
	12	6	14	2.91E+03	3.56E+01	3.87E-01	2.91E+03	6.42E+03	5.82E+00	0.119
	12	7	16	2.71E+03	3.31E+01	3.60E-01	2.71E+03	5.97E+03	5.42E+00	0.110
	12	8	18	3.11E+03	3.80E+01	4.13E-01	3.11E+03	6.86E+03	6.23E+00	0.127
	12	9	20	3.20E+03	3.91E+01	4.25E-01	3.20E+03	7.06E+03	6.40E+00	0.131
	12	10	22	3.14E+03	3.83E+01	4.16E-01	3.14E+03	6.91E+03	6.27E+00	0.128
	12	11	24	3.52E+03	4.29E+01	4.67E-01	3.52E+03	7.75E+03	7.03E+00	0.143
	12	12	26	3.25E+03	3.97E+01	4.31E-01	3.25E+03	7.16E+03	6.49E+00	0.132
	12	13	28	2.75E+03	3.36E+01	3.66E-01	2.75E+03	6.07E+03	5.51E+00	0.112
	12	14	30	2.66E+03	3.26E+01	3.54E-01	2.66E+03	5.87E+03	5.33E+00	0.109
	12	15	32	3.09E+03	3.77E+01	4.10E-01	3.09E+03	6.81E+03	6.18E+00	0.126
	12	16	34	3.05E+03	3.72E+01	4.04E-01	3.05E+03	6.71E+03	6.09E+00	0.124
	12	17	36	2.66E+03	3.26E+01	3.54E-01	2.66E+03	5.87E+03	5.33E+00	0.109
	12	18	38	2.80E+03	3.42E+01	3.72E-01	2.80E+03	6.17E+03	5.60E+00	0.114
	12	19	40	3.02E+03	3.69E+01	4.01E-01	3.02E+03	6.66E+03	6.05E+00	0.123
	12	20	42	3.09E+03	3.77E+01	4.10E-01	3.09E+03	6.81E+03	6.18E+00	0.126
	12	21	44	3.18E+03	3.88E+01	4.22E-01	3.18E+03	7.01E+03	6.36E+00	0.130
	12	22	46	3.52E+03	4.29E+01	4.67E-01	3.52E+03	7.75E+03	7.03E+00	0.143
	12	23	48	3.02E+03	3.69E+01	4.01E-01	3.02E+03	6.66E+03	6.05E+00	0.123
	12	24	50	3.18E+03	3.88E+01	4.22E-01	3.18E+03	7.01E+03	6.36E+00	0.130
	12	25	52	2.96E+03	3.61E+01	3.92E-01	2.96E+03	6.52E+03	5.91E+00	0.121
	12	26	54	3.29E+03	4.02E+01	4.37E-01	3.29E+03	7.26E+03	6.58E+00	0.134
	12	27	56	2.73E+03	3.34E+01	3.63E-01	2.73E+03	6.02E+03	5.46E+00	0.111
	12	28	58	2.40E+03	2.93E+01	3.18E-01	2.40E+03	5.28E+03	4.79E+00	0.098
	12	29	60	3.11E+03	3.80E+01	4.13E-01	3.11E+03	6.86E+03	6.23E+00	0.127
CB-7 to E. Ditch	15	Zero	2	4.41E+03	5.39E+01	5.85E-01	4.41E+03	9.72E+03	8.82E+00	0.180

FSS RELEASE RECORD
NORTH YARD STORM DRAIN BURIED PIPING
SURVEY UNIT 00150A/B & C



North Yard Storm Drain Buried Pipe FSS Measurements (continued)

PIPE	PIPE ID	POSITION	FEET INTO PIPE	GROSS GAMMA ACTIVITY (dpm/100cm ²)	Co-60 (dpm/100cm ²)	Cs-134 (dpm/100cm ²)	Cs-137 (dpm/100cm ²)	Ni-63 (dpm/100cm ²)	Sr-90 (dpm/100cm ²)	OpSOF
CB-7 to E. Ditch	15	1	4	3.62E+03	4.43E+01	4.81E-01	3.62E+03	7.99E+03	7.25E+00	0.148
	15	2	6	3.97E+03	4.85E+01	5.27E-01	3.97E+03	8.76E+03	7.95E+00	0.162
	15	3	8	3.71E+03	4.53E+01	4.93E-01	3.71E+03	8.18E+03	7.42E+00	0.151
	15	4	10	3.97E+03	4.85E+01	5.27E-01	3.97E+03	8.76E+03	7.95E+00	0.162
	15	5	12	3.14E+03	3.84E+01	4.17E-01	3.14E+03	6.93E+03	6.29E+00	0.128
	15	6	14	3.58E+03	4.37E+01	4.75E-01	3.58E+03	7.89E+03	7.16E+00	0.146
	15	7	16	4.50E+03	5.49E+01	5.97E-01	4.50E+03	9.91E+03	8.99E+00	0.183
	15	8	18	6.77E+03	8.27E+01	8.98E-01	6.77E+03	1.49E+04	1.35E+01	0.276
	15	9	20	4.63E+03	5.65E+01	6.14E-01	4.63E+03	1.02E+04	9.26E+00	0.189
	15	10	22	4.19E+03	5.12E+01	5.56E-01	4.19E+03	9.24E+03	8.38E+00	0.171
	15	11	24	4.37E+03	5.33E+01	5.80E-01	4.37E+03	9.62E+03	8.73E+00	0.178
	15	12	26	3.36E+03	4.11E+01	4.46E-01	3.36E+03	7.41E+03	6.72E+00	0.137
	15	13	28	3.71E+03	4.53E+01	4.93E-01	3.71E+03	8.18E+03	7.42E+00	0.151
	15	14	30	4.28E+03	5.23E+01	5.68E-01	4.28E+03	9.43E+03	8.56E+00	0.174
	15	15	32	3.93E+03	4.80E+01	5.22E-01	3.93E+03	8.66E+03	7.86E+00	0.160
	15	16	34	4.06E+03	4.96E+01	5.39E-01	4.06E+03	8.95E+03	8.12E+00	0.166
	15	17	36	3.97E+03	4.85E+01	5.27E-01	3.97E+03	8.76E+03	7.95E+00	0.162
	15	18	38	4.58E+03	5.60E+01	6.09E-01	4.58E+03	1.01E+04	9.17E+00	0.187
	15	19	40	6.24E+03	7.63E+01	8.29E-01	6.24E+03	1.38E+04	1.25E+01	0.255
	15	20	42	4.71E+03	5.76E+01	6.26E-01	4.71E+03	1.04E+04	9.43E+00	0.192
	15	21	44	4.10E+03	5.01E+01	5.45E-01	4.10E+03	9.04E+03	8.21E+00	0.167
	15	22	46	4.41E+03	5.39E+01	5.85E-01	4.41E+03	9.72E+03	8.82E+00	0.180
	15	23	48	3.89E+03	4.75E+01	5.16E-01	3.89E+03	8.56E+03	7.77E+00	0.158
	15	24	50	4.45E+03	5.44E+01	5.91E-01	4.45E+03	9.81E+03	8.91E+00	0.182
	15	25	52	4.89E+03	5.97E+01	6.49E-01	4.89E+03	1.08E+04	9.78E+00	0.199
	15	26	54	4.45E+03	5.44E+01	5.91E-01	4.45E+03	9.81E+03	8.91E+00	0.182
	15	27	56	4.98E+03	6.08E+01	6.61E-01	4.98E+03	1.10E+04	9.95E+00	0.203
	15	28	58	5.11E+03	6.24E+01	6.78E-01	5.11E+03	1.13E+04	1.02E+01	0.208
	15	29	60	5.94E+03	7.25E+01	7.88E-01	5.94E+03	1.31E+04	1.19E+01	0.242

ATTACHMENT 3
SIGN TEST

FSS RELEASE RECORD
NORTH YARD STORM DRAIN BURIED PIPING
SURVEY UNIT 00150A/B & C



Sign Test – North Yard Storm Drain Buried Pipe

Survey Area	00150	Survey Area	NORTH YARD DRAIN PIPE
Survey Unit	00150A, B & C	Survey Unit	6, 8, 12 and 15-inch ID Buried Pipe
Classification	2	Type I Error	0.05
		Number of Measurements	272

#	SOF (Ws)	1-Ws	Sign
1	0.093	0.907	+1
2	0.118	0.882	+1
3	0.091	0.909	+1
4	0.069	0.931	+1
5	0.075	0.925	+1
6	0.098	0.902	+1
7	0.076	0.924	+1
8	0.092	0.908	+1
9	0.129	0.871	+1
10	0.129	0.871	+1
11	0.103	0.897	+1
12	0.118	0.882	+1
13	0.112	0.888	+1
14	0.103	0.897	+1
15	0.096	0.904	+1
16	0.093	0.907	+1
17	0.083	0.917	+1
18	0.108	0.892	+1
19	0.112	0.888	+1
20	0.084	0.916	+1
21	0.084	0.916	+1
22	0.075	0.925	+1
23	0.095	0.905	+1
24	0.087	0.913	+1
25	0.090	0.910	+1
26	0.094	0.906	+1
27	0.081	0.919	+1
28	0.089	0.911	+1
29	0.085	0.915	+1
30	0.084	0.916	+1
31	0.081	0.919	+1
32	0.088	0.912	+1
33	0.105	0.895	+1

#	SOF (Ws)	1-Ws	Sign
137	0.090	0.910	+1
138	0.087	0.913	+1
139	0.101	0.899	+1
140	0.083	0.917	+1
141	0.089	0.911	+1
142	0.084	0.916	+1
143	0.087	0.913	+1
144	0.078	0.922	+1
145	0.101	0.899	+1
146	0.092	0.908	+1
147	0.094	0.906	+1
148	0.076	0.924	+1
149	0.085	0.915	+1
150	0.102	0.898	+1
151	0.080	0.920	+1
152	0.082	0.918	+1
153	0.074	0.926	+1
154	0.078	0.922	+1
155	0.091	0.909	+1
156	0.077	0.923	+1
157	0.073	0.927	+1
158	0.084	0.916	+1
159	0.086	0.914	+1
160	0.081	0.919	+1
161	0.096	0.904	+1
162	0.087	0.913	+1
163	0.076	0.924	+1
164	0.096	0.904	+1
165	0.068	0.932	+1
166	0.085	0.915	+1
167	0.088	0.912	+1
168	0.086	0.914	+1
169	0.087	0.913	+1

Sign Test – North Yard Storm Drain Buried Pipe (continued)

#	SOF (Ws)	1-Ws	Sign
34	0.114	0.886	+1
35	0.075	0.925	+1
36	0.062	0.938	+1
37	0.079	0.921	+1
38	0.071	0.929	+1
39	0.084	0.916	+1
40	0.092	0.908	+1
41	0.095	0.905	+1
42	0.101	0.899	+1
43	0.071	0.929	+1
44	0.071	0.929	+1
45	0.075	0.925	+1
46	0.109	0.891	+1
47	0.112	0.888	+1
48	0.089	0.911	+1
49	0.087	0.913	+1
50	0.106	0.894	+1
51	0.104	0.896	+1
52	0.098	0.902	+1
53	0.096	0.904	+1
54	0.113	0.887	+1
55	0.114	0.886	+1
56	0.107	0.893	+1
57	0.135	0.865	+1
58	0.112	0.888	+1
59	0.107	0.893	+1
60	0.136	0.864	+1
61	0.117	0.883	+1
62	0.129	0.871	+1
63	0.117	0.883	+1
64	0.136	0.864	+1
65	0.117	0.883	+1
66	0.134	0.866	+1
67	0.132	0.868	+1
68	0.114	0.886	+1
69	0.107	0.893	+1
70	0.104	0.896	+1
71	0.093	0.907	+1

#	SOF (Ws)	1-Ws	Sign
170	0.104	0.896	+1
171	0.103	0.897	+1
172	0.087	0.913	+1
173	0.101	0.899	+1
174	0.103	0.897	+1
175	0.081	0.919	+1
176	0.099	0.901	+1
177	0.073	0.927	+1
178	0.100	0.900	+1
179	0.085	0.915	+1
180	0.087	0.913	+1
181	0.075	0.925	+1
182	0.102	0.898	+1
183	0.073	0.927	+1
184	0.101	0.899	+1
185	0.084	0.916	+1
186	0.079	0.921	+1
187	0.098	0.902	+1
188	0.101	0.899	+1
189	0.096	0.904	+1
190	0.093	0.907	+1
191	0.098	0.902	+1
192	0.087	0.913	+1
193	0.085	0.915	+1
194	0.095	0.905	+1
195	0.104	0.896	+1
196	0.088	0.912	+1
197	0.096	0.904	+1
198	0.087	0.913	+1
199	0.085	0.915	+1
200	0.086	0.914	+1
201	0.095	0.905	+1
202	0.095	0.905	+1
203	0.096	0.904	+1
204	0.078	0.922	+1
205	0.152	0.848	+1
206	0.107	0.893	+1
207	0.101	0.899	+1

Sign Test – North Yard Storm Drain Buried Pipe (continued)

#	SOF (Ws)	1-Ws	Sign
72	0.094	0.906	+1
73	0.103	0.897	+1
74	0.089	0.911	+1
75	0.088	0.912	+1
76	0.112	0.888	+1
77	0.090	0.910	+1
78	0.128	0.872	+1
79	0.098	0.902	+1
80	0.113	0.887	+1
81	0.089	0.911	+1
82	0.093	0.907	+1
83	0.075	0.925	+1
84	0.095	0.905	+1
85	0.110	0.890	+1
86	0.083	0.917	+1
87	0.114	0.886	+1
88	0.101	0.899	+1
89	0.113	0.887	+1
90	0.100	0.900	+1
91	0.096	0.904	+1
92	0.112	0.888	+1
93	0.104	0.896	+1
94	0.084	0.916	+1
95	0.090	0.910	+1
96	0.091	0.909	+1
97	0.090	0.910	+1
98	0.082	0.918	+1
99	0.079	0.921	+1
100	0.089	0.911	+1
101	0.096	0.904	+1
102	0.083	0.917	+1
103	0.087	0.913	+1
104	0.074	0.926	+1
105	0.092	0.908	+1
106	0.092	0.908	+1
107	0.094	0.906	+1
108	0.102	0.898	+1
109	0.096	0.904	+1

#	SOF (Ws)	1-Ws	Sign
208	0.094	0.906	+1
209	0.091	0.909	+1
210	0.084	0.916	+1
211	0.084	0.916	+1
212	0.090	0.910	+1
213	0.130	0.870	+1
214	0.124	0.876	+1
215	0.126	0.874	+1
216	0.133	0.867	+1
217	0.119	0.881	+1
218	0.122	0.878	+1
219	0.119	0.881	+1
220	0.110	0.890	+1
221	0.127	0.873	+1
222	0.131	0.869	+1
223	0.128	0.872	+1
224	0.143	0.857	+1
225	0.132	0.868	+1
226	0.112	0.888	+1
227	0.109	0.891	+1
228	0.126	0.874	+1
229	0.124	0.876	+1
230	0.109	0.891	+1
231	0.114	0.886	+1
232	0.123	0.877	+1
233	0.126	0.874	+1
234	0.130	0.870	+1
235	0.143	0.857	+1
236	0.123	0.877	+1
237	0.130	0.870	+1
238	0.121	0.879	+1
239	0.134	0.866	+1
240	0.111	0.889	+1
241	0.098	0.902	+1
242	0.127	0.873	+1
243	0.180	0.820	+1
244	0.148	0.852	+1
245	0.162	0.838	+1

Sign Test – North Yard Storm Drain Buried Pipe (continued)

#	SOF (Ws)	1-Ws	Sign
110	0.094	0.906	+1
111	0.080	0.920	+1
112	0.080	0.920	+1
113	0.072	0.928	+1
114	0.091	0.909	+1
115	0.074	0.926	+1
116	0.089	0.911	+1
117	0.088	0.912	+1
118	0.090	0.910	+1
119	0.087	0.913	+1
120	0.068	0.932	+1
121	0.094	0.906	+1
122	0.079	0.921	+1
123	0.100	0.900	+1
124	0.064	0.936	+1
125	0.086	0.914	+1
126	0.105	0.895	+1
127	0.112	0.888	+1
128	0.110	0.890	+1
129	0.076	0.924	+1
130	0.096	0.904	+1
131	0.092	0.908	+1
132	0.087	0.913	+1
133	0.098	0.902	+1
134	0.110	0.890	+1
135	0.085	0.915	+1
136	0.100	0.900	+1

#	SOF (Ws)	1-Ws	Sign
246	0.151	0.849	+1
247	0.162	0.838	+1
248	0.128	0.872	+1
249	0.146	0.854	+1
250	0.183	0.817	+1
251	0.276	0.724	+1
252	0.189	0.811	+1
253	0.171	0.829	+1
254	0.178	0.822	+1
255	0.137	0.863	+1
256	0.151	0.849	+1
257	0.174	0.826	+1
258	0.160	0.840	+1
259	0.166	0.834	+1
260	0.162	0.838	+1
261	0.187	0.813	+1
262	0.255	0.745	+1
263	0.192	0.808	+1
264	0.167	0.833	+1
265	0.180	0.820	+1
266	0.158	0.842	+1
267	0.182	0.818	+1
268	0.199	0.801	+1
269	0.182	0.818	+1
270	0.203	0.797	+1
271	0.208	0.792	+1
272	0.242	0.758	+1

Number of positive differences (S+) 272

Critical Value 150

The Survey Unit MEETS the Acceptance Criteria

ATTACHMENT 4
QC DATA ASSESSMENT

Attachment 4 – QC Data Assessment

NORTH YARD STORM DRAIN BURIED PIPE – QC AGREEMENT

Survey Unit # 00150 Survey Unit Name North Yard Storm Drain Buried Pipe
Sample Plan # S2-00150A, B & C

Sample Description: Comparison of replicate gross-gamma measurements for QC from within the various Pipe ID sections that make up the North Yard Storm Drain pipe.

STANDARD				REPLICATE		
ID	ACTIVITY (dpm/100cm ²)	+20% (dpm/100cm ²)	-20% (dpm/100cm ²)	ID	ACTIVITY (dpm/100cm ²)	ACCEPTABLE (Y/N)
CB-8 to CB-9	2.36E+03	2.83E+03	1.88E+03	30QC	2.77E+03	Y
CB-8 to CB-9	2.20E+03	2.64E+03	1.76E+03	50QC	2.29E+03	Y
CB-8 to CB-1	2.25E+03	2.70E+03	1.80E+03	30QC	2.11E+03	Y
CB-1 to CB-2	2.81E+03	3.37E+03	2.24E+03	20QC	2.80E+03	Y
CB-1 to CB-2	3.23E+03	3.87E+03	2.58E+03	44QC	2.78E+03	Y
CB-2 to CB-3	2.81E+03	3.37E+03	2.24E+03	40QC	2.29E+03	Y
CB-2 to CB-3	1.93E+03	2.32E+03	1.55E+03	24QC	2.22E+03	Y
CB-3 to CB-4	2.12E+03	2.55E+03	1.70E+03	24QC	2.17E+03	Y
CB-3 to CB-4	2.48E+03	2.97E+03	1.98E+03	24QC	2.24E+03	Y
CB-4 to CB-5	1.79E+03	2.15E+03	1.43E+03	20QC	2.10E+03	Y
CB-4 to CB-5	2.15E+03	2.57E+03	1.72E+03	20QC	1.46E+03	N
CB-5 to CB-6	2.40E+03	2.89E+03	1.92E+03	20QC	2.36E+03	Y
CB-5 to CB-6	2.55E+03	3.06E+03	2.04E+03	36QC	2.07E+03	Y
CB-7	3.73E+03	4.47E+03	2.98E+03	8QC	2.57E+03	N
CB-7	2.66E+03	3.20E+03	2.13E+03	30QC	3.05E+03	Y
CB-7	3.18E+03	3.82E+03	2.54E+03	50QC	2.55E+03	Y
CB-7	4.28E+03	5.13E+03	3.42E+03	30QC	4.02E+03	Y
CB-7	4.45E+03	5.34E+03	3.56E+03	50QC	4.37E+03	Y
Comments/Corrective Actions: Using the acceptance criteria specified in section 4.1.2 of ZS-LT-01, there was acceptable agreement between the replicate measurements and the original measurement in 16 of the 18 comparisons. Two (2) QC measurements did not fall within 20% of the original measurement. For pipe 8-inch ID pipe between CB-4 and CB-5, the 20 ft. measurement was approximately 32% less than the original measurement. For the 12-inch pipe out of CB-7, the 8 ft. measurement was approximately 31% less than the original measurement. All measurements were well below 50% of the DCGL and the instrument and detector passed the post use response check. No further action was deemed necessary.				The acceptance criteria for replicate static measurements and scan surveys is that the same conclusion is reached for each measurement. That is defined as $\pm 20\%$ of the standard		