

# **Background Reference Area Report**

## **Zion Nuclear Power Station**

### **Zion, IL**

**Project No 313162**

**Revision 0**

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- ☒ New Report
- ☐ Title Change
- ☐ Report Revision
- ☐ Report Re-Write
- ☐ Cancellation

Effective  
Date 2-7-2012

### **EXECUTIVE SUMMARY**

This Background Reference Area Report provides a summary of the survey activities performed and their results in order to assess the levels of natural radioactivity within the environment and building materials at the Zion Nuclear Power Station located at Zion, Illinois. The primary purpose was to identify and quantify the levels of natural activity, including fallout, within soils and construction materials in support of unconditional release and license termination. This includes the unconditional release and potential re-use of concrete and soils originating at the Zion Nuclear Power Station as backfill materials.

As summarized in this report, the background levels of radioactivity in materials are presented as measured both by beta and gamma scan surveys and direct static measurements as well as sampling for volumetric activity for representative materials. Specific materials of concern addressed within this report include asphalt, concrete, and soil.

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**LIST OF ACRONYMS AND ABBREVIATIONS**

|         |   |
|---------|---|
| cm      | centimeter  |
| Co      | cobalt  |
| cpm     | counts per minute   |
| Cs      | cesium  |
| dpm     | disintegrations per minute                                  |
| DQO     | data quality objectives                                     |
| GPS     | global positioning system                                   |
| GPR     | ground penetrating radar                                    |
| MARSSIM | Multi-Agency Radiation Survey and Site Investigation Manual |
| MDA     | minimum detectable activity                                 |
| MDC     | minimum detectable concentration                            |
| MDCR    | minimum detectable count rate                               |
| NaI     | sodium iodide   |
| NIST    | National Institute of Standards and Technology              |
| pCi/g   | pico-curies per gram  |
| QA      | quality assurance   |
| QC      | quality control   |
| RPD     | relative percent difference                                 |
| TAT     | turn-around time  |
| USNRC   | United State Nuclear Regulatory Commission                  |

## **1.0 INTRODUCTION**

The Zion Nuclear Power Station is located at 101 Shiloh Boulevard, Zion, Illinois. The facility is currently undergoing decommissioning activities managed by *ZionSolutions*, LLC with the ultimate goal of license termination. To support the release of the facility, *EnergySolutions*, LLC was selected by *ZionSolutions*, LLC to develop a Plan for performing surveys and sampling in order to assess the levels of natural radioactivity including historical fallout in background that would be present at the facility.

Because there is natural radioactivity and historical fallout in the environment (i.e., background), it is necessary to assess the levels of activity in order to differentiate between activity found in nature and any residual activity that may be present as a result of licensed activities. This was performed through the selection of reference background areas known to be unaffected by plant operations to ensure any measured radioactivity would be of natural origin. It was determined that the best location for measuring background would be outside the restricted area boundary toward the north as based in part on Reference 6.1, Annual Report on the Meteorological Monitoring Program at Zion Nuclear Power Station for 2010, Murray and Trettel, Inc. 2/21/2011, which demonstrates that winds are predominately from the west and northwest. As a result, locations north and northwest of the restricted area are less likely to be impacted by airborne particulate and gaseous effluents from past plant operations.

Additionally, it is necessary to ensure the background reference areas are representative of the materials and areas to be surveyed at the facility for release. This includes soils of similar geology and construction materials of similar age and content. As a result, the reference area(s) should be located as near the facility as possible and representative of the construction of the plant. It was determined, based upon this selection criterion, that the area around the former Visitors Center would be representative of background at the site. Figure 1-1 shows a site map and the background survey locations used to document the levels of natural activity in background.



Figure 1-1 Background Survey Reference Area(s)

## **2.0 ORGANIZATION**

The project team performing the background surveys consisted of a Project Manager/Supervisor supported by two Radiation Protection Technicians and subcontract labor for the collection of background samples including core samples of soil, asphalt and concrete. A summary of the roles and responsibilities is provided as follows:

### **2.1 EnergySolutions Project Manager - PM**

The EnergySolutions PM was the primary interface with ZionSolutions, LLC. The PM was responsible for managing the project team and ensuring the successful completion of the background surveys. The PM provided the necessary field supervision for the crew and oversaw all field work while interfacing with the ZionSolutions, LLC staff to ensure the surveys were performed in accordance with the proper plans, procedures and project site requirements. The PM was also responsible for ensuring that everyone was properly trained.

### **2.2 ZionSolutions, LLC Characterization/License Termination Manager**

The ZionSolutions, LLC Characterization/License Termination Manager was the primary interface for the project. ZionSolutions, LLC provided all the required site-specific training for EnergySolutions, LLC personnel and subcontractors and secured space for the storage of EnergySolutions instruments, check sources and equipment. ZionSolutions also assisted in obtaining the necessary excavation permit required for soil sampling.

### **2.3 Radiation ProtectionTechnician(s) - RPTs**

Two RPTs supported the background survey effort. They were responsible for the overall performance of the surveys and oversaw the collection of samples by the subcontractor in accordance with the Characterization Plan. They performed all radiological surveys and sample handling and reported to the EnergySolutions PM.

### **2.4 Subcontract Labor**

Subcontract labor was used for the collection of all background samples including direct push sampling for soils as well as core and rubble samples of asphalt and concrete. The subcontract labor was responsible for following the project plans and procedures as directed by the RPTs and the PM.

## **3.0 QUALITY ASSURANCE AND QUALITY CONTROL**

The EnergySolutions, LLC Quality Assurance/Quality Control (QA/QC) Program was utilized to ensure that all quality and regulatory requirements were satisfied. All activities affecting quality were controlled by following written plans and procedures. The QA/QC implementation included the following measures.



### 3.1 Selection of Personnel

Personnel were selected having the proper training and experience in the performance of surveys and the collection of samples. The EnergySolutions PM was a Health Physicist with over ten years experience in survey and sampling activities, including the performance of characterization surveys. All project personnel were also familiar with the requirements of the Characterization Plan, the instrumentation and equipment used for the surveys and all implementing procedures.

### 3.2 Training

All project personnel, including subcontractors who performed sampling activities, received site-specific training as required by ZionSolutions, LLC and EnergySolutions, LLC. The training included information about site-specific hazards that were present, emergency response procedures and other facility access requirements. All personnel and subcontractors performed work in accordance with company safety guidelines and ZionSolutions, LLC safety requirements.

Personnel reviewed the Characterization Plan and applicable procedures as provided in Table 3-1. These were used as the basis for performing the background surveys. Any personnel unfamiliar with the specific instrumentation and/or equipment utilized received training on its proper operation. All training was documented as necessary.

### 3.3 Plans and Procedures

All activities affecting quality were controlled by approved plans and procedures. Table 3-1 provides a list of the EnergySolutions, LLC approved procedures that were used during the background study for the control of instrumentation and the performance of surveys.

**Table 3-1 Procedure List**

| <b>Document</b> | <b>EnergySolutions Program / Procedure</b>   |
|-----------------|--|
| CS-AD-PR-002    | Commercial Services Project Records  |
| CS-FO-PR-001    | Performance of Radiological Surveys  |
| CS-FO-PR-002    | Calibration and Maintenance of Radiological Survey Instruments                                 |
| CS-FO-PR-003    | Soil Surveys, Collection of Water, Sediment, Vegetation and Soil Samples, and Chain-of-Custody |
| CS-FO-PR-004    | QA/QC of Portable Radiological Survey Instruments  |
| CS-FO-PR-005    | General Operation of Radiological Survey Instruments   |

The Characterization Plan provided specific guidance on the performance of the background surveys and specified the types and numbers of measurements to be

performed and samples collected. This Plan also specified the instrumentation to be used, the type of laboratory sample analysis performed, and the required detection sensitivities associated with various measurements and analyses.

The operating procedures, as listed, specified the proper instrument controls to ensure their proper operation. The procedures also specified the proper sample handling and control requirements.

### 3.4 Instrumentation

#### 3.4.1. Instrument Selection

Table 3-2 identifies the radiological instrumentation that was used for the background survey including their use and estimated detection sensitivities. Actual instrument sensitivities are documented on the surveys and in the sample analysis reports.

**Table 3-2 Survey Instrumentation**

| Instrument   | Typical Sensitivity                             | Use   |
|--|---|---|
| Model 2350-1<br>Data Logger  | NA  | Microprocessor based ratemeter / scalar counter for use with a variety of detectors |
| Model 43-37<br>(584 cm <sup>2</sup> active area; 430 cm <sup>2</sup> open) | 1,000 – 5,000 dpm/100 cm <sup>2</sup>           | Gas flow detector used for surface activity measurements and scans ( $\beta$ )      |
| Model 43-68<br>(126 cm <sup>2</sup> active area; 100 cm <sup>2</sup> open) | 300 – 1,500 dpm/100 cm <sup>2</sup>             | Gas flow detector used for surface activity measurements and scans ( $\beta$ )      |
| Model 44-10<br>(2x2 NaI crystal)   | Nuclide specific<br>(1 – 10 pCi/g : $\mu$ R/hr) | Sodium Iodide detector used for open land surveys ( $\gamma$ emitters)              |
| HPGe   | Nuclide specific<br>(0.1-1 pCi/g)               | Nuclide identification and quantification ( $\gamma$ emitters)                      |

Note: Typical sensitivities are dependent upon the mode of operation. The low end of the range corresponds to fixed point measurements while the higher end of the range corresponds to scanning sensitivities. Actual detection sensitivities are documented as part of the survey documentation.

Survey instruments were chosen based upon the radionuclides of concern (both in natural background and licensed activities), their emissions and any required detection sensitivities as established by ZionSolutions, LLC. A Ludlum Model 2350-1 Data Logger was used in combination with Model 43-37 large area gas flow proportional detector to perform beta scans on asphalt and concrete surfaces while the Ludlum Model 43-68 gas flow proportional detector was used to obtain static measurements for total gross beta activity.

A Ludlum Model 44-10 sodium iodide detector (NaI) in combination with the Data Logger was used for obtaining count rate measurements over soil

areas. A portable GPS unit was used in conjunction with the survey instruments to collect location coordinates for reproducibility for the open land surveys. The Trimble handheld GPS unit with a backpack-mounted antenna recorded the GPS location for each one-second integrated count that was collected as part of the scans. The GPS unit was also used to record the location of each static gamma measurements and sampling location.

A high purity germanium (HPGe) gamma spectroscopy system was used by the off-site laboratory for the identification and quantification of specific radionuclides in volumetric samples.

#### 3.4.2. Calibration

All instrumentation used were calibrated on an annual basis using National Institute of Standards and Technology (NIST) traceable sources and calibration equipment using sources representative of the emissions and energies being surveyed.

Instrument calibration typically includes the following as applicable:

- High voltage calibration
- Scaler calibration verification
- Discriminator/threshold calibration
- Alarm operation verification
- Operating voltage determinations for detectors
- Determination of calibration constants
- Calibration Source Response
- Dead time correction determinations

Calibration labels showing the instrument identification number, calibration date, and calibration due date were attached to all instruments and verified daily to ensure the instrument was within calibration prior to use. All instruments were also inspected and response checked using an appropriate radiation source prior to use to ensure they were operating properly and within established acceptance criteria.

#### 3.4.3. Instrument Response Tests and Inspection

Upon receipt, all project instrumentation calibrations were verified, instruments inspected and initial response test data collected. These initial measurements were used to establish instrument performance standards (response ranges) in which the instruments were tested against on a daily basis prior to and after each use. The daily response tests were compared to these performance standards to ensure the instruments were functioning properly. When an instrument failed a response test, the results were investigated to determine the cause of failure. In the event that an instrument was not functioning properly, the instrument was removed from service for repair and re-calibration as necessary.

### 3.5 Sample Analyses

One of the most important aspects of Quality Assurance and Quality Control was to ensure the validity and reliability of the sample analyses of the off-site gamma spectroscopy system. The following sections discuss the key elements for the QA/QC of the gamma spec analyses.

#### 3.5.1. Sample Collection and Preparation

All samples were collected following an approved sampling procedure. Between samples, all sampling tools were cleaned to remove any visible soil or other material as necessary to ensure no cross contamination. Samples were then assigned unique sample IDs and submitted for shipment to an off-site lab selected from the *EnergySolutions* Approved Suppliers List under Chain-of-Custody record (COC) for analysis.

Each sample was processed by the off-site laboratory in accordance with their standard operating procedures. Samples were dried, as necessary, and then crushed/pulverized and homogenized prior to analysis. The off-site lab was also responsible for all data reduction, quality control reviews, and reporting of sample results.

Upon receipt of the sample results, *EnergySolutions* reviewed the results to ensure the proper analyses were performed, quality control parameters met and that the analyses met the detection sensitivities as required.

#### 3.5.2. Sample Splits

To ensure data reproducibility, sample splits were analyzed. This was performed to ensure the off-site gamma spec system would report similar results within specified acceptance criteria. Split samples were collected in the field for 5% of the samples while an additional 5% were split by the off-site laboratory upon receipt. The sample split results were then evaluated to ensure similar results were reported using the Relative Percent Difference (RPD) method as applicable with a goal of an RPD of less than or equal to 50% for samples with activity less than 5 times the MDA and 30% for those samples with higher activity. The RPD was calculated using the equation below.

$$\%RPD = \frac{|S_1 - S_2|}{\overline{S}} \times 100$$

Where:  $S_1$  = Split sample 1 results (pCi/g), and  
 $S_2$  = Split sample 2 results (pCi/g).

Samples with measured activities below MDA were not evaluated.

#### 3.5.3. Sample Chain-of-Custody

All samples shipped off-site were accompanied by a COC record tracking their location and possession. Copies of these records were maintained through the life cycle of the samples through sample disposal. These



records identified the specific sample IDs, Fed-Ex tracking numbers and the required sample analyses to be performed. Upon review of the off-site sample analyses and acceptance of the data, the samples will be disposed by the off-site lab as directed by *ZionSolutions*, LLC.

#### 3.5.4. Detection Sensitivity

Detection sensitivities for the off-site gamma spectroscopy system were dependent upon several system parameters. These include background, size of the sample, sample geometry, system efficiency, analysis count time and the radionuclides of concern (emission energy and yield). Typically, detection sensitivities range between 0.1 to 1 pCi/g. For radionuclides with higher emission yields and less peak interference such as  $^{137}\text{Cs}$ , and  $^{40}\text{K}$ , the lower detection sensitivities (i.e., 0.1 pCi/g) are achievable. Actual detection sensitivities are presented as part of the analysis results for the primary radionuclides of concern.

### 3.6 Records

Survey and sampling data were documented and maintained in accordance with *EnergySolutions* procedures. All surveys and sampling data received independent review to ensure all the necessary surveys were performed, samples collected and analyses performed and that adequate detection sensitivities were met.

## 4.0 SURVEY DESIGN

The background survey design was based upon the survey protocols as outlined in Reference 6.2, CS-RS-PN-022, *Characterization Plan for New Rail Lines at the Zion Nuclear Station*, Rev. 1. Background reference areas were selected to ensure they would not be impacted by site operations and that would be representative of the local area background and construction at the Zion Nuclear Power Station. Figure 1-1 provides the locations utilized as part of the background survey. A summary of the survey protocols as applied is provided in the following sections.

### 4.1 Objective

The objectives of the background survey were to determine the radiological background characteristics for un-impacted asphalt, concrete and soil. Specifically, the background survey was designed and performed to document:

- The background readings for instruments to be used during field surveys including surface scans and direct measurements, and
- The background activity concentrations for the radionuclides of concern present in soil, concrete and asphalt.

### 4.2 Radionuclides of Concern

The most prevalent radionuclides of concern in natural background include potassium, natural thorium and natural uranium and their associated daughter products. In addition, there are limited amounts of Cs-137 that may be present as a result of historical nuclear weapons testing fallout; however, no other radionuclides should be present within background. If other nuclides were

identified, that would be an indication that the background reference areas are not representative of natural background and the area is likely impacted by licensed site activities.

#### **4.3 Asphalt and Concrete**

Surface scans and direct surface activity measurements were performed for gross beta activity on both asphalt and concrete surfaces within the background reference areas. This was performed to determine the typical instruments response to materials of construction to account for any natural activity that would be present in the materials as measured during surveys. The surveys were performed using the same instruments and survey techniques that will be used during release surveys.

The scans were distributed evenly over each background reference area and recorded on a survey map using the Ludlum Model 43-37 large area gas flow proportional detector. A total of 25 one-minute static measurements were also collected using the Ludlum Model 43-68 gas flow proportional detector.

In addition to the surface scans and direct measurements, samples were collected for volumetric analysis by gamma spectroscopy analysis. Fifteen (15) samples for both asphalt and concrete were obtained of loose surface materials and sent off-site for analysis.

#### **4.4 Surface Soil**

Gamma walkover scans and direct measurements were performed over soil and vegetation using a Ludlum Model 44-10 NaI detector coupled to a global positioning system (GPS) at a height of approximately 4 inches. These reference measurements and surface scans were used to determine the instruments response over soil and vegetation. The surveys were performed using the same instruments and survey techniques that would be used for release surveys. A total of 30 one-minute static measurements were also collected.

In addition to the surface scans and direct measurements, fifteen (15) soil samples were collected at evenly distributed locations from the top 6-inches of soil. The sample locations were distributed throughout the background reference area and each position logged using the GPS system. All surface soil samples were collected and sent off-site for analysis.

#### **4.5 Subsurface Soil**

Because of the potential of difference in geology, subsurface samples were collected at each surface sampling location to account for any differences in background if present. Subsurface samples were collected at depths between 6 inches below grade down to a depth of about 4 feet using a GeoProbe™ direct push sampler and a core sleeve. The subsurface soils were removed from each core sleeve and a composite sample collected and sent off-site for analysis.

## 5.0 RESULTS

A summary of the background survey results as measured is provided in the following sections. This includes summaries of the surface scan and direct measurement results for field survey instruments, sample analysis results and maps of the background survey locations as applicable.

### 5.1 Asphalt

Asphalt surveys were performed and samples collected from the roadway intersection west of the Zion visitor's center as shown in Figure 1-1. The surveys performed and their results are presented as follows:

#### 5.1.1. Surface Scans

As part of the surface scans, a total of 64 individual observations were recorded by the HP Technician to the nearest tens digit while performing the survey using a Ludlum Model 43-37 gas flow proportional floor monitor. A copy of the scan survey as documented is provided as Attachment 7-1. The survey data ranged between 1,040 and 1,360 gross cpm with an average observed reading of 1,180 cpm. No further statistical evaluation was performed as these were observed field readings recorded by the HP Technician and not individual scalar measurements.

#### 5.1.2. Direct Measurements

In addition to the surface scans, a total of 25 one minute scalar counts were collected using the Ludlum model 43-68 gas flow proportional detector. A copy of the direct survey results as documented is provided as Attachment 7-2. A summary of these results is provided in Table 5-1 below.

**Table 5-1 Asphalt Surface Activity Results**

| Measurements | Results in dpm/100 cm <sup>2</sup> |     |         |        |                      |
|--------------|------------------------------------|-----|---------|--------|----------------------|
|              | Min                                | Max | Average | St Dev | 95% UCL <sup>a</sup> |
| 25           | 101                                | 393 | 257     | 77     | 284                  |

a 95% Upper Confidence Level on the average based on 25 measurements or 24 (n-1) degrees of freedom.

The 95% UCL, upper confidence level on the mean, is determined as follows:

$$95\%UCL = Average + \left( t_{\alpha, n-1} \times \frac{\sigma}{\sqrt{n}} \right)$$

Where:  $t_{\alpha, n-1}$  = Student t statistic, single tail test and 5% error  
 $n$  = number of measurements,  
 $n-1$  = degrees of freedom, and  
 $\sigma$  = Standard Deviation of the data/sample set

### 5.1.3. Volumetric Activity

Asphalt samples were collected from around the Visitors Center adjacent to the background reference area as shown in Figure 1-1 by collecting loose asphalt in the area. Approximately 0.5 liters of materials were collected for each sample and the sample shipped off-site for gamma spectroscopy analysis. Attachment 7-3 and Attachment 7-4 provide the sample analysis results as reported by the off-site laboratory. A summary of these results is provided in Table 5-2 as follows presenting the average activities, standard deviations and the 95% upper confidence level on the mean. Activities for the primary radionuclides of concern are presented including any associated daughter products as detected in order to provide further evidence that any residual activity is of natural origin.

**Table 5-2 Asphalt Volumetric Activity Results**

| Nuclide           | Results in pCi/g |                 |                      |
|-------------------|------------------|-----------------|----------------------|
|                   | Average          | Std. Dev        | 95% UCL <sup>a</sup> |
| <sup>228</sup> Ac | <b>1.60E-01</b>  | <b>6.55E-02</b> | <b>1.90E-01</b>      |
| <sup>212</sup> Pb | <b>1.77E-01</b>  | <b>3.81E-02</b> | <b>1.95E-01</b>      |
| <sup>208</sup> Tl | <b>1.57E-01</b>  | <b>5.56E-02</b> | <b>1.82E-01</b>      |
| <sup>234</sup> Th | <i>8.60E-02</i>  | <i>3.65E-01</i> | <i>2.52E-01</i>      |
| <sup>214</sup> Pb | <b>1.55E-01</b>  | <b>3.68E-02</b> | <b>1.72E-01</b>      |
| <sup>214</sup> Bi | <b>1.19E-01</b>  | <b>4.01E-02</b> | <b>1.37E-01</b>      |
| <sup>235</sup> U  | <i>3.51E-03</i>  | <i>4.11E-02</i> | <i>2.22E-02</i>      |
| <sup>40</sup> K   | <b>4.64E+00</b>  | <b>9.26E-01</b> | <b>5.06E+00</b>      |
| <sup>137</sup> Cs | <i>1.23E-03</i>  | <i>1.05E-02</i> | <i>6.02E-03</i>      |

a 95% Upper Confidence Level on the average based on 15 measurements or 14 (n-1) degrees of freedom.

b Bold values are greater than the MDA; Italicized values are less than MDA.

### 5.1.4. Conclusions

Based upon a review of the sample analysis results, only natural activity expected in background was detected. No other licensed materials were identified in the samples. Additionally, based upon the activities of the daughter products within the decay chain, in approximate equilibrium, the background reference area(s) and samples are representative of background and are not impacted by site activities.

## 5.2 Concrete

Concrete surveys were performed north of the Zion Visitor's Center as shown in Figure 1-1 at the Hosah Park Preservation area around two concrete picnic areas; however, the concrete samples were not collected from these areas. Concrete samples were collected from a rubble pile and concrete abutments near an old parking lot west of the Visitors Center as well as pieces of concrete from a local Lake County area park, neither of which is depicted in Figure 1-1.

### 5.2.1. Surface Scans

As part of the surface scans, a total of 36 individual observations were recorded by the HP Technician to the nearest tens digit while performing the survey using the Ludlum Model 43-37 gas flow proportional floor monitor at the Hosah Park Preservation area. A copy of the scan survey as documented is provided in Attachment 7-5. The survey data ranged between 1,240 and 1,510 gross cpm with an average observed reading of 1,360 cpm. No further statistical evaluation was performed as these were observed field measurements that were recorded by the HP Technician and not individual scalar measurements.

### 5.2.2. Direct Measurements

A total of 25 one minute scalar counts were collected using the Ludlum model 43-68 gas flow proportional detector were also collected from the picnic area. A copy of the direct survey results as documented is provided as Attachment 7-6. A summary of these results is provided in Table 5-3 below.

**Table 5-3 Concrete Surface Activity Results**

| Measurements | Results in dpm/100 cm <sup>2</sup> |     |         |        |                      |
|--------------|------------------------------------|-----|---------|--------|----------------------|
|              | Min                                | Max | Average | St Dev | 95% UCL <sup>a</sup> |
| 25           | 141                                | 541 | 356     | 100    | 391                  |

a 95% Upper Confidence Level on the average based on 25 measurements of 24 degrees of freedom.

### 5.2.3. Volumetric Activity

Concrete samples were not collected from the picnic area where the scan surveys and direct surveys were performed. Samples were collected from a rubble pile from the parking area located west of the Visitors Center as well as from a local Lake County area park. Approximately 0.5 liters of materials were collected for each sample and the sample shipped off-site for gamma spectroscopy analysis. Attachment 7-7 and Attachment 7-8 provide the sample analysis results as reported by the off-site laboratory. A summary of these results is provided in Table 5-4 as follows presenting the average activities, standard deviations and the 95% upper confidence

level on the mean. Activities for the primary radionuclides of concern are presented including any associated daughter products as detected in order to provide further evidence that any residual activity is of natural origin.

#### 5.2.4. Conclusions

Based upon a review of the sample analysis results, only natural activity expected in background was detected. No other licensed materials were identified in the samples. Additionally, based upon the activities of the daughter products within the decay chain, in approximate equilibrium, the background reference area(s) and samples are representative of background and are not impacted by site activities.

**Table 5-4 Concrete Volumetric Activity Results**

| Nuclide           | Results in pCi/g |                 |                      |
|-------------------|------------------|-----------------|----------------------|
|                   | Average          | Std. Dev        | 95% UCL <sup>a</sup> |
| <sup>228</sup> Ac | <b>3.08E-01</b>  | <b>1.03E-01</b> | <b>3.55E-01</b>      |
| <sup>212</sup> Pb | <b>3.01E-01</b>  | <b>1.15E-01</b> | <b>3.54E-01</b>      |
| <sup>208</sup> Tl | <b>2.60E-01</b>  | <b>8.74E-02</b> | <b>3.00E-01</b>      |
| <sup>234</sup> Th | <i>3.48E-01</i>  | <i>3.27E-01</i> | <i>4.96E-01</i>      |
| <sup>214</sup> Pb | <b>3.03E-01</b>  | <b>6.57E-02</b> | <b>3.32E-01</b>      |
| <sup>214</sup> Bi | <b>3.00E-01</b>  | <b>6.51E-02</b> | <b>3.30E-01</b>      |
| <sup>235</sup> U  | <i>8.78E-02</i>  | <i>9.81E-02</i> | <i>1.32E-01</i>      |
| <sup>40</sup> K   | <b>5.55E+00</b>  | <b>2.63E+00</b> | <b>6.74E+00</b>      |
| <sup>137</sup> Cs | <i>1.21E-02</i>  | <i>1.82E-02</i> | <i>2.03E-02</i>      |

a 95% Upper Confidence Level on the average based on 15 measurements or 14 (n-1) degrees of freedom.

b Bold values are greater than the MDA; Italicized values are less than MDA.

### 5.3 Surface Soil

Soil surveys were performed and samples collected from an area directly south and adjacent to the Zion visitor's center as shown in Figure 1-1. The surveys performed and their results are presented as follows:

#### 5.3.1. Open Land Survey

Prior to obtaining soil samples, a walkover scan was performed over the background reference area using the Ludlum Model 44-10 NaI detector at a height of 4-inches. A total of 166 individual observations were recorded by the HP Technician to the nearest tens digit while performing the

survey. A copy of the scan survey as documented is provided in Attachment 7-9. The survey data ranged between 4,320 and 7,410 gross cpm with an average observed reading of 5,708 cpm. No further statistical evaluation was performed as this set of data were observed field measurements that were recorded by the HP Technician and not individual scalar measurements.

Subsequently, an additional scan was performed in October 2011 coupling the instrument to a GPS unit to document the scan. The GPS polled the instrument every couple seconds for a 1-second integrated count and converted the reading to counts per minute. A copy of the GPS walkover survey is provided in Figure 5-1.

A summary of the scan results as documented in Figure 5-1 is provided in Table 5-5 below.

**Table 5-5 Surface Soil Scan Results (October 2011)**

| Measurements | Results in cpm (gross) |                     |         |        |         |
|--------------|------------------------|---------------------|---------|--------|---------|
|              | Min                    | Max                 | Average | St Dev | 95% UCL |
| 584          | 4,320                  | 16,680 <sup>a</sup> | 6,334   | 828    | 6,390   |

a The maximum reading is likely due to a short in the cable and could not be reproduced. It is a single individual measurement and was not removed from the data set. Averaged over the 584 measurements, the contribution to the data set average is approximately 28 cpm.

A more extensive walkover scan was performed in November 2011 over the same area while also covering the footprint of the former Visitor's Center. A copy of the GPS walkover survey is provided in Figure 5-2.

A summary of the scan results as documented in Figure 5-2 is provided in Table 5-7 below.

**Table 5-6 Surface Soil Scan Results (November 2011)**

| Measurements | Results in cpm (gross) |       |         |        |         |
|--------------|------------------------|-------|---------|--------|---------|
|              | Min                    | Max   | Average | St Dev | 95% UCL |
| 8,955        | 2,520                  | 9,240 | 5,192   | 832    | 5,206   |



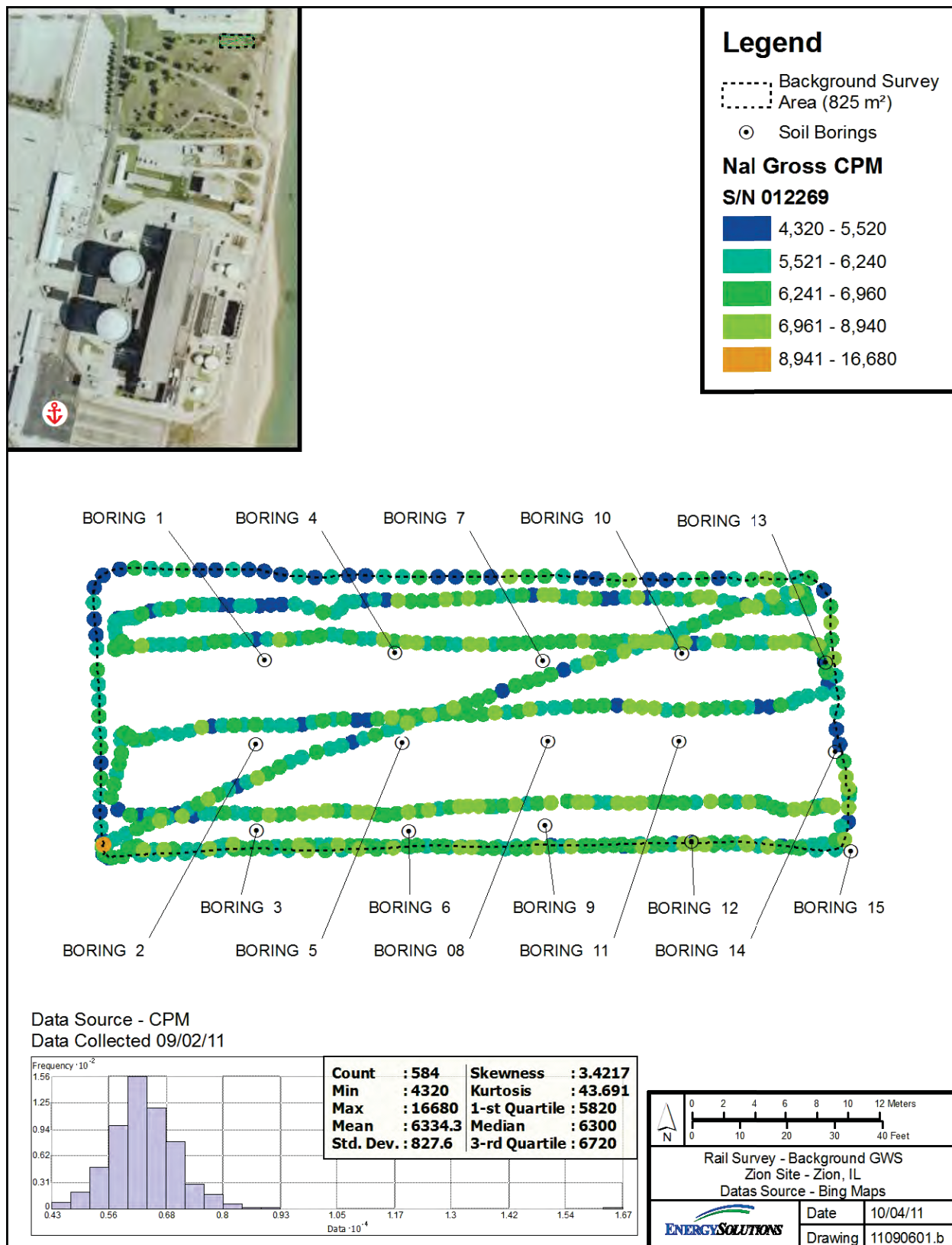


Figure 5-1 Walkover Gamma Scan – Surface Soil (October 2011)



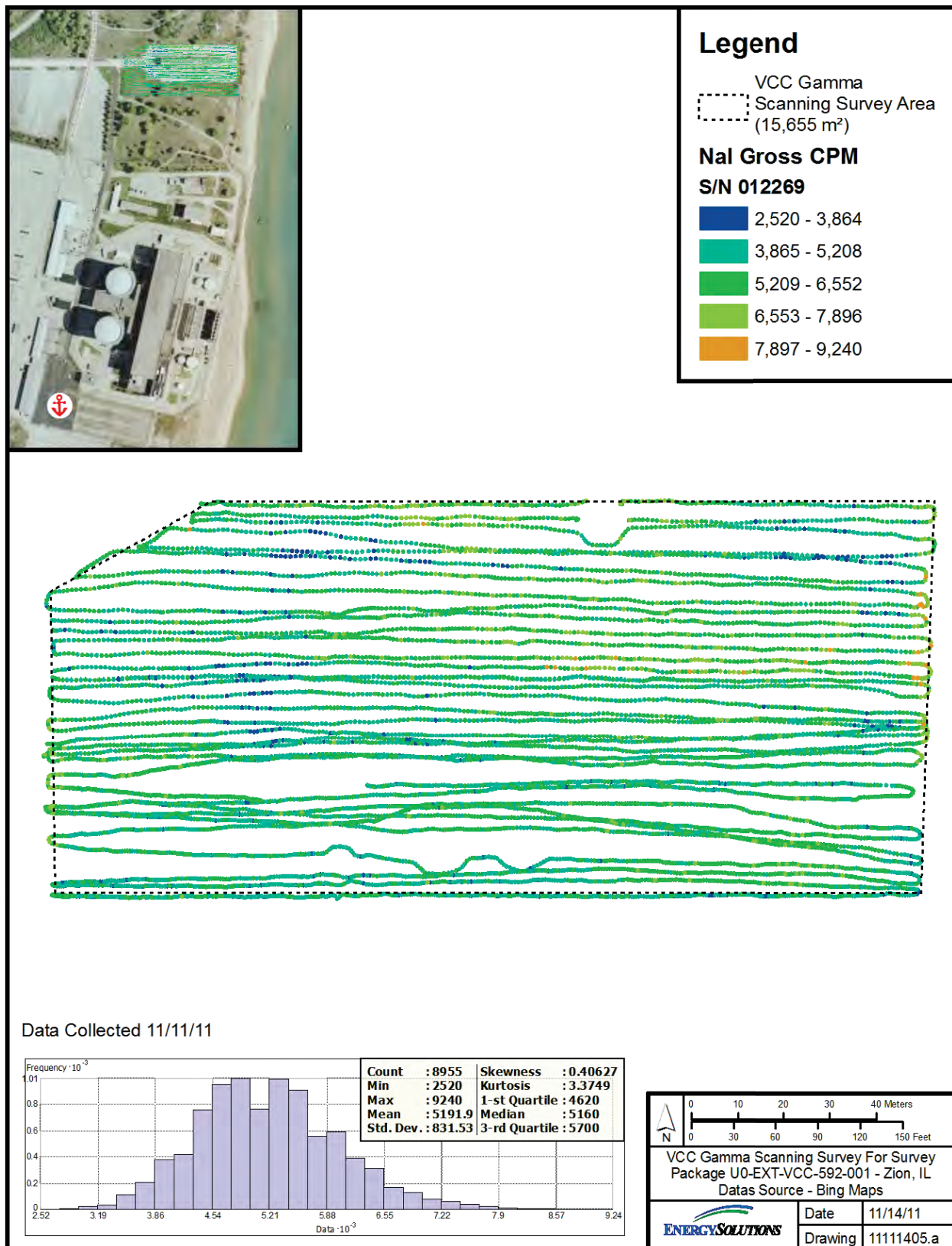


Figure 5-2 Walkover Gamma Scan – Surface Soil (November 2011)

### 5.3.2. Direct Measurements

A total of 30 one minute scalar counts were collected using the Ludlum model 44-10 were obtained 4-inches above the soil surface spaced throughout the background reference area as shown in Figure 5-1. A copy of the direct survey results as documented is provided as Attachment 7-10. A summary of these results is provided in Table 5-7 below.

**Table 5-7 Surface Soil Measurement Results**

| Measurements | Results in cpm (gross) |       |         |        |                      |
|--------------|------------------------|-------|---------|--------|----------------------|
|              | Min                    | Max   | Average | St Dev | 95% UCL <sup>a</sup> |
| 30           | 4,530                  | 6,362 | 5,718   | 543    | 5,886                |

a 95% Upper Confidence Level on the average based on 30 measurements of 29 degrees of freedom.

### 5.3.3. Volumetric Activity

Fifteen (15) surface soil samples were collected at locations laid out equidistant from each as shown in Figure 5-1 within the background reference area. Samples of surface soil and gravels (0 to 6 inches in depth) were obtained using a scoop, hand auger or other small implements. Each sample consisted of approximately 0.5 liter of soil, with large sticks, rocks and other debris removed. Samples were labeled using the designator "SF" and a unique sample number for the sampling location. Prior to moving to a new sampling location, all sampling tools were cleaned to remove any visible soil or other material.

Attachment 7-11 and Attachment 7-12 provide the sample analysis results as reported by the off-site laboratory. A summary of these results is provided in Table 5-8 as follows presenting the average activities, standard deviations and the 95% upper confidence level on the mean. Activities for the primary radionuclides of concern are presented including any associated daughter products as detected in order to provide further evidence that any residual activity is of natural origin.

### 5.3.4. Conclusions

Based upon a review of the sample analysis results, only natural activity expected in background was detected. No other licensed materials were identified in the samples. Additionally, based upon the activities of the daughter products within the decay chain, in approximate equilibrium, the background reference area(s) and samples are representative of background and are not impacted by site activities.

Table 5-8 Surface Soil Volumetric Activity Results

| Nuclide           | Results in pCi/g |                 |                      |
|-------------------|------------------|-----------------|----------------------|
|                   | Average          | Std. Dev        | 95% UCL <sup>a</sup> |
| <sup>228</sup> Ac | <b>5.20E-01</b>  | <b>1.02E-01</b> | <b>5.66E-01</b>      |
| <sup>212</sup> Pb | <b>5.30E-01</b>  | <b>8.94E-02</b> | <b>5.70E-01</b>      |
| <sup>208</sup> Tl | <b>4.45E-01</b>  | <b>8.78E-02</b> | <b>4.85E-01</b>      |
| <sup>234</sup> Th | <i>6.05E-01</i>  | <i>4.68E-01</i> | <i>8.18E-00</i>      |
| <sup>214</sup> Pb | <b>5.43E-01</b>  | <b>9.21E-02</b> | <b>5.85E-01</b>      |
| <sup>214</sup> Bi | <b>5.44E-01</b>  | <b>1.10E-01</b> | <b>5.94E-01</b>      |
| <sup>235</sup> U  | <i>9.83E-02</i>  | <i>1.16E-01</i> | <i>1.51E-01</i>      |
| <sup>40</sup> K   | <b>1.40E+01</b>  | <b>2.00E+00</b> | <b>1.49E+01</b>      |
| <sup>137</sup> Cs | <i>6.61E-03</i>  | <i>2.15E-02</i> | <i>1.64E-02</i>      |

a 95% Upper Confidence Level on the average based on 15 measurements or 14 (n-1) degrees of freedom.

b Bold values are greater than the MDA; Italicized values are less than MDA.

#### 5.4 Sub-Surface Soil

The areas of subsurface sampling were surveyed using ground penetrating radar (GPR) to identify underground anomalies down to approximately 5 feet below grade prior to sampling. In addition, all underground utilities were located. The sampling performed and their results are presented as follows:

##### 5.4.1. Surface Scans and Direct Measurements

No soil scans were performed for subsurface sampling.

##### 5.4.2. Volumetric Activity

Subsurface samples were collected at each surface sampling location as shown in Figure 5-1. Samples were collected at depths between 6 inches below grade down to a depth of about 4 feet using a GeoProbe™ direct push sampler and a core sleeve. The subsurface soils were removed from each core sleeve and a composite sample collected and sent off-site for analysis. Each sample consisted of approximately 0.5 liter of soil, with large sticks, rocks and other debris removed. Samples were labeled using the designator “DP” and a unique sample number for the sampling location.

Attachment 7-13 and Attachment 7-14 provide the sample analysis results as reported by the off-site laboratory. A summary of these results is

provided in Table 5-9 as follows presenting the average activities, standard deviations and the 95% upper confidence level on the mean. Activities for the primary radionuclides of concern are presented including any associated daughter products as detected in order to provide further evidence that any residual activity is of natural origin

#### 5.4.3. Conclusions

Based upon a review of the sample analysis results, only natural activity expected in background was detected. No other licensed materials were identified in the samples. Additionally, based upon the activities of the daughter products within the decay chain, in approximate equilibrium, the background reference area(s) and samples are representative of background and are not impacted by site activities. Lastly, upon review of both the surface and subsurface soil sampling, there appears to be no difference between the background activities.

**Table 5-9 Subsurface Soil Volumetric Activity Results**

| Nuclide           | Results in pCi/g |                 |                      |
|-------------------|------------------|-----------------|----------------------|
|                   | Average          | Std. Dev        | 95% UCL <sup>a</sup> |
| <sup>228</sup> Ac | <b>4.87E-01</b>  | <b>1.14E-01</b> | <b>5.39E-01</b>      |
| <sup>212</sup> Pb | <b>4.98E-01</b>  | <b>1.68E-01</b> | <b>5.74E-01</b>      |
| <sup>208</sup> Tl | <b>4.42E-01</b>  | <b>9.56E-02</b> | <b>4.85E-01</b>      |
| <sup>234</sup> Th | <i>5.74E-01</i>  | <i>4.87E-01</i> | <i>7.95E-00</i>      |
| <sup>214</sup> Pb | <b>6.10E-01</b>  | <b>1.92E-01</b> | <b>6.97E-01</b>      |
| <sup>214</sup> Bi | <b>6.06E-01</b>  | <b>1.76E-01</b> | <b>6.86E-01</b>      |
| <sup>235</sup> U  | <i>5.26E-02</i>  | <i>7.70E-02</i> | <i>8.76E-02</i>      |
| <sup>40</sup> K   | <b>1.36E+01</b>  | <b>2.89E+00</b> | <b>1.49E+01</b>      |
| <sup>137</sup> Cs | <i>-1.95E-03</i> | <i>1.83E-02</i> | <i>6.35E-03</i>      |

a 95% Upper Confidence Level on the average based on 15 measurements or 14 (n-1) degrees of freedom.

b Bold values are greater than the MDA; Italicized values are less than MDA.

#### 5.5 Quality Assurance and Quality Control Samples

Sample splits were performed on 5% of all background samples collected. Split samples were performed in the field and by the laboratory. A total of 8 split samples were analyzed, 4 field splits and 4 laboratory splits. A summary of the QA/QC results is provided in Attachment 7-15.

All QA/QC samples were evaluated using the RPD method with a goal of an RPD of less than or equal to 50% for samples with activity less than 5 times the MDA and 30% for those samples with higher activity. Sample with reported activities below MDA were not evaluated. All QA/QC sample results met the RPD testing criteria with the exception of one asphalt sample, Z-BKG-ASPHALT-DUP-01. This sample was a field split and can be considered not to be a true split sample as the material was not processed in the field to homogenize the sample prior to splitting. As a result, this sample was more likely to fail as it can be considered a separate discrete sample.

## **6.0 REFERENCES**

- 6.1 Annual Report on the Meteorological Monitoring Program at Zion Nuclear Power Station for 2010, Murray and Trettel, Inc. 2/21/2011
- 6.2 CS-RS-PN-022, *Characterization Plan for New Rail Lines at the Zion Nuclear Station*, Rev. 1

## **7.0 ATTACHMENTS**

- 7.1 **Asphalt Background Survey – Surface Scans**
- 7.2 **Asphalt Background Survey – Direct Measurements**
- 7.3 **Asphalt Sample Results – Primary Nuclides**
- 7.4 **Asphalt Sample Results wt Progeny**
- 7.5 **Concrete Background Survey – Surface Scans**
- 7.6 **Concrete Background Survey – Direct Measurements**
- 7.7 **Concrete Sample Results – Primary Nuclides**
- 7.8 **Concrete Sample Results wt Progeny**
- 7.9 **Soil Survey – Surface Scans**
- 7.10 **Soil Survey – Direct Measurements**
- 7.11 **Surface Soil Results – Primary Nuclides**
- 7.12 **Surface Soil Results wt Progeny**
- 7.13 **Subsurface Soil Results – Primary Nuclides**
- 7.14 **Subsurface Soil Results wt Progeny**
- 7.15 **Sample QA / QC Results**



Attachment 7-1 Asphalt Background Survey – Surface Scans

Performance of Radiological Surveys Zion Bkg Study Beta Scans Asphalt Area 8-24-11 CS-FO-PR-001 Revision 1

(Attachment 5.3 Equivalent

Survey Cover

Survey # Z-BKG-ASPH-SCAN 2

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Survey Type: CHAR  
Description: Zion Beta Scans of Asphalt ( Background Survey)  
Performed by: Jerry Plumlee  
Date: 8/24/2011

Instrumentation

| Model                           | Serial Number | Calibration  | Mode     | Det.  | Inst Eff. (ei)  | Surface Eff.  |
|---------------------------------|---------------|--------------|----------|-------|-----------------|---------------|
|                                 |               | n            | Scalar / | (cm2) | (%)             | (%)           |
| <b>Alpha (Direct/Removable)</b> |               |              |          |       |                 |               |
| D NA                            | NA            | NA           | NA       | NA    | NA              | NA            |
| R NA                            | NA            | NA           | NA       | NA    | NA              | NA            |
| <b>Beta (Scan)</b>              |               |              |          |       |                 |               |
| D 2350-1 43-37B                 | 98620 092791  | 1-1-12 5-2-1 | Rate     | 584.0 | 19.0%           | 100.0%        |
| R NA                            | NA            | NA           | NA       | NA    | NA              | NA            |
|                                 |               |              |          |       | BCF             | Cal. Const.   |
| <b>Gamma</b>                    |               |              |          |       | mrads per mR/hr | cts per mR/hr |
| D NA                            | NA            | NA           | NA       | NA    | NA              | NA            |

Diagram

Key

| Zion Asphalt Bkg Scan Study Area |    |    |    |    |    |    |    |
|----------------------------------|----|----|----|----|----|----|----|
|                                  |    |    |    |    |    |    |    |
| 8                                | 9  | 24 | 25 | 40 | 41 | 56 | 57 |
| 7                                | 10 | 23 | 26 | 39 | 42 | 55 | 58 |
| 6                                | 11 | 22 | 27 | 38 | 43 | 54 | 59 |
| 5                                | 12 | 21 | 28 | 37 | 44 | 53 | 60 |
| 4                                | 13 | 20 | 29 | 36 | 45 | 52 | 61 |
| 3                                | 14 | 19 | 30 | 35 | 46 | 51 | 62 |
| 2                                | 15 | 18 | 31 | 34 | 47 | 50 | 63 |
| 1                                | 16 | 17 | 32 | 33 | 48 | 49 | 64 |

Contamination

- LAW

- Smear

- Direct

Dose Rates (OW/CW)

\* - Contact

# - Beta Scan Locations

Air Sampling

A/S - Location

9/28/2011

Reviewed by:

Date:

8/30/11

CS-FO-PR-001  
Revision 1

Zion Bkg Study Beta Scans Asphalt Area 8-24-11

Performance of  
Radiological Surveys

(Attachment 5.4)  
Beta Scan Activity  
Equivalent

Survey # Z-BKG-ASPH-SCAN

Page 2 of 4

| Parameter     | Units       | Alpha  |           | Beta   |           |
|---------------|-------------|--------|-----------|--------|-----------|
|               |             | Direct | Removable | Direct | Removable |
| Sample CT     | min         | NA     | NA        | 1 sec  | NA        |
| Bkgd CT       | min         | NA     | NA        | 10.0   | NA        |
| Resp. Time    | min         | NA     | NA        | 1 sec  | NA        |
| Background    | cpm         | NA     | NA        | 947    | NA        |
| MDC           | dpm/100 cm2 | NA     | NA        | N/A    | NA        |
| Flag / Limit* | cpm/584cm2  | NA     | NA        | 1179   | NA        |

Average: 1179 CPM  
OF 64 0.584cm2  
IN 5 MINUTE  
PERMITS 170 CPM

| Scan Bkgd (cpm) |      |
|-----------------|------|
| 10 min          | Beta |
| 9370            | 947  |
| 9561            |      |
|                 |      |
|                 |      |
|                 |      |

| Location | Alpha     |             |             | Beta            |             |             |
|----------|-----------|-------------|-------------|-----------------|-------------|-------------|
|          | Direct    | Removable   | Gross Cts   | Scan Bkgd (cpm) | Gross Cts   | Removable   |
|          | Gross Cts | dpm/100 cm2 | dpm/100 cm2 | cpm             | dpm/100 cm2 | dpm/100 cm2 |
| 1        | NA        | NA          | NA          | 1180            | 947         | NA          |
| 2        | NA        | NA          | NA          | 1170            | 947         | NA          |
| 3        | NA        | NA          | NA          | 1190            | 947         | NA          |
| 4        | NA        | NA          | NA          | 1150            | 947         | NA          |
| 5        | NA        | NA          | NA          | 1160            | 947         | NA          |
| 6        | NA        | NA          | NA          | 1230            | 947         | NA          |
| 7        | NA        | NA          | NA          | 1190            | 947         | NA          |
| 8        | NA        | NA          | NA          | 1090            | 947         | NA          |
| 9        | NA        | NA          | NA          | 1140            | 947         | NA          |
| 10       | NA        | NA          | NA          | 1220            | 947         | NA          |
| 11       | NA        | NA          | NA          | 1200            | 947         | NA          |
| 12       | NA        | NA          | NA          | 1180            | 947         | NA          |
| 13       | NA        | NA          | NA          | 1210            | 947         | NA          |
| 14       | NA        | NA          | NA          | 1360            | 947         | NA          |
| 15       | NA        | NA          | NA          | 1260            | 947         | NA          |
| 16       | NA        | NA          | NA          | 1240            | 947         | NA          |
| 17       | NA        | NA          | NA          | 1270            | 947         | NA          |
| 18       | NA        | NA          | NA          | 1210            | 947         | NA          |
| 19       | NA        | NA          | NA          | 1190            | 947         | NA          |
| 20       | NA        | NA          | NA          | 1160            | 947         | NA          |

\* IS AVERAGE OF 1179 CPM + INSTRUMENT MDCR OF 584 CPM

9/28/2011

Reviewed by:

Date: 8/24/11



Zion Bkg Study Beta Scans Asphalt Area 8-24-11

CS-FO-PR-001  
Revision 1

Performance of  
Radiological Surveys

(Attachment 5.5)  
Equivalent

Beta Scan - Cont.

Survey # Z-BKG-ASPH-SCAN

Page 3 of 4

| Location | Alpha     |             |           |             | Beta |            |           |             |
|----------|-----------|-------------|-----------|-------------|------|------------|-----------|-------------|
|          | Direct    |             | Removable |             | Scan |            | Removable |             |
|          | Gross Cts | dpm/100 cm2 | Gross Cts | dpm/100 cm2 | cpm  | Bkgd (cpm) | Gross Cts | dpm/100 cm2 |
| 21       | NA        | NA          | NA        | NA          | 1120 | 947        | NA        | NA          |
| 22       | NA        | NA          | NA        | NA          | 1160 | 947        | NA        | NA          |
| 23       | NA        | NA          | NA        | NA          | 1140 | 947        | NA        | NA          |
| 24       | NA        | NA          | NA        | NA          | 1040 | 947        | NA        | NA          |
| 25       | NA        | NA          | NA        | NA          | 1080 | 947        | NA        | NA          |
| 26       | NA        | NA          | NA        | NA          | 1170 | 947        | NA        | NA          |
| 27       | NA        | NA          | NA        | NA          | 1150 | 947        | NA        | NA          |
| 28       | NA        | NA          | NA        | NA          | 1230 | 947        | NA        | NA          |
| 29       | NA        | NA          | NA        | NA          | 1110 | 947        | NA        | NA          |
| 30       | NA        | NA          | NA        | NA          | 1160 | 947        | NA        | NA          |
| 31       | NA        | NA          | NA        | NA          | 1180 | 947        | NA        | NA          |
| 32       | NA        | NA          | NA        | NA          | 1190 | 947        | NA        | NA          |
| 33       | NA        | NA          | NA        | NA          | 1170 | 947        | NA        | NA          |
| 34       | NA        | NA          | NA        | NA          | 1180 | 947        | NA        | NA          |
| 35       | NA        | NA          | NA        | NA          | 1190 | 947        | NA        | NA          |
| 36       | NA        | NA          | NA        | NA          | 1220 | 947        | NA        | NA          |
| 37       | NA        | NA          | NA        | NA          | 1200 | 947        | NA        | NA          |
| 38       | NA        | NA          | NA        | NA          | 1190 | 947        | NA        | NA          |
| 39       | NA        | NA          | NA        | NA          | 1190 | 947        | NA        | NA          |
| 40       | NA        | NA          | NA        | NA          | 1150 | 947        | NA        | NA          |
| 41       | NA        | NA          | NA        | NA          | 1080 | 947        | NA        | NA          |
| 42       | NA        | NA          | NA        | NA          | 1140 | 947        | NA        | NA          |
| 43       | NA        | NA          | NA        | NA          | 1230 | 947        | NA        | NA          |
| 44       | NA        | NA          | NA        | NA          | 1190 | 947        | NA        | NA          |
| 45       | NA        | NA          | NA        | NA          | 1220 | 947        | NA        | NA          |
| 46       | NA        | NA          | NA        | NA          | 1180 | 947        | NA        | NA          |
| 47       | NA        | NA          | NA        | NA          | 1140 | 947        | NA        | NA          |
| 48       | NA        | NA          | NA        | NA          | 1190 | 947        | NA        | NA          |

CS-FO-PR-001

Performance of

Performed by: JEE PAGE ( Date: 8/28/11 )

9/28/2011



Zion Bkg Study Beta Scans Asphalt Area 8-24-11

Revision 1

Radiological Surveys

Beta Scan- Cont.

Survey # Z-BK-ASPH-SCAN 2

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(Attachment 5.5)  
Equivalent

| Location | Alpha     |             |           |             | Beta      |            |             |           |
|----------|-----------|-------------|-----------|-------------|-----------|------------|-------------|-----------|
|          | Direct    |             | Removable |             | Scan      |            | Removable   |           |
|          | Gross Cts | dpm/100 cm2 | Gross Cts | dpm/100 cm2 | Gross Cts | Bkgd (cpm) | dpm/100 cm2 | Gross Cts |
| 49       | NA        | NA          | NA        | NA          | 1200      | 947        | NA          | NA        |
| 50       | NA        | NA          | NA        | NA          | 1050      | 947        | NA          | NA        |
| 51       | NA        | NA          | NA        | NA          | 1090      | 947        | NA          | NA        |
| 52       | NA        | NA          | NA        | NA          | 1150      | 947        | NA          | NA        |
| 53       | NA        | NA          | NA        | NA          | 1180      | 947        | NA          | NA        |
| 54       | NA        | NA          | NA        | NA          | 1160      | 947        | NA          | NA        |
| 55       | NA        | NA          | NA        | NA          | 1120      | 947        | NA          | NA        |
| 56       | NA        | NA          | NA        | NA          | 1110      | 947        | NA          | NA        |
| 57       | NA        | NA          | NA        | NA          | 1150      | 947        | NA          | NA        |
| 58       | NA        | NA          | NA        | NA          | 1180      | 947        | NA          | NA        |
| 59       | NA        | NA          | NA        | NA          | 1270      | 947        | NA          | NA        |
| 60       | NA        | NA          | NA        | NA          | 1250      | 947        | NA          | NA        |
| 61       | NA        | NA          | NA        | NA          | 1150      | 947        | NA          | NA        |
| 62       | NA        | NA          | NA        | NA          | 1270      | 947        | NA          | NA        |
| 63       | NA        | NA          | NA        | NA          | 1320      | 947        | NA          | NA        |
| 64       | NA        | NA          | NA        | NA          | 1230      | 947        | NA          | NA        |
| 65       |           |             |           |             |           |            |             |           |
| 66       |           |             |           |             |           |            |             |           |
| 67       |           |             |           |             |           |            |             |           |
| 68       |           |             |           |             |           |            |             |           |
| 69       |           |             |           |             |           |            |             |           |
| 70       |           |             |           |             |           |            |             |           |
| 71       |           |             |           |             |           |            |             |           |
| 72       |           |             |           |             |           |            |             |           |
| 73       |           |             |           |             |           |            |             |           |
| 74       |           |             |           |             |           |            |             |           |
| 75       |           |             |           |             |           |            |             |           |
| 76       |           |             |           |             |           |            |             |           |

9/28/2011

Performed by: JEE PAGE Date: 8/30/11

Attachment 7-2 Asphalt Background Survey – Direct Measurements

Performance of  
Radiological Surveys

CS-FO-PR-001  
Revision 1

(Attachment 5.3)  
Equivalent

Survey Cover

Survey ID: Z-BKG-ASPHALT-STATIC-1

Page 1 of 3

Survey Type:

CHAR

Description:

Z BKG Asphalt Static Beta Readings at North Study Area

Performed by:

Jerry Plumlee

Date:

8/27/2011

☒ Direct Survey

☐ Smear Survey

☐ Exposure Rate Survey

Instrumentation

| Model                    | Serial Number | Calibration Due Date | Mode          | Det. Area (cm <sup>2</sup> ) | Inst Eff. (ε <sub>i</sub> ) (%) | Surface Eff. (ε <sub>s</sub> ) (%) |
|--------------------------|---------------|----------------------|---------------|------------------------------|---------------------------------|------------------------------------|
| Alpha (Direct/Removable) |               |                      |               |                              |                                 |                                    |
| D                        | NA            | NA                   | Rate          | NA                           | NA                              | NA                                 |
| R                        | NA            | NA                   | NA            | NA                           | NA                              | NA                                 |
| Beta (Direct/Removable)  |               |                      |               |                              |                                 |                                    |
| D                        | 2350-1 43-68B | 126188 09508         | 8-1-12 5-3-12 | Scalar                       | 126.0                           | 22.0%                              |
| R                        | NA            | NA                   | NA            | NA                           | NA                              | NA                                 |
|                          |               |                      |               |                              | BCF                             | Cal. Const.                        |
| Gamma                    |               |                      |               |                              | mrad per mR/hr                  | cts per mR/hr                      |
| D                        | NA            | NA                   | NA            | NA                           | NA                              | NA                                 |

70 m<sup>2</sup> in size

Diagram

Key

STUDY AREA IS OUTSIDE RESTRICTED AREA JUST NORTH EAST OF MAIN PARKING LOT OUTSIDE RESTRICTED AREA. STUDY AREA IS JUST EAST OF PLANT ACCESS ROAD ON A SECTION OF ASPHALT WHICH SERVED AS AN EASY WAY TO THE FORMER ZION VISITOR CENTER.

Contamination

Σ - LAW

○ - Smear

△ - Direct

Dose Rates  
(OW/CW)

\* - Contact

# - Gen. Area

Air Sampling

A/S - Location

Reviewed by:

*[Signature]*

Date: 8/28/11



CS-FO-PR-001  
Revision 1

Performance of  
Radiological Surveys

(Attachment 5.4)  
Equivalent  
Direct / Removable Activity ( $\alpha/\beta$ )  
Survey ID: Z-BKG-ASPHALT-STATIC-1  
Page 2 of 3

| Parameter    | Units                   | Alpha  |           | Beta   |           |
|--------------|-------------------------|--------|-----------|--------|-----------|
|              |                         | Direct | Removable | Direct | Removable |
| Sample CT    | min                     | NA     | NA        | 1.0    | NA        |
| Bkgd CT      | min                     | NA     | NA        | 10.0   | NA        |
| Resp. Time   | min                     | NA     | NA        | 1.0    | NA        |
| Background   | cpm                     | NA     | NA        | 225    | NA        |
| MDC          | dpm/100 cm <sup>2</sup> | NA     | NA        | 196    | NA        |
| Flag / Limit | dpm/100 cm <sup>2</sup> | NA     | NA        | NA     | NA        |

Pre BKG  
Post BKG

| GA Direct Bkgd (gross cts) |      |
|----------------------------|------|
| 10 min                     | Beta |
| 2253                       | 225  |
| 2251                       |      |
|                            |      |
|                            |      |
|                            |      |

| Location                | Alpha  |           |           |                         | Beta       |           |           |                         |
|-------------------------|--------|-----------|-----------|-------------------------|------------|-----------|-----------|-------------------------|
|                         | Direct | Gross Cts | Removable | dpm/100 cm <sup>2</sup> | Direct     | Gross Cts | Removable | dpm/100 cm <sup>2</sup> |
| Z-BKG-ASPHALT-STATIC-1  | NA     | NA        | NA        | NA                      | Bkgd (cpm) | 225       | 296       | NA                      |
| Z-BKG-ASPHALT-STATIC-2  | NA     | NA        | NA        | NA                      | Bkgd (cpm) | 225       | 188       | NA                      |
| Z-BKG-ASPHALT-STATIC-3  | NA     | NA        | NA        | NA                      | Bkgd (cpm) | 225       | 299       | NA                      |
| Z-BKG-ASPHALT-STATIC-4  | NA     | NA        | NA        | NA                      | Bkgd (cpm) | 225       | 317       | NA                      |
| Z-BKG-ASPHALT-STATIC-5  | NA     | NA        | NA        | NA                      | Bkgd (cpm) | 225       | 155       | NA                      |
| Z-BKG-ASPHALT-STATIC-6  | NA     | NA        | NA        | NA                      | Bkgd (cpm) | 225       | 307       | NA                      |
| Z-BKG-ASPHALT-STATIC-7  | NA     | NA        | NA        | NA                      | Bkgd (cpm) | 225       | 112       | NA                      |
| Z-BKG-ASPHALT-STATIC-8  | NA     | NA        | NA        | NA                      | Bkgd (cpm) | 225       | 213       | NA                      |
| Z-BKG-ASPHALT-STATIC-9  | NA     | NA        | NA        | NA                      | Bkgd (cpm) | 225       | 314       | NA                      |
| Z-BKG-ASPHALT-STATIC-10 | NA     | NA        | NA        | NA                      | Bkgd (cpm) | 225       | 260       | NA                      |
| Z-BKG-ASPHALT-STATIC-11 | NA     | NA        | NA        | NA                      | Bkgd (cpm) | 225       | 195       | NA                      |
| Z-BKG-ASPHALT-STATIC-12 | NA     | NA        | NA        | NA                      | Bkgd (cpm) | 225       | 299       | NA                      |
| Z-BKG-ASPHALT-STATIC-13 | NA     | NA        | NA        | NA                      | Bkgd (cpm) | 225       | 274       | NA                      |
| Z-BKG-ASPHALT-STATIC-14 | NA     | NA        | NA        | NA                      | Bkgd (cpm) | 225       | 393       | NA                      |
| Z-BKG-ASPHALT-STATIC-15 | NA     | NA        | NA        | NA                      | Bkgd (cpm) | 225       | 278       | NA                      |
| Z-BKG-ASPHALT-STATIC-16 | NA     | NA        | NA        | NA                      | Bkgd (cpm) | 225       | 260       | NA                      |
| Z-BKG-ASPHALT-STATIC-17 | NA     | NA        | NA        | NA                      | Bkgd (cpm) | 225       | 227       | NA                      |
| Z-BKG-ASPHALT-STATIC-18 | NA     | NA        | NA        | NA                      | Bkgd (cpm) | 225       | 278       | NA                      |
| Z-BKG-ASPHALT-STATIC-19 | NA     | NA        | NA        | NA                      | Bkgd (cpm) | 225       | 166       | NA                      |
| Z-BKG-ASPHALT-STATIC-20 | NA     | NA        | NA        | NA                      | Bkgd (cpm) | 225       | 202       | NA                      |

Reviewed by: *[Signature]* Date: 8/28/11

Survey ID: Z-BKG-ASPHALT-STATIC-1

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Direct / Removable Activity ( $\alpha/\beta$ ) - Cont.

**(Attachment 5.5)  
Equivalent**

[illegible]

Performed by: Jon D. Galt Date: 8/28/11



Attachment 7-3 Asphalt Sample Results – Primary Nuclides

| Sample               | <sup>228</sup> Ac – (pCi/g) |                    |          | <sup>234</sup> Th - (pCi/g) |                    |          | <sup>235</sup> U – (pCi/g) |                    |          | <sup>137</sup> Cs – (pCi/g) |                    |          |
|----------------------|-----------------------------|--------------------|----------|-----------------------------|--------------------|----------|----------------------------|--------------------|----------|-----------------------------|--------------------|----------|
|                      | Result                      | Error<br>(2-sigma) | MDA      | Result                      | Error<br>(2-sigma) | MDA      | Result                     | Error<br>(2-sigma) | MDA      | Result                      | Error<br>(2-sigma) | MDA      |
| Z-BKG-ASPHALT-SYS-01 | <i>5.78E-02</i>             | 8.43E-02           | 1.58E-01 | <i>-9.45E-02</i>            | 3.64E-01           | 6.30E-01 | <i>3.15E-02</i>            | 1.25E-01           | 2.06E-01 | <i>2.04E-05</i>             | 2.26E-02           | 4.10E-02 |
| Z-BKG-ASPHALT-SYS-02 | <i>2.09E-01</i>             | 1.61E-01           | 3.06E-01 | <i>8.56E-01</i>             | 7.93E-01           | 9.22E-01 | <i>-1.07E-02</i>           | 1.95E-01           | 3.26E-01 | <i>-1.80E-02</i>            | 4.46E-02           | 7.38E-02 |
| Z-BKG-ASPHALT-SYS-03 | <b>1.74E-01</b>             | 6.65E-02           | 9.39E-02 | <i>-4.25E-02</i>            | 3.49E-01           | 6.38E-01 | <i>-3.46E-02</i>           | 1.12E-01           | 1.83E-01 | <i>9.26E-03</i>             | 1.76E-02           | 3.18E-02 |
| Z-BKG-ASPHALT-SYS-04 | <i>1.60E-01</i>             | 9.55E-02           | 1.81E-01 | <i>4.68E-01</i>             | 5.36E-01           | 5.88E-01 | <i>4.31E-02</i>            | 1.11E-01           | 1.90E-01 | <i>-1.43E-02</i>            | 2.31E-02           | 3.91E-02 |
| Z-BKG-ASPHALT-SYS-05 | <b>1.96E-01</b>             | 8.62E-02           | 9.45E-02 | <i>1.43E-01</i>             | 3.30E-01           | 6.12E-01 | <i>3.04E-02</i>            | 1.01E-01           | 1.70E-01 | <i>7.02E-03</i>             | 1.64E-02           | 2.94E-02 |
| Z-BKG-ASPHALT-SYS-06 | <b>2.38E-01</b>             | 1.03E-01           | 1.62E-01 | <i>-2.74E-01</i>            | 3.74E-01           | 6.31E-01 | <i>9.22E-03</i>            | 1.37E-01           | 2.09E-01 | <i>-1.15E-03</i>            | 2.25E-02           | 3.92E-02 |
| Z-BKG-ASPHALT-SYS-07 | <b>1.69E-01</b>             | 7.69E-02           | 1.19E-01 | <i>2.08E-01</i>             | 3.70E-01           | 6.80E-01 | <i>9.16E-02</i>            | 9.99E-02           | 1.73E-01 | <i>-2.59E-03</i>            | 1.94E-02           | 3.46E-02 |
| Z-BKG-ASPHALT-SYS-08 | <b>2.19E-01</b>             | 1.30E-01           | 1.96E-01 | <i>4.84E-01</i>             | 4.20E-01           | 7.83E-01 | <i>-6.65E-02</i>           | 1.11E-01           | 1.79E-01 | <i>-9.48E-03</i>            | 2.22E-02           | 3.82E-02 |
| Z-BKG-ASPHALT-SYS-09 | <b>1.24E-01</b>             | 7.29E-02           | 9.80E-02 | <i>-1.59E-01</i>            | 3.36E-01           | 6.09E-01 | <i>-1.18E-02</i>           | 1.02E-01           | 1.68E-01 | <i>-7.46E-03</i>            | 1.52E-02           | 2.47E-02 |
| Z-BKG-ASPHALT-SYS-10 | <b>1.51E-01</b>             | 8.29E-02           | 1.15E-01 | <i>3.28E-01</i>             | 3.77E-01           | 6.75E-01 | <i>-1.27E-02</i>           | 1.30E-01           | 2.12E-01 | <i>7.39E-03</i>             | 2.30E-02           | 4.26E-02 |
| Z-BKG-ASPHALT-SYS-11 | <b>2.35E-01</b>             | 8.87E-02           | 1.32E-01 | <i>4.35E-02</i>             | 3.98E-01           | 7.22E-01 | <i>5.08E-02</i>            | 1.05E-01           | 1.80E-01 | <i>5.37E-03</i>             | 2.15E-02           | 3.95E-02 |
| Z-BKG-ASPHALT-SYS-12 | <b>2.28E-01</b>             | 1.01E-01           | 1.73E-01 | <i>-2.37E-01</i>            | 3.48E-01           | 6.21E-01 | <i>-5.35E-02</i>           | 1.13E-01           | 1.83E-01 | <i>2.33E-02</i>             | 2.83E-02           | 3.16E-02 |
| Z-BKG-ASPHALT-SYS-13 | <i>1.19E-01</i>             | 8.72E-02           | 1.69E-01 | <i>1.48E-01</i>             | 3.90E-01           | 6.85E-01 | <i>-3.24E-03</i>           | 1.26E-01           | 2.05E-01 | <i>4.57E-03</i>             | 2.35E-02           | 4.29E-02 |
| Z-BKG-ASPHALT-SYS-14 | <i>1.06E-01</i>             | 1.55E-01           | 3.06E-01 | <i>-6.50E-01</i>            | 5.96E-01           | 9.90E-01 | <i>-5.07E-03</i>           | 1.85E-01           | 3.11E-01 | <i>8.76E-03</i>             | 4.91E-02           | 8.64E-02 |
| Z-BKG-ASPHALT-SYS-15 | <i>1.91E-02</i>             | 8.47E-02           | 1.55E-01 | <i>6.88E-02</i>             | 4.08E-01           | 6.97E-01 | <i>-5.93E-03</i>           | 1.35E-01           | 2.19E-01 | <i>5.73E-03</i>             | 2.37E-02           | 4.35E-02 |
| Average              | <b>1.60E-01</b>             | 1.02E-01           | 1.64E-01 | <i>8.60E-02</i>             | 4.43E-01           | 6.99E-01 | <i>3.51E-03</i>            | 1.29E-01           | 2.08E-01 | <i>1.23E-03</i>             | 2.65E-02           | 4.26E-02 |
| Standard Deviation   | <b>6.55E-02</b>             |                    |          | <i>3.65E-01</i>             |                    |          | <i>4.11E-02</i>            |                    |          | <i>1.05E-02</i>             |                    |          |
| 95% Upper CL         | <b>1.90E-01</b>             |                    |          | <i>2.52E-01</i>             |                    |          | <i>2.22E-02</i>            |                    |          | <i>6.02E-03</i>             |                    |          |

a    Bold values are greater than the MDA.  
b    Italicized values are less than the MDA



Attachment 7-4 Asphalt Sample Results wt Progeny

| Sample               | <sup>232</sup> Th Decay Chain |                              |                              | <sup>238</sup> U Decay Chain |                              |                              | <sup>40</sup> K<br>(pCi/g) | <sup>235</sup> U<br>(pCi/g) | <sup>137</sup> Cs<br>(pCi/g) |
|----------------------|-------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|----------------------------|-----------------------------|------------------------------|
|                      | <sup>228</sup> Ac<br>(pCi/g)  | <sup>212</sup> Pb<br>(pCi/g) | <sup>208</sup> Tl<br>(pCi/g) | <sup>234</sup> Th<br>(pCi/g) | <sup>214</sup> Pb<br>(pCi/g) | <sup>214</sup> Bi<br>(pCi/g) |                            |                             |                              |
| Z-BKG-ASPHALT-SYS-01 | 5.78E-02                      | 1.05E-01                     | 1.31E-01                     | -9.45E-02                    | 8.38E-02                     | 1.01E-01                     | 3.36E+00                   | 3.15E-02                    | 2.04E-05                     |
| Z-BKG-ASPHALT-SYS-02 | 2.09E-01                      | 2.37E-01                     | 1.65E-01                     | 8.56E-01                     | 2.09E-01                     | 1.27E-01                     | 6.32E+00                   | -1.07E-02                   | -1.80E-02                    |
| Z-BKG-ASPHALT-SYS-03 | 1.74E-01                      | 1.55E-01                     | 1.81E-01                     | -4.25E-02                    | 1.54E-01                     | 1.41E-01                     | 4.58E+00                   | -3.46E-02                   | 9.26E-03                     |
| Z-BKG-ASPHALT-SYS-04 | 1.60E-01                      | 1.72E-01                     | 1.23E-01                     | 4.68E-01                     | 1.37E-01                     | 6.25E-02                     | 4.35E+00                   | 4.31E-02                    | -1.43E-02                    |
| Z-BKG-ASPHALT-SYS-05 | 1.96E-01                      | 2.00E-01                     | 1.09E-01                     | 1.43E-01                     | 1.29E-01                     | 1.51E-01                     | 4.39E+00                   | 3.04E-02                    | 7.02E-03                     |
| Z-BKG-ASPHALT-SYS-06 | 2.38E-01                      | 1.81E-01                     | 1.38E-01                     | -2.74E-01                    | 1.75E-01                     | 1.29E-01                     | 4.76E+00                   | 9.22E-03                    | -1.15E-03                    |
| Z-BKG-ASPHALT-SYS-07 | 1.69E-01                      | 1.49E-01                     | 7.40E-02                     | 2.08E-01                     | 1.38E-01                     | 8.26E-02                     | 4.19E+00                   | 9.16E-02                    | -2.59E-03                    |
| Z-BKG-ASPHALT-SYS-08 | 2.19E-01                      | 1.33E-01                     | 1.26E-01                     | 4.84E-01                     | 1.60E-01                     | 1.81E-01                     | 5.15E+00                   | -6.65E-02                   | -9.48E-03                    |
| Z-BKG-ASPHALT-SYS-09 | 1.24E-01                      | 1.57E-01                     | 9.55E-02                     | -1.59E-01                    | 1.53E-01                     | 1.10E-01                     | 3.77E+00                   | -1.18E-02                   | -7.46E-03                    |
| Z-BKG-ASPHALT-SYS-10 | 1.51E-01                      | 1.66E-01                     | 2.00E-01                     | 3.28E-01                     | 1.79E-01                     | 1.06E-01                     | 3.85E+00                   | -1.27E-02                   | 7.39E-03                     |
| Z-BKG-ASPHALT-SYS-11 | 2.35E-01                      | 2.06E-01                     | 1.74E-01                     | 4.35E-02                     | 1.48E-01                     | 1.74E-01                     | 6.05E+00                   | 5.08E-02                    | 5.37E-03                     |
| Z-BKG-ASPHALT-SYS-12 | 2.28E-01                      | 2.23E-01                     | 1.81E-01                     | -2.37E-01                    | 2.25E-01                     | 1.29E-01                     | 6.01E+00                   | -5.35E-02                   | 2.33E-02                     |
| Z-BKG-ASPHALT-SYS-13 | 1.19E-01                      | 1.99E-01                     | 2.92E-01                     | 1.48E-01                     | 1.79E-01                     | 1.66E-01                     | 5.19E+00                   | -3.24E-03                   | 4.57E-03                     |
| Z-BKG-ASPHALT-SYS-14 | 1.06E-01                      | 2.30E-01                     | 2.29E-01                     | -6.50E-01                    | 1.59E-01                     | 4.78E-02                     | 3.69E+00                   | -5.07E-03                   | 8.76E-03                     |
| Z-BKG-ASPHALT-SYS-15 | 1.91E-02                      | 1.46E-01                     | 1.38E-01                     | 6.88E-02                     | 9.92E-02                     | 8.04E-02                     | 3.96E+00                   | -5.93E-03                   | 5.73E-03                     |
| Average              | 1.60E-01                      | 1.77E-01                     | 1.57E-01                     | 8.60E-02                     | 1.55E-01                     | 1.19E-01                     | 4.64E+00                   | 3.51E-03                    | 1.23E-03                     |
| Standard Deviation   | 6.55E-02                      | 3.81E-02                     | 5.56E-02                     | 3.65E-01                     | 3.68E-02                     | 4.01E-02                     | 9.26E-01                   | 4.11E-02                    | 1.05E-02                     |
| 95% Upper CL         | 1.90E-01                      | 1.95E-01                     | 1.82E-01                     | 2.52E-01                     | 1.72E-01                     | 1.37E-01                     | 5.06E+00                   | 2.22E-02                    | 6.02E-03                     |

a Bold values are greater than the MDA.  
b Italicized values are less than the MDA

Attachment 7-5 Concrete Background Survey – Surface Scans

Hosah Park Beta Scan Picnic Area 1 8-24-2011 (Autosaved)

Performance of  
Radiological Surveys

CS-FO-PR-001  
Revision 1

(Attachment 5.3  
Equivalent

Survey Cover

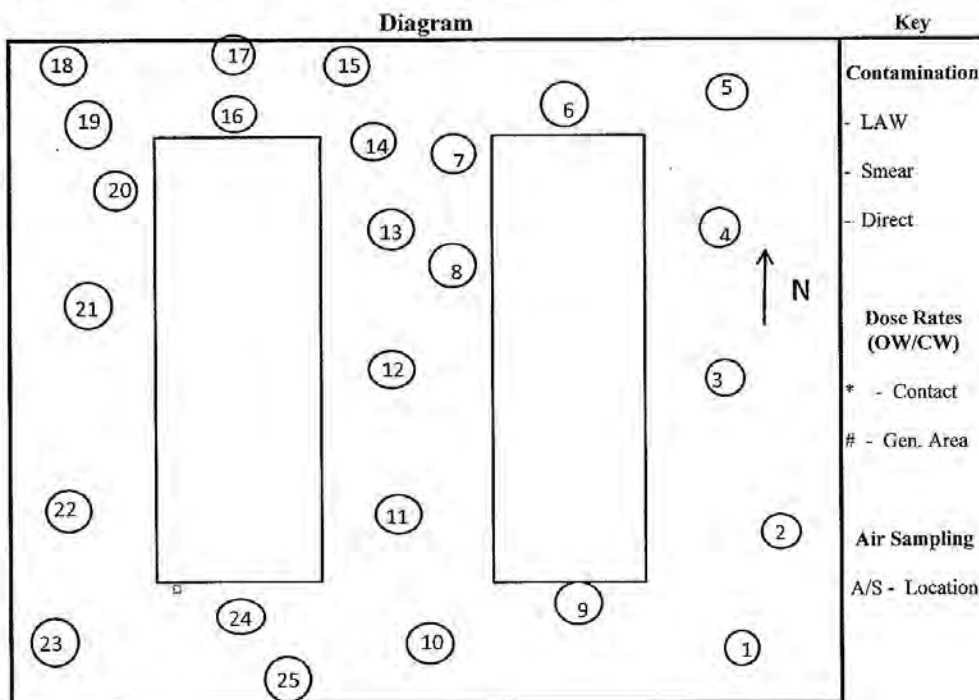
Survey ID: Z-BKG-CONCRETE-SCAN-3

Page 1 of 3

Survey Type: CHAR  
Description: Hosah Park Preservation Area 1 Beta Scan  
Performed by: Jerry Plumlee  
Date: 8/24/2011

Instrumentation

| Model                           | Serial Number | Calibration Due Date | Mode          | Det. Area | Inst Eff. (ei) | Surface Eff.  |
|---------------------------------|---------------|----------------------|---------------|-----------|----------------|---------------|
|                                 |               |                      | Scalar / Rate | (cm2)     | (%)            | (%)           |
| <b>Alpha (Direct/Removable)</b> |               |                      |               |           |                |               |
| D                               | NA            | NA                   | NA            | NA        | NA             | NA            |
| R                               | NA            | NA                   | NA            | NA        | NA             | NA            |
| <b>Beta (Scan)</b>              |               |                      |               |           |                |               |
| D                               | 2350-1 43-37B | 98620 09279          | 8-1-12 5-2-12 | Rate      | 584.0          | 19.0%         |
| R                               | NA            | NA                   | NA            | NA        | NA             | NA            |
| <b>Gamma</b>                    |               |                      |               |           | BCF            | Cal. Const.   |
|                                 |               |                      |               |           | mrad per mR/hr | cts per mR/hr |
| D                               | NA            | NA                   | NA            | NA        | NA             | NA            |



9/28/2011

Reviewed by:

*[Signature]*

Date:

8/30/11

CS-FO-PR-001  
Revision 1

Hosah Park Beta Scan Picnic Area 1 8-24-2011 (Autosaved)

Survey ID: Z-BKG-CONCRETE-SCAN-3

Page 2 of 3

**Beta Scan**  
(Attachment 5.4)  
Equivalent

| Parameter    | Units       | Alpha  |           | Beta  |           |
|--------------|-------------|--------|-----------|-------|-----------|
|              |             | Direct | Removable | Scan  | Removable |
| Sample CT    | min         | NA     | NA        | 1 sec | NA        |
| Bkgd CT      | min         | NA     | NA        | 10.0  | NA        |
| Resp. Time   | min         | NA     | NA        | 1 sec | NA        |
| Background   | cpm         | NA     | NA        | 1053  | NA        |
| MDC SCAN     | dpm/100 cm2 | NA     | NA        | N/A   | NA        |
| Flag / Limit | dpm/100 cm2 | NA     | NA        | N/A   | NA        |

| Beta Scan Bkgd (cpm) |          |
|----------------------|----------|
| 10 min               | Avg Bkgd |
| 10542                | 1053     |
| 10513                |          |
|                      |          |
|                      |          |

Pre BKD  
Post BKD  
Avg 1258 cpm  
of 30 observations  
Avg Bkg 1053 cpm  
\* P.R. N.D.R. = 622 cpm  
\* Avg Bkg 1053 cpm  
\* P.R. N.D.R. = 622 cpm

| Location | Alpha     |             |           |             | Beta      |                |             |           |
|----------|-----------|-------------|-----------|-------------|-----------|----------------|-------------|-----------|
|          | Direct    |             | Removable |             | Scan      |                | Removable   |           |
|          | Gross Cts | dpm/100 cm2 | Gross Cts | dpm/100 cm2 | Gross cpm | Avg Bkgd (cpm) | dpm/100 cm2 | Gross Cts |
| 1        | NA        | NA          | NA        | NA          | 1280      | 1053           | NA          | NA        |
| 2        | NA        | NA          | NA        | NA          | 1270      | 1053           | NA          | NA        |
| 3        | NA        | NA          | NA        | NA          | 1270      | 1053           | NA          | NA        |
| 4        | NA        | NA          | NA        | NA          | 1240      | 1053           | NA          | NA        |
| 5        | NA        | NA          | NA        | NA          | 1410      | 1053           | NA          | NA        |
| 6        | NA        | NA          | NA        | NA          | 1330      | 1053           | NA          | NA        |
| 7        | NA        | NA          | NA        | NA          | 1340      | 1053           | NA          | NA        |
| 8        | NA        | NA          | NA        | NA          | 1390      | 1053           | NA          | NA        |
| 9        | NA        | NA          | NA        | NA          | 1310      | 1053           | NA          | NA        |
| 10       | NA        | NA          | NA        | NA          | 1340      | 1053           | NA          | NA        |
| 11       | NA        | NA          | NA        | NA          | 1350      | 1053           | NA          | NA        |
| 12       | NA        | NA          | NA        | NA          | 1250      | 1053           | NA          | NA        |
| 13       | NA        | NA          | NA        | NA          | 1290      | 1053           | NA          | NA        |
| 14       | NA        | NA          | NA        | NA          | 1350      | 1053           | NA          | NA        |
| 15       | NA        | NA          | NA        | NA          | 1420      | 1053           | NA          | NA        |
| 16       | NA        | NA          | NA        | NA          | 1360      | 1053           | NA          | NA        |
| 17       | NA        | NA          | NA        | NA          | 1310      | 1053           | NA          | NA        |
| 18       | NA        | NA          | NA        | NA          | 1450      | 1053           | NA          | NA        |
| 19       | NA        | NA          | NA        | NA          | 1370      | 1053           | NA          | NA        |
| 20       | NA        | NA          | NA        | NA          | 1310      | 1053           | NA          | NA        |

9/28/2011

Reviewed by:  Date: 8/30/11



Survey ID: Z-BKD-CONCRETE-SCAN-1

Page 3 of 3

**Beta Scan - Cont.**

**(Attachment 5.5)  
Equivalent**

[illegible]

9/28/2011

Performed by: Joe Ogden Date: 8/30/11

Hosah Park Beta Scan Picnic Area 2 8-24-2011 (Autosaved)

Performance of  
Radiological Surveys

CS-FO-PR-001  
Revision 1

(Attachment 5.3  
Equivalent

Survey Cover

Survey ID: Z-BKG-CONCRETE-SCAN-3

Page 1 of 2

Survey Type:

CHAR

Description:

Hosah Park Preservation Area 2 Beta Scan

Performed by:

Jerry Plumlee

Date:

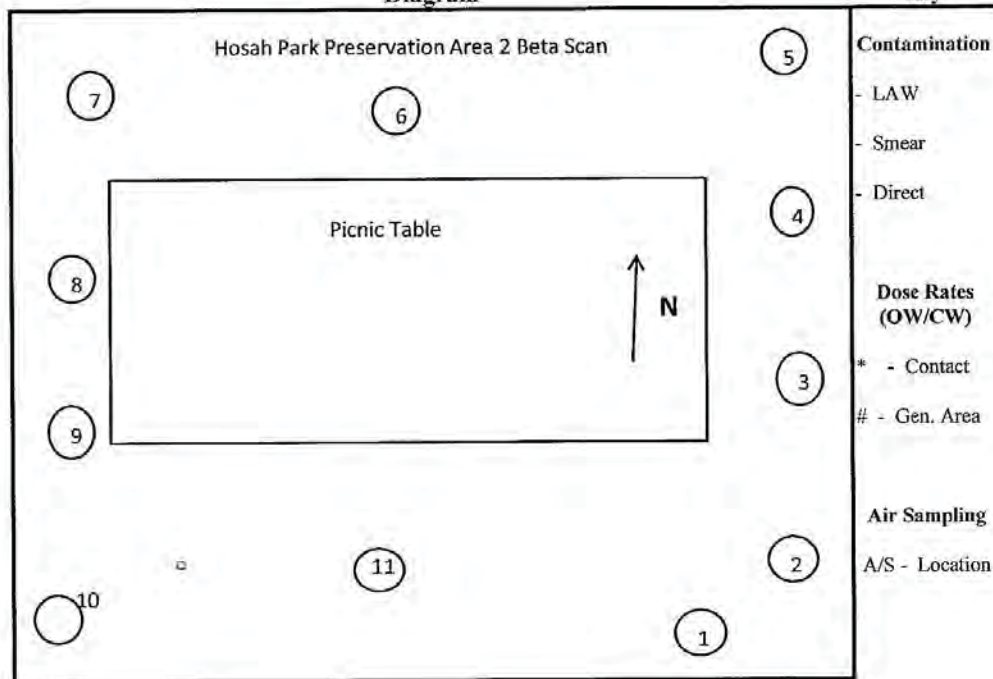
8/24/2011

Instrumentation

| Model                           | Serial Number | Calibration Due Date | Mode Scalar / Rate | Det. Area (cm <sup>2</sup> ) | Inst Eff. (el) (%) | Surface Eff. (%) |
|---------------------------------|---------------|----------------------|--------------------|------------------------------|--------------------|------------------|
| <b>Alpha (Direct/Removable)</b> |               |                      |                    |                              |                    |                  |
| D NA                            | NA            | NA                   | NA                 | NA                           | NA                 | NA               |
| R NA                            | NA            | NA                   | NA                 | NA                           | NA                 | NA               |
| <b>Beta (Scan)</b>              |               |                      |                    |                              |                    |                  |
| D 2350-1 43-37B                 | 98620 09279   | 8-1-12 5-2-12        | Rate               | 584.0                        | 19.0%              | 100.0%           |
| R NA                            | NA            | NA                   | NA                 | NA                           | NA                 | NA               |
| <b>Gamma</b>                    |               |                      |                    |                              | BCF                | Cal. Const.      |
|                                 |               |                      |                    |                              | mrad per mR/hr     | cts per mR/hr    |
| D NA                            | NA            | NA                   | NA                 | NA                           | NA                 | NA               |

Diagram

Key



0/28/2011

Reviewed by:

*[Signature]*

Date:

8/30/11



Survey ID: Z-BKG-CONCRETE-SCAN-3  
Page 2 of 2

**Beta Scan  
(Attachment 5.4)  
Equivalent**

| Beta Scan Bkgd (cpm) |          |
|----------------------|----------|
| 10 min               | Avg Bkgd |
| 10584                | 1073     |
| 10872                |          |
|                      |          |
|                      |          |
|                      |          |
|                      |          |

Pre BKG  
Post BKG  
Avg 138cpm  
Std 36cpm  
ATV BKG 138cpm  
Avg and std 623cpm  
GAS 0 on 1053cpm-006

| Parameter    | Units       | Alpha  |           | Beta  |           |
|--------------|-------------|--------|-----------|-------|-----------|
|              |             | Direct | Removable | Scan  | Removable |
| Sample CT    | min         | NA     | NA        | 1 sec | NA        |
| Bkgd CT      | min         | NA     | NA        | 10.0  | NA        |
| Resp. Time   | min         | NA     | NA        | 1 sec | NA        |
| Background   | cpm         | NA     | NA        | 1073  | NA        |
| MDC          | cpm/100 cm2 | NA     | NA        | N/A   | NA        |
| Flag / Limit | cpm/100 cm2 | NA     | NA        | NA    | NA        |

[illegible]

Reviewed by: Joe Graham Date: 5/22/11

Attachment 7-6 Concrete Background Survey – Direct Measurements

Performance of  
Radiological Surveys

CS-FO-PR-001  
Revision 1

(Attachment 5.3)  
Equivalent

Survey Cover

Survey ID: 7-BKG-CONC-STAT-13

Page 1 of 2

Survey Type: INFO

Description: Hosah Park Picnic Area Concrete Bkg Re-Survey 1 minute Statics

Performed by: Vicky Baldwin

Date: 8/24/2011

- ☒ Direct Survey  
☐ Smear Survey  
☐ Exposure Rate Survey

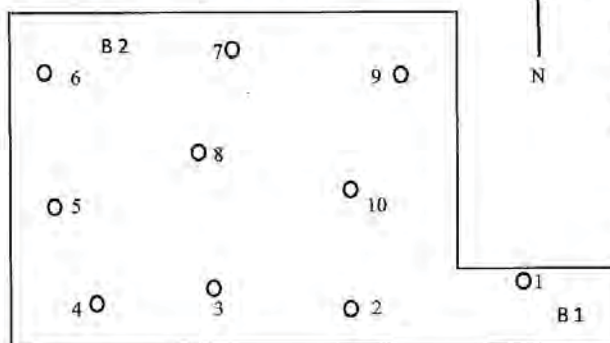
Instrumentation

Hosah Park is located North of Plant.

| Model                           | Serial Number | Calibration Due Date | Mode<br>Scalar / Rate | Det. Area<br>(cm <sup>2</sup> ) | Inst<br>(%) | Surface<br>(%) |
|---------------------------------|---------------|----------------------|-----------------------|---------------------------------|-------------|----------------|
| <b>Alpha (Direct/Removable)</b> |               |                      |                       |                                 |             |                |
| D NA                            | NA            | NA                   |                       | NA                              | NA          | NA             |
| R NA                            | NA            | NA                   |                       | NA                              | NA          | NA             |
| <b>Beta (Direct/Removable)</b>  |               |                      |                       |                                 |             |                |
| D 2350-1                        | 126188        | 1-Aug-12             | Scalar                | 126.0                           | 22.0%       | 100.0%         |
| R NA                            | NA            | NA                   |                       | NA                              | NA          | NA             |
| D 43-48B                        | 092508        | 3-May-12             | Scalar                |                                 | BCF         | Cal. Const.    |
|                                 |               |                      |                       |                                 | d per mts   | ts per mR/hr   |
| D NA                            | NA            | NA                   |                       | NA                              | NA          | NA             |

Diagram

Picnic Area Concrete area is: 12' x 10'



Note: Total of 3-1 minute static measurements collected on the concrete.

# O : number and location of measurement.

See attached for results

B 3: Location of Backgrounds

Reviewed by: [Signature]

Date: 8/24/11



### Direct / Removable Activity ( $\alpha/\beta$ )

Survey ID: Z-3086-CONC-STAT133

| Parameter    | Units                   | Alpha  |           | Beta   |           |
|--------------|-------------------------|--------|-----------|--------|-----------|
|              |                         | Direct | Removable | Direct | Removable |
| Sample CT    | min                     |        |           | 1.0    | NA        |
| Bkgd CT      | min                     |        |           | 10.0   |           |
| Resp. Time   | min                     |        |           | 1.0    | 0.18      |
| Background   | cpm                     |        |           | 267.2  |           |
| MDC          | dpm/100 cm <sup>2</sup> |        |           | 213.3  | 208.6     |
| Flag / Limit | dpm/100 cm <sup>2</sup> |        |           | 213.3  | 208.6     |

[illegible][illegible]

Reviewed by: Joe Sparto Date: 8/24/11

Performance of  
Radiological Surveys

CS-FO-PR-001  
Revision 1

(Attachment 5.3)  
Equivalent

Survey Cover

Survey ID: 2-016-con-static-3  
Page 1 of 2

Survey Type: INFO

Description: Hosah Park Preservation Area Concrete Bkg Re- Survey 1 minute Statics

Performed by: Vicky Baldwin

Date: 8/24/2011

- ☒ Direct Survey  
☐ Smear Survey  
☐ Exposure Rate Survey

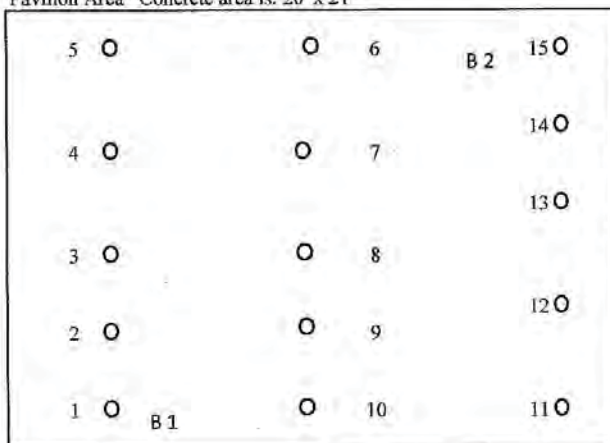
Instrumentation

Hosah Park is located North of Plant.

| Model                           | Serial Number | Calibration Due Date | Mode<br>Scalar / Rate | Det. Area<br>(cm <sup>2</sup> ) | Inst<br>(%)         | Surface<br>(%) |
|---------------------------------|---------------|----------------------|-----------------------|---------------------------------|---------------------|----------------|
| <b>Alpha (Direct/Removable)</b> |               |                      |                       |                                 |                     |                |
| D NA                            | NA            | NA                   |                       | NA                              | NA                  | NA             |
| R NA                            | NA            | NA                   |                       | NA                              | NA                  | NA             |
| <b>Beta (Direct/Removable)</b>  |               |                      |                       |                                 |                     |                |
| D 2350-1                        | 126188        | 1-Aug-12             | Scalar                | 126.0                           | 22.0%               | 100.0%         |
| R NA                            | NA            | NA                   |                       | NA                              | NA                  | NA             |
| D 43-683                        | 093508        | 3 May 12             | Scalar                |                                 | BCF                 | Cal. Const.    |
|                                 |               |                      |                       |                                 | d per mcts per mR/h |                |
| D NA                            | NA            | NA                   |                       | NA                              | NA                  | NA             |

Diagram

Pavilion Area Concrete area is: 20' x 21'



Note Total of 15-1 minute static measurements collected on the concrete.

# O : number and location of measurement.

See attached for results



B # : Location of BKG

Reviewed by: Joe O'Neil Date: 8/24/11



**Direct / Removable Activity ( $\alpha/\beta$ )**  
(Attachment 5.4)  
Equivalent

[illegible]

Reviewed by: Joe Spiller Date: 8/14/11



Attachment 7-7 Concrete Sample Results – Primary Nuclides

| Sample                      | <sup>228</sup> Ac – (pCi/g) |                    |          | <sup>234</sup> Th - (pCi/g) |                    |          | <sup>235</sup> U – (pCi/g) |                    |          | <sup>137</sup> Cs – (pCi/g) |                    |          |
|-----------------------------|-----------------------------|--------------------|----------|-----------------------------|--------------------|----------|----------------------------|--------------------|----------|-----------------------------|--------------------|----------|
|                             | Result                      | Error<br>(2-sigma) | MDA      | Result                      | Error<br>(2-sigma) | MDA      | Result                     | Error<br>(2-sigma) | MDA      | Result                      | Error<br>(2-sigma) | MDA      |
| Z-BKG-ICEHOUSE-CONC-SYS-1   | <b>5.68E-01</b>             | 1.32E-01           | 1.27E-01 | <i>5.80E-01</i>             | 5.45E-01           | 7.41E-01 | <i>3.67E-02</i>            | 1.55E-01           | 2.56E-01 | <i>3.06E-02</i>             | 2.85E-02           | 5.35E-02 |
| Z-BKG-ICEHOUSE-CONC-SYS-2   | <b>3.02E-01</b>             | 1.14E-01           | 1.36E-01 | <i>4.91E-01</i>             | 4.68E-01           | 8.49E-01 | <i>1.83E-01</i>            | 1.81E-01           | 2.15E-01 | <i>1.47E-02</i>             | 2.41E-02           | 4.55E-02 |
| Z-BKG-RETENTWALL-CONC-SYS-1 | <b>2.53E-01</b>             | 1.14E-01           | 1.24E-01 | <i>7.97E-03</i>             | 3.66E-01           | 6.28E-01 | <i>-4.20E-02</i>           | 1.23E-01           | 1.99E-01 | <i>2.05E-02</i>             | 2.21E-02           | 4.22E-02 |
| Z-BKG-FLAGPOLE-CONC-SYS-1   | <b>3.11E-01</b>             | 1.49E-01           | 2.07E-01 | <b>9.24E-01</b>             | 6.07E-01           | 6.11E-01 | <i>2.29E-02</i>            | 1.41E-01           | 2.33E-01 | <i>2.85E-02</i>             | 2.57E-02           | 4.90E-02 |
| Z-BKG-BEACHHOUSE-CONC-SYS-1 | <b>1.83E-01</b>             | 7.69E-02           | 1.56E-01 | <b>7.36E-01</b>             | 5.02E-01           | 5.07E-01 | <b>1.96E-01</b>            | 2.06E-01           | 1.94E-01 | <b>4.51E-02</b>             | 2.55E-02           | 2.77E-02 |
| Z-BKG-CONC-SYS-1            | <b>2.78E-01</b>             | 7.27E-02           | 8.54E-02 | <i>9.73E-02</i>             | 3.57E-01           | 6.47E-01 | <i>1.50E-02</i>            | 1.19E-01           | 1.94E-01 | <i>-1.80E-03</i>            | 1.85E-02           | 3.15E-02 |
| Z-BKG-CONC-SYS-2            | <b>3.63E-01</b>             | 1.86E-01           | 3.24E-01 | <i>1.28E-01</i>             | 5.90E-01           | 1.00E+00 | <i>1.08E-01</i>            | 1.89E-01           | 3.25E-01 | <i>-5.32E-03</i>            | 4.43E-02           | 7.34E-02 |
| Z-BKG-CONC-SYS-3            | <b>1.76E-01</b>             | 7.41E-02           | 1.03E-01 | <i>8.86E-02</i>             | 3.57E-01           | 6.44E-01 | <i>6.25E-02</i>            | 1.16E-01           | 1.91E-01 | <i>8.91E-03</i>             | 1.50E-02           | 2.87E-02 |
| Z-BKG-CONC-SYS-4            | <b>2.61E-01</b>             | 8.98E-02           | 1.03E-01 | <i>2.19E-01</i>             | 4.11E-01           | 7.14E-01 | <i>1.62E-02</i>            | 1.42E-01           | 2.19E-01 | <i>-2.02E-03</i>            | 2.26E-02           | 4.08E-02 |
| Z-BKG-CONC-SYS-5            | <i>2.40E-01</i>             | 1.78E-01           | 3.43E-01 | <i>1.88E-01</i>             | 6.42E-01           | 1.10E+00 | <i>1.11E-01</i>            | 2.04E-01           | 3.52E-01 | <i>3.70E-02</i>             | 4.57E-02           | 8.31E-02 |
| Z-BKG-CONC-SYS-6            | <b>2.76E-01</b>             | 9.06E-02           | 1.13E-01 | <i>2.64E-01</i>             | 3.92E-01           | 6.84E-01 | <i>7.17E-02</i>            | 1.28E-01           | 2.14E-01 | <i>-1.20E-02</i>            | 2.30E-02           | 3.99E-02 |
| Z-BKG-CONC-SYS-7            | <b>3.90E-01</b>             | 1.03E-01           | 1.17E-01 | <b>6.83E-01</b>             | 6.99E-01           | 6.12E-01 | <i>-1.09E-02</i>           | 1.16E-01           | 1.92E-01 | <i>-7.90E-04</i>            | 2.19E-02           | 3.62E-02 |
| Z-BKG-CONC-SYS-8            | <b>4.38E-01</b>             | 1.94E-01           | 3.55E-01 | <i>4.89E-02</i>             | 5.94E-01           | 1.01E+00 | <b>3.48E-01</b>            | 2.62E-01           | 3.18E-01 | <i>2.69E-02</i>             | 4.27E-02           | 7.62E-02 |
| Z-BKG-CONC-SYS-9            | <b>2.25E-01</b>             | 7.67E-02           | 1.03E-01 | <b>8.23E-01</b>             | 5.78E-01           | 4.85E-01 | <i>1.13E-01</i>            | 1.18E-01           | 1.95E-01 | <i>-2.11E-03</i>            | 1.52E-02           | 2.72E-02 |
| Z-BKG-CONC-SYS-10           | <b>3.54E-01</b>             | 1.14E-01           | 1.34E-01 | <i>-6.30E-02</i>            | 4.15E-01           | 7.06E-01 | <i>8.56E-02</i>            | 1.38E-01           | 2.31E-01 | <i>-7.32E-03</i>            | 2.33E-02           | 4.10E-02 |
| Average                     | <b>3.08E-01</b>             | 1.24E-01           | 1.69E-01 | <i>3.48E-01</i>             | <i>5.14E-01</i>    | 7.29E-01 | <i>8.78E-02</i>            | <i>1.61E-01</i>    | 2.35E-01 | <i>1.21E-02</i>             | <i>2.82E-02</i>    | 4.64E-02 |
| Standard Deviation          | <b>1.03E-01</b>             |                    |          | <i>3.27E-01</i>             |                    |          | <i>9.81E-02</i>            |                    |          | <i>1.82E-02</i>             |                    |          |
| 95% Upper CL                | <b>3.55E-01</b>             |                    |          | <i>4.96E-01</i>             |                    |          | <i>1.32E-01</i>            |                    |          | <i>2.03E-02</i>             |                    |          |

a    Bold values are greater than the MDA.  
b    Italicized values are less than the MDA

Attachment 7-8 Concrete Sample Results wt Progeny

| Sample                      | <sup>232</sup> Th Decay Chain |                              |                              | <sup>238</sup> U Decay Chain |                              |                              | <sup>40</sup> K<br>(pCi/g) | <sup>235</sup> U<br>(pCi/g) | <sup>137</sup> Cs<br>(pCi/g) |
|-----------------------------|-------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|----------------------------|-----------------------------|------------------------------|
|                             | <sup>228</sup> Ac<br>(pCi/g)  | <sup>212</sup> Pb<br>(pCi/g) | <sup>208</sup> Tl<br>(pCi/g) | <sup>234</sup> Th<br>(pCi/g) | <sup>214</sup> Pb<br>(pCi/g) | <sup>214</sup> Bi<br>(pCi/g) |                            |                             |                              |
| Z-BKG-ICEHOUSE-CONC-SYS-1   | 5.68E-01                      | 6.52E-01                     | 4.95E-01                     | 5.80E-01                     | 4.45E-01                     | 4.13E-01                     | 1.08E+01                   | 3.67E-02                    | 3.06E-02                     |
| Z-BKG-ICEHOUSE-CONC-SYS-2   | 3.02E-01                      | 3.39E-01                     | 2.75E-01                     | 4.91E-01                     | 3.10E-01                     | 3.60E-01                     | 1.17E+01                   | 1.83E-01                    | 1.47E-02                     |
| Z-BKG-RETENTWALL-CONC-SYS-1 | 2.53E-01                      | 2.38E-01                     | 1.83E-01                     | 7.97E-03                     | 2.65E-01                     | 2.33E-01                     | 4.06E+00                   | -4.20E-02                   | 2.05E-02                     |
| Z-BKG-FLAGPOLE-CONC-SYS-1   | 3.11E-01                      | 3.01E-01                     | 2.23E-01                     | 9.24E-01                     | 3.73E-01                     | 3.48E-01                     | 5.23E+00                   | 2.29E-02                    | 2.85E-02                     |
| Z-BKG-BEACHHOUSE-CONC-SYS-1 | 1.83E-01                      | 1.97E-01                     | 1.41E-01                     | 7.36E-01                     | 3.16E-01                     | 3.27E-01                     | 4.03E+00                   | 1.96E-01                    | 4.51E-02                     |
| Z-BKG-CONC-SYS-1            | 2.78E-01                      | 2.57E-01                     | 2.19E-01                     | 9.73E-02                     | 2.81E-01                     | 2.47E-01                     | 4.89E+00                   | 1.50E-02                    | -1.80E-03                    |
| Z-BKG-CONC-SYS-2            | 3.63E-01                      | 3.41E-01                     | 2.32E-01                     | 1.28E-01                     | 2.43E-01                     | 3.47E-01                     | 3.83E+00                   | 1.08E-01                    | -5.32E-03                    |
| Z-BKG-CONC-SYS-3            | 1.76E-01                      | 1.60E-01                     | 2.06E-01                     | 8.86E-02                     | 2.09E-01                     | 1.61E-01                     | 3.83E+00                   | 6.25E-02                    | 8.91E-03                     |
| Z-BKG-CONC-SYS-4            | 2.61E-01                      | 2.84E-01                     | 2.80E-01                     | 2.19E-01                     | 2.95E-01                     | 2.52E-01                     | 4.70E+00                   | 1.62E-02                    | -2.02E-03                    |
| Z-BKG-CONC-SYS-5            | 2.40E-01                      | 3.02E-01                     | 1.84E-01                     | 1.88E-01                     | 2.94E-01                     | 3.40E-01                     | 4.57E+00                   | 1.11E-01                    | 3.70E-02                     |
| Z-BKG-CONC-SYS-6            | 2.76E-01                      | 2.62E-01                     | 2.71E-01                     | 2.64E-01                     | 2.76E-01                     | 3.00E-01                     | 4.63E+00                   | 7.17E-02                    | -1.20E-02                    |
| Z-BKG-CONC-SYS-7            | 3.90E-01                      | 3.50E-01                     | 3.36E-01                     | 6.83E-01                     | 2.46E-01                     | 2.70E-01                     | 4.12E+00                   | -1.09E-02                   | -7.90E-04                    |
| Z-BKG-CONC-SYS-8            | 4.38E-01                      | 2.25E-01                     | 2.71E-01                     | 4.89E-02                     | 3.63E-01                     | 2.73E-01                     | 3.55E+00                   | 3.48E-01                    | 2.69E-02                     |
| Z-BKG-CONC-SYS-9            | 2.25E-01                      | 2.24E-01                     | 2.22E-01                     | 8.23E-01                     | 2.31E-01                     | 2.63E-01                     | 4.40E+00                   | 1.13E-01                    | -2.11E-03                    |
| Z-BKG-CONC-SYS-10           | 3.54E-01                      | 3.89E-01                     | 3.65E-01                     | -6.30E-02                    | 3.92E-01                     | 3.65E-01                     | 8.85E+00                   | 8.56E-02                    | -7.32E-03                    |
| Average                     | 3.08E-01                      | 3.01E-01                     | 2.60E-01                     | 3.48E-01                     | 3.03E-01                     | 3.00E-01                     | 5.55E+00                   | 8.78E-02                    | 1.21E-02                     |
| Standard Deviation          | 1.03E-01                      | 1.15E-01                     | 8.74E-02                     | 3.27E-01                     | 6.57E-02                     | 6.51E-02                     | 2.63E+00                   | 9.81E-02                    | 1.82E-02                     |
| 95% Upper CL                | 3.55E-01                      | 3.54E-01                     | 3.00E-01                     | 4.96E-01                     | 3.32E-01                     | 3.30E-01                     | 6.74E+00                   | 1.32E-01                    | 2.03E-02                     |

a    Bold values are greater than the MDA.  
b    Italicized values are less than the MDA

Attachment 7-9 Soil Survey – Surface Scans

Zion Bkg Gamma Scans Soil Area 8-12-11

Performance of  
Radiological Surveys

CS-FO-PR-001  
Revision 1

(Attachment 5.3)  
Equivalent

Survey Cover

Survey ID: Z-BKG-SOIL-SCAN-1

Page 1 of 8

Survey Type:

INFO

Description:

Zion Bkg Gamma Scan Soil Area - NE (70' x 150')

Performed by:

Jerry Plumlee, Vicki Baldwin

Date:

8/12/2011

Average Area Exposure Rate Scan Value: 5710 cpm

Instrumentation

Minimum Value: 4320 cpm

Maximum Value: 7410 cpm

| Model                           | Serial Number | Calibration Due Date | Mode<br>Scalar / Rate | Det. Area<br>(cm <sup>2</sup> ) | Inst Eff. (ei)<br>(%) | Surface Eff.<br>(%) |
|---------------------------------|---------------|----------------------|-----------------------|---------------------------------|-----------------------|---------------------|
| <b>Alpha (Direct/Removable)</b> |               |                      |                       |                                 |                       |                     |
| D NA                            | NA            | NA                   | NA                    | NA                              | NA                    | NA                  |
| R NA                            | NA            | NA                   | NA                    | NA                              | NA                    | NA                  |
| <b>Beta (Scan)</b>              |               |                      |                       |                                 |                       |                     |
| D NA                            | NA            | NA                   | NA                    | NA                              | NA                    | NA                  |
| R NA                            | NA            | NA                   | NA                    | NA                              | NA                    | NA                  |
| <b>Gamma</b>                    |               |                      |                       |                                 | BCF                   | Cal. Const.         |
|                                 |               |                      |                       |                                 | mrad per mR/hr        | cts per mR/hr       |
| E 2350-1 w 44-10                | 95352         | 7-Jan-12             | Rate                  | NA                              | NA                    | 1.0%                |

44-10674140

Diagram

Key

Note:  
10 min pre bkg: 54320 gross counts or 5432 cpm  
10 min Post bkg: 52769 gross counts or 5277 cpm

See attached sheet # 7  
8724

**Contamination**

- LAW
- Smear
- Direct

**Dose Rates (OW/CW)**

- \* - Contact
- # - Gen. Area

**Air Sampling**

A/S - Location

8/12/2011

Reviewed by: J. O'Garra

Date: 8/12/11



Performance of  
Radiological Surveys

Zion Bkg Gamma Scans Soil Area 8-12-11

CS-FO-PR-001

Revision 1

(Attachment 5.6)  
Equivalent

Exposure Rates ( $\beta$ - $\gamma$ )

Survey ID: Z-BKG-SOIL-SCAN-1

Page 2 of 4

| Location | Ion Chamber |       |         | NaI(Tl) |           |       |
|----------|-------------|-------|---------|---------|-----------|-------|
|          | OW          | CW    | Beta    | Na      | Rate Mode |       |
|          | mR/hr       | mR/hr | mRad/hr | Na      | In Cpm    | mR/hr |
| 1        | NA          | NA    | NA      | NA      | 5930      | NA    |
| 2        |             |       |         |         | 5450      |       |
| 3        |             |       |         |         | 5150      |       |
| 4        |             |       |         |         | 5900      |       |
| 5        |             |       |         |         | 5410      |       |
| 6        |             |       |         |         | 6150      |       |
| 7        |             |       |         |         | 5550      |       |
| 8        |             |       |         |         | 5530      |       |
| 9        |             |       |         |         | 5160      |       |
| 10       |             |       |         |         | 5780      |       |
| 11       |             |       |         |         | 5700      |       |
| 12       |             |       |         |         | 6060      |       |
| 13       |             |       |         |         | 5740      |       |
| 14       |             |       |         |         | 5460      |       |
| 15       |             |       |         |         | 5750      |       |
| 16       |             |       |         |         | 5490      |       |
| 17       |             |       |         |         | 5510      |       |
| 18       |             |       |         |         | 6060      |       |
| 19       |             |       |         |         | 5490      |       |
| 20       |             |       |         |         | 5510      |       |
| 21       |             |       |         |         | 6220      |       |
| 22       |             |       |         |         | 5450      |       |
| 23       |             |       |         |         | 5750      |       |
| 24       |             |       |         |         | 5920      |       |
| 25       |             |       |         |         | 6620      |       |
| 26       |             |       |         |         | 6010      |       |
| 27       |             |       |         |         | 6270      |       |
| 28       |             |       |         |         | 5220      |       |
| 29       |             |       |         |         | 5540      |       |
| 30       |             |       |         |         | 5870      |       |
| 31       |             |       |         |         | 5160      |       |
| 32       |             |       |         |         | 5900      |       |
| 33       |             |       |         |         | 6030      |       |
| 34       |             |       |         |         | 6210      |       |
| 35       |             |       |         |         | 6630      |       |
| 36       |             |       |         |         | 5950      |       |
| 37       |             |       |         |         | 6390      |       |
| 38       |             |       |         |         | 6400      |       |
| 39       |             |       |         |         | 5820      |       |

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Performance of  
Radiological Surveys

Zion Bkg Gamma Scans Soil Area 8-12-11

CS-FO-PR-001

Revision 1

(Attachment 5.6)  
Equivalent

Exposure Rates ( $\beta$ - $\gamma$ )

Survey ID: Z-BKG-SOIL-SCAN-1

Page 3 of 9

| Location | Ion Chamber |       |         | NaI(Tl) |           |       |
|----------|-------------|-------|---------|---------|-----------|-------|
|          | OW          | CW    | Beta    | Na      | Rate Mode |       |
|          | mR/hr       | mR/hr | mRad/hr | Na      | In Cpm    | mR/hr |
| 40       | NA          | NA    | NA      | NA      | 6050      | NA    |
| 41       |             |       |         |         | 5990      |       |
| 42       |             |       |         |         | 5650      |       |
| 43       |             |       |         |         | 4950      |       |
| 44       |             |       |         |         | 5030      |       |
| 45       |             |       |         |         | 4950      |       |
| 46       |             |       |         |         | 5250      |       |
| 7        |             |       |         |         | 5150      |       |
| 48       |             |       |         |         | 5300      |       |
| 49       |             |       |         |         | 5600      |       |
| 50       |             |       |         |         | 5060      |       |
| 51       |             |       |         |         | 5400      |       |
| 52       |             |       |         |         | 4990      |       |
| 53       |             |       |         |         | 5250      |       |
| 54       |             |       |         |         | 5260      |       |
| 55       |             |       |         |         | 4940      |       |
| 56       |             |       |         |         | 4520      |       |
| 57       |             |       |         |         | 4580      |       |
| 58       |             |       |         |         | 4750      |       |
| 59       |             |       |         |         | 5000      |       |
| 60       |             |       |         |         | 5230      |       |
| 61       |             |       |         |         | 5550      |       |
| 62       |             |       |         |         | 5170      |       |
| 63       |             |       |         |         | 4820      |       |
| 64       |             |       |         |         | 4760      |       |
| 65       |             |       |         |         | 4680      |       |
| 66       |             |       |         |         | 5080      |       |
| 67       |             |       |         |         | 4320      |       |
| 68       |             |       |         |         | 4600      |       |
| 69       |             |       |         |         | 5050      |       |
| 70       |             |       |         |         | 4930      |       |
| 71       |             |       |         |         | 5330      |       |
| 72       |             |       |         |         | 5220      |       |
| 73       |             |       |         |         | 5680      |       |
| 74       |             |       |         |         | 5250      |       |
| 75       |             |       |         |         | 5050      |       |
| 76       |             |       |         |         | 5900      |       |
| 77       |             |       |         |         | 6610      |       |
| 78       |             |       |         |         | 5580      |       |

8/12/2011

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Performance of  
Radiological Surveys

Zion Bkg Gamma Scans Soil Area 8-12-11

CS-FO-PR-001  
Revision 1

(Attachment 5.6)  
Equivalent

Exposure Rates ( $\beta$ - $\gamma$ )

Survey ID: Z-BKG-SOIL-SCAN-1

Page 4 of 8

| Location | Ion Chamber |       |         | NaI(Tl) |           |       |
|----------|-------------|-------|---------|---------|-----------|-------|
|          | OW          | CW    | Beta    | Na      | Rate Mode |       |
|          | mR/hr       | mR/hr | mRad/hr | Na      | In Cpm    | mR/hr |
| 79       | NA          | NA    | NA      | NA      | 5760      | NA    |
| 80       |             |       |         |         | 5420      |       |
| 81       |             |       |         |         | 5850      |       |
| 82       |             |       |         |         | 6220      |       |
| 83       |             |       |         |         | 5580      |       |
| 84       |             |       |         |         | 5650      |       |
| 85       |             |       |         |         | 5710      |       |
| 86       |             |       |         |         | 6010      |       |
| 87       |             |       |         |         | 6330      |       |
| 88       |             |       |         |         | 5530      |       |
| 89       |             |       |         |         | 5520      |       |
| 90       |             |       |         |         | 5750      |       |
| 91       |             |       |         |         | 5590      |       |
| 92       |             |       |         |         | 5990      |       |
| 93       |             |       |         |         | 6100      |       |
| 94       |             |       |         |         | 5530      |       |
| 95       |             |       |         |         | 5700      |       |
| 96       |             |       |         |         | 5350      |       |
| 97       |             |       |         |         | 5490      |       |
| 98       |             |       |         |         | 6330      |       |
| 99       |             |       |         |         | 6450      |       |
| 100      |             |       |         |         | 6000      |       |
| 101      |             |       |         |         | 5530      |       |
| 102      |             |       |         |         | 5800      |       |
| 103      |             |       |         |         | 5260      |       |
| 104      |             |       |         |         | 4990      |       |
| 105      |             |       |         |         | 4660      |       |
| 106      |             |       |         |         | 4580      |       |
| 107      |             |       |         |         | 5550      |       |
| 108      |             |       |         |         | 6000      |       |
| 109      |             |       |         |         | 6300      |       |
| 110      |             |       |         |         | 6220      |       |
| 111      |             |       |         |         | 6490      |       |
| 112      |             |       |         |         | 6360      |       |
| 113      |             |       |         |         | 5890      |       |
| 114      |             |       |         |         | 5960      |       |
| 115      |             |       |         |         | 6080      |       |
| 116      |             |       |         |         | 5560      |       |
| 117      |             |       |         |         | 5760      |       |

8/12/2011

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Performance of  
Radiological Surveys

Zion Bkg Gamma Scans Soil Area 8-12-11

CS-FO-PR-001  
Revision 1

(Attachment 5.6)  
Equivalent

Exposure Rates ( $\beta$ - $\gamma$ )

Survey ID: Z-BKG-SOIL-SCAN-1

Page 5 of 8

| Location | Ion Chamber |       |         | NaI(Tl) |           |       |
|----------|-------------|-------|---------|---------|-----------|-------|
|          | OW          | CW    | Beta    | Na      | Rate Mode |       |
|          | mR/hr       | mR/hr | mRad/hr | Na      | In Cpm    | mR/hr |
| 118      | NA          | NA    | NA      | NA      | 5640      | NA    |
| 119      |             |       |         |         | 5960      |       |
| 120      |             |       |         |         | 5750      |       |
| 121      |             |       |         |         | 5540      |       |
| 122      |             |       |         |         | 6200      |       |
| 123      |             |       |         |         | 6040      |       |
| 124      |             |       |         |         | 6290      |       |
| 125      |             |       |         |         | 6070      |       |
| 126      |             |       |         |         | 6310      |       |
| 127      |             |       |         |         | 6400      |       |
| 128      |             |       |         |         | 5830      |       |
| 129      |             |       |         |         | 6500      |       |
| 130      |             |       |         |         | 6900      |       |
| 131      |             |       |         |         | 5450      |       |
| 132      |             |       |         |         | 6130      |       |
| 133      |             |       |         |         | 5470      |       |
| 134      |             |       |         |         | 5230      |       |
| 135      |             |       |         |         | 4950      |       |
| 136      |             |       |         |         | 5640      |       |
| 137      |             |       |         |         | 6080      |       |
| 138      |             |       |         |         | 6370      |       |
| 139      |             |       |         |         | 5750      |       |
| 140      |             |       |         |         | 5940      |       |
| 141      |             |       |         |         | 5450      |       |
| 142      |             |       |         |         | 6830      |       |
| 143      |             |       |         |         | 6060      |       |
| 144      |             |       |         |         | 6370      |       |
| 145      |             |       |         |         | 5600      |       |
| 146      |             |       |         |         | 6680      |       |
| 147      |             |       |         |         | 6590      |       |
| 148      |             |       |         |         | 5970      |       |
| 149      |             |       |         |         | 5530      |       |
| 150      |             |       |         |         | 5430      |       |
| 151      |             |       |         |         | 5450      |       |
| 152      |             |       |         |         | 5440      |       |
| 153      |             |       |         |         | 6410      |       |
| 154      |             |       |         |         | 6230      |       |
| 155      |             |       |         |         | 5410      |       |
| 156      |             |       |         |         | 5580      |       |

8/12/2011

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CS-FO-PR-001  
Revision 1

Performance of  
Radiological Surveys

Zion Bkg Gamma Scans Soil Area 8-12-11

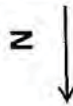
(Attachment 5.5) Zion Bkg Gamma Soil Scan Area - NE  
Equivalent

Survey ID: 7-BKG-SOIL-SCAN-1

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| Location | Column1  | Column2 | Column3 | Column4 | Column5 | Column6 | Column7 | Column8 |     |     |     |     |     |     |     |     |    |
|----------|--|---------|---------|---------|---------|---------|---------|---------|-----|-----|-----|-----|-----|-----|-----|-----|----|
|          | Area is 70' x 150' Note: # locations indicate where 2350-1 w 44-10 scan readings were taken. |         |         |         |         |         |         |         |     |     |     |     |     |     |     |     |    |
|          | 32   | 33      | 34      | 35      | 36      | 37      | 38      | 39      | 40  | 41  | 42  | 43  |     |     |     |     |    |
|          | 31   |         |         |         |         |         |         |         |     |     |     | 44  |     |     |     |     |    |
|          | 30   |         |         |         |         |         |         |         |     |     |     | 45  |     |     |     |     |    |
|          | 29   |         |         |         |         |         |         |         |     |     |     | 46  |     |     |     |     |    |
|          | 28   | 151     | 153     | 155     | 157     | 159     | 160     | 161     | 163 | 164 | 165 | 47  |     |     |     |     |    |
|          | 27   | 150     | 152     | 154     | 156     | 158     | 159     | 160     | 161 | 162 | 163 | 164 | 48  |     |     |     |    |
|          | 26   |         |         |         |         |         |         |         |     |     |     | 49  |     |     |     |     |    |
|          | 25   |         |         |         |         |         |         |         |     |     |     | 50  |     |     |     |     |    |
|          | 24   |         |         |         |         |         |         |         |     |     |     | 51  |     |     |     |     |    |
|          | 23   | 149     | 148     | 147     | 146     | 145     | 144     | 143     | 142 | 141 | 140 | 139 | 138 | 137 | 136 | 52  |    |
|          | 22   |         |         |         |         |         |         |         |     |     |     |     |     |     |     | 53  |    |
|          | 21   |         |         |         |         |         |         |         |     |     |     |     |     |     |     | 54  |    |
|          | 20   |         |         |         |         |         |         |         |     |     |     |     |     |     |     | 55  |    |
|          | 19   |         |         |         |         |         |         |         |     |     |     |     |     |     |     | 56  |    |
|          | 18   | 120     | 122     | 124     | 126     | 128     | 130     | 132     | 134 | 136 | 138 | 140 | 142 | 144 | 146 | 57  |    |
|          | 17   |         |         |         |         |         |         |         |     |     |     |     |     |     |     | 58  |    |
|          | 16   |         |         |         |         |         |         |         |     |     |     |     |     |     |     | 59  |    |
|          | 15   |         |         |         |         |         |         |         |     |     |     |     |     |     |     | 60  |    |
|          | 14   |         |         |         |         |         |         |         |     |     |     |     |     |     |     | 61  |    |
|          | 13   | 118     | 117     | 116     | 115     | 114     | 113     | 112     | 111 | 110 | 109 | 108 | 107 | 106 | 105 | 62  |    |
|          | 12   | 119     |         |         |         |         |         |         |     |     |     |     |     |     |     | 63  |    |
|          | 11   |         |         |         |         |         |         |         |     |     |     |     |     |     |     | 64  |    |
|          | 10   |         |         |         |         |         |         |         |     |     |     |     |     |     |     | 65  |    |
|          | 9  |         |         |         |         |         |         |         |     |     |     |     |     |     |     | 66  |    |
|          | 8  |         |         |         |         |         |         |         |     |     |     |     |     |     |     | 67  |    |
|          | 7  |         |         |         |         |         |         |         |     |     |     |     |     |     |     | 68  |    |
|          | 6  | 90      | 91      | 92      | 93      | 94      | 95      | 96      | 97  | 98  | 99  | 100 | 101 | 102 | 103 | 104 | 69 |
|          | 5  |         |         |         |         |         |         |         |     |     |     |     |     |     |     |     | 70 |
|          | 4  |         |         |         |         |         |         |         |     |     |     |     |     |     |     |     | 71 |
|          | 3  |         |         |         |         |         |         |         |     |     |     |     |     |     |     |     | 72 |
|          | 2  |         |         |         |         |         |         |         |     |     |     |     |     |     |     |     | 73 |
|          | 1  | 89      | 88      | 87      | 86      | 85      | 84      | 83      | 82  | 81  | 80  | 79  | 78  | 77  | 76  | 75  | 74 |

N



8/12/2011

Performed by: SEE PAGE 1 Date: 8/12/11

Attachment 7-10 Soil Survey – Direct Measurements

Performance of  
Radiological Surveys

CS-FO-PR-001  
Revision 1

(Attachment 5.3)  
Equivalent

Survey Cover

Survey ID: Z-BKG-Static-2011  
Page 1 of 2

Survey Type: INFO  
Description: Zion Gamma Bkg Static measurements located North field  
Performed by: Vicky Baldwin / Jerry Plumlee  
Date: 8/12/2011

- ☒ Direct Survey  
☐ Smear Survey  
☐ Exposure Rate Survey

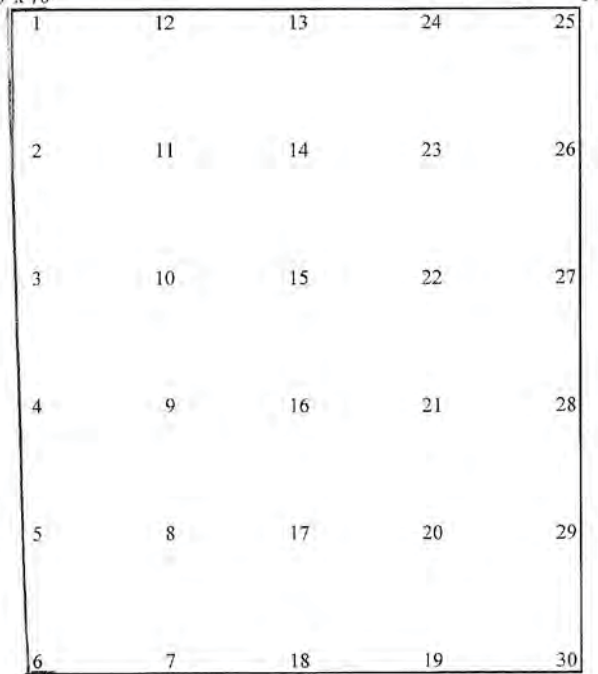
Instrumentation

Size of area is 10,500ft<sup>2</sup>. 30 - 1 minute static measurements were collected.  
Static measurements were collected at 4 inches above soil.

| Model                           | Serial Number | Calibration Due Date | Mode<br>Scalar / Rate | Det. Area<br>(cm <sup>2</sup> ) | Inst Eff. (ε <sub>i</sub> )<br>(%) | Surface Eff. (ε <sub>s</sub> )<br>(%) |
|---------------------------------|---------------|----------------------|-----------------------|---------------------------------|------------------------------------|---------------------------------------|
| <b>Alpha (Direct/Removable)</b> |               |                      |                       |                                 |                                    |                                       |
| D                               | NA            |                      |                       |                                 |                                    |                                       |
| R                               |               |                      |                       | NA                              |                                    |                                       |
| <b>Beta (Direct/Removable)</b>  |               |                      |                       |                                 |                                    |                                       |
| D                               | NA            |                      |                       |                                 |                                    |                                       |
| R                               |               |                      |                       | NA                              |                                    |                                       |
| <b>Gamma</b>                    |               |                      |                       |                                 | BCF                                | Cal. Const.                           |
|                                 |               |                      |                       |                                 | mrad per mR/hr                     | cts per mR/hr                         |
| D                               | NA            | 95352                | 1/7/12                | Scalar                          | NA                                 | na                                    |
|                                 |               |                      |                       |                                 |                                    | 1.00E-00                              |

Diagram

Area is: 150' x 70'



Key

Contamination

- Smear  
 - Direct

Dose Rates  
(OW/CW)

- \* - Contact  
 # - Gen. Area

Air Sampling

A/S - Location

Reviewed by: J. Dyer Date: 8/12/11



**CS-FO-PR-001**  
**Revision 1**

Survey ID: 7-060-301-STATKJ  
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Attachment 7-11 Surface Soil Results – Primary Nuclides

| Sample             | <sup>228</sup> Ac – (pCi/g) |                    |          | <sup>234</sup> Th - (pCi/g) |                    |          | <sup>235</sup> U – (pCi/g) |                    |          | <sup>137</sup> Cs – (pCi/g) |                    |          |
|--------------------|-----------------------------|--------------------|----------|-----------------------------|--------------------|----------|----------------------------|--------------------|----------|-----------------------------|--------------------|----------|
|                    | Result                      | Error<br>(2-sigma) | MDA      | Result                      | Error<br>(2-sigma) | MDA      | Result                     | Error<br>(2-sigma) | MDA      | Result                      | Error<br>(2-sigma) | MDA      |
| Z-BKG-SOIL-SF-01   | 7.21E-01                    | 1.63E-01           | 1.44E-01 | 3.15E-01                    | 4.95E-01           | 8.63E-01 | 8.43E-02                   | 1.59E-01           | 2.60E-01 | 1.05E-02                    | 2.39E-02           | 4.31E-02 |
| Z-BKG-SOIL-SF-02   | 3.33E-01                    | 9.38E-02           | 1.14E-01 | 1.52E-01                    | 4.06E-01           | 7.07E-01 | 2.38E-01                   | 1.79E-01           | 2.14E-01 | -8.53E-03                   | 2.09E-02           | 3.50E-02 |
| Z-BKG-SOIL-SF-03   | 6.49E-01                    | 2.26E-01           | 3.00E-01 | -1.17E-01                   | 8.12E-01           | 1.33E+00 | 7.23E-02                   | 2.46E-01           | 4.02E-01 | -2.82E-02                   | 5.54E-02           | 8.57E-02 |
| Z-BKG-SOIL-SF-04   | 6.13E-01                    | 1.50E-01           | 2.73E-01 | 1.18E+00                    | 8.62E-01           | 7.54E-01 | 7.40E-02                   | 1.36E-01           | 2.28E-01 | -1.27E-02                   | 2.62E-02           | 4.43E-02 |
| Z-BKG-SOIL-SF-05   | 4.19E-01                    | 1.08E-01           | 1.27E-01 | -2.74E-01                   | 4.71E-01           | 7.97E-01 | -1.46E-01                  | 1.63E-01           | 2.46E-01 | 6.60E-02                    | 4.81E-02           | 3.87E-02 |
| Z-BKG-SOIL-SF-06   | 5.34E-01                    | 1.30E-01           | 1.36E-01 | 8.54E-01                    | 8.61E-01           | 7.89E-01 | 8.29E-02                   | 1.65E-01           | 2.64E-01 | 1.84E-03                    | 2.47E-02           | 4.29E-02 |
| Z-BKG-SOIL-SF-07   | 5.13E-01                    | 1.16E-01           | 1.49E-01 | 5.17E-01                    | 5.19E-01           | 9.29E-01 | 6.32E-02                   | 1.37E-01           | 2.33E-01 | -9.25E-03                   | 2.86E-02           | 4.49E-02 |
| Z-BKG-SOIL-SF-08   | 4.27E-01                    | 2.58E-01           | 3.92E-01 | 3.37E-01                    | 7.13E-01           | 1.23E+00 | 2.92E-01                   | 2.65E-01           | 3.76E-01 | 1.17E-02                    | 4.80E-02           | 8.33E-02 |
| Z-BKG-SOIL-SF-09   | 5.29E-01                    | 1.44E-01           | 1.57E-01 | 1.18E+00                    | 1.06E+00           | 8.87E-01 | 6.50E-02                   | 1.64E-01           | 2.80E-01 | -6.62E-03                   | 3.15E-02           | 5.55E-02 |
| Z-BKG-SOIL-SF-10   | 4.20E-01                    | 1.23E-01           | 1.40E-01 | 9.60E-01                    | 5.63E-01           | 7.37E-01 | 2.16E-01                   | 2.36E-01           | 2.54E-01 | 1.49E-02                    | 2.68E-02           | 4.88E-02 |
| Z-BKG-SOIL-SF-11   | 4.91E-01                    | 1.10E-01           | 1.59E-01 | 5.12E-01                    | 5.61E-01           | 9.98E-01 | 2.34E-02                   | 1.40E-01           | 2.37E-01 | 5.31E-03                    | 2.51E-02           | 4.55E-02 |
| Z-BKG-SOIL-SF-12   | 6.18E-01                    | 1.30E-01           | 1.47E-01 | 8.13E-01                    | 8.46E-01           | 7.82E-01 | 8.56E-02                   | 1.58E-01           | 2.62E-01 | 9.79E-03                    | 2.58E-02           | 4.69E-02 |
| Z-BKG-SOIL-SF-13   | 4.73E-01                    | 1.17E-01           | 1.49E-01 | 1.22E+00                    | 8.89E-01           | 7.16E-01 | -4.03E-02                  | 1.50E-01           | 2.44E-01 | 2.93E-02                    | 2.44E-02           | 3.73E-02 |
| Z-BKG-SOIL-SF-14   | 4.93E-01                    | 1.18E-01           | 1.32E-01 | 4.82E-01                    | 4.41E-01           | 7.85E-01 | 2.69E-01                   | 2.12E-01           | 2.18E-01 | 1.13E-02                    | 2.23E-02           | 4.08E-02 |
| Z-BKG-SOIL-SF-15   | 5.68E-01                    | 1.25E-01           | 1.31E-01 | 9.40E-01                    | 5.52E-01           | 7.32E-01 | 9.54E-02                   | 1.53E-01           | 2.54E-01 | 3.82E-03                    | 2.71E-02           | 4.44E-02 |
| Average            | 5.20E-01                    | 1.47E-01           | 1.77E-01 | 6.05E-01                    | 6.98E-01           | 8.69E-01 | 9.83E-02                   | 1.82E-01           | 2.65E-01 | 6.61E-03                    | 3.23E-02           | 4.91E-02 |
| Standard Deviation | 1.02E-01                    |                    |          | 4.68E-01                    |                    |          | 1.16E-01                   |                    |          | 2.15E-02                    |                    |          |
| 95% Upper CL       | 5.66E-01                    |                    |          | 8.18E-01                    |                    |          | 1.51E-01                   |                    |          | 1.64E-02                    |                    |          |

a Bold values are greater than the MDA.  
b Italicized values are less than the MDA

Attachment 7-12 Surface Soil Results wt Progeny

| Sample             | <sup>232</sup> Th Decay Chain |                              |                              | <sup>238</sup> U Decay Chain |                              |                              | <sup>40</sup> K<br>(pCi/g) | <sup>235</sup> U<br>(pCi/g) | <sup>137</sup> Cs<br>(pCi/g) |
|--------------------|-------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|----------------------------|-----------------------------|------------------------------|
|                    | <sup>228</sup> Ac<br>(pCi/g)  | <sup>212</sup> Pb<br>(pCi/g) | <sup>208</sup> Tl<br>(pCi/g) | <sup>234</sup> Th<br>(pCi/g) | <sup>214</sup> Pb<br>(pCi/g) | <sup>214</sup> Bi<br>(pCi/g) |                            |                             |                              |
| Z-BKG-SOIL-SF-01   | 7.21E-01                      | 7.35E-01                     | 6.04E-01                     | 3.15E-01                     | 6.46E-01                     | 6.97E-01                     | 1.76E+01                   | 8.43E-02                    | 1.05E-02                     |
| Z-BKG-SOIL-SF-02   | 3.33E-01                      | 4.21E-01                     | 3.89E-01                     | 1.52E-01                     | 3.74E-01                     | 3.94E-01                     | 1.13E+01                   | 2.38E-01                    | -8.53E-03                    |
| Z-BKG-SOIL-SF-03   | 6.49E-01                      | 4.47E-01                     | 5.21E-01                     | -1.17E-01                    | 4.97E-01                     | 4.27E-01                     | 1.52E+01                   | 7.23E-02                    | -2.82E-02                    |
| Z-BKG-SOIL-SF-04   | 6.13E-01                      | 4.98E-01                     | 3.54E-01                     | 1.18E+00                     | 5.23E-01                     | 5.25E-01                     | 1.33E+01                   | 7.40E-02                    | -1.27E-02                    |
| Z-BKG-SOIL-SF-05   | 4.19E-01                      | 4.34E-01                     | 4.64E-01                     | -2.74E-01                    | 4.34E-01                     | 3.80E-01                     | 1.29E+01                   | -1.46E-01                   | 6.60E-02                     |
| Z-BKG-SOIL-SF-06   | 5.34E-01                      | 5.29E-01                     | 4.65E-01                     | 8.54E-01                     | 7.37E-01                     | 7.19E-01                     | 1.67E+01                   | 8.29E-02                    | 1.84E-03                     |
| Z-BKG-SOIL-SF-07   | 5.13E-01                      | 5.55E-01                     | 4.24E-01                     | 5.17E-01                     | 5.51E-01                     | 4.97E-01                     | 1.44E+01                   | 6.32E-02                    | -9.25E-03                    |
| Z-BKG-SOIL-SF-08   | 4.27E-01                      | 4.16E-01                     | 4.56E-01                     | 3.37E-01                     | 5.07E-01                     | 5.77E-01                     | 1.11E+01                   | 2.92E-01                    | 1.17E-02                     |
| Z-BKG-SOIL-SF-09   | 5.29E-01                      | 5.83E-01                     | 2.51E-01                     | 1.18E+00                     | 5.11E-01                     | 5.60E-01                     | 1.48E+01                   | 6.50E-02                    | -6.62E-03                    |
| Z-BKG-SOIL-SF-10   | 4.20E-01                      | 5.23E-01                     | 5.65E-01                     | 9.60E-01                     | 5.71E-01                     | 6.44E-01                     | 1.52E+01                   | 2.16E-01                    | 1.49E-02                     |
| Z-BKG-SOIL-SF-11   | 4.91E-01                      | 4.76E-01                     | 3.90E-01                     | 5.12E-01                     | 5.25E-01                     | 4.31E-01                     | 1.31E+01                   | 2.34E-02                    | 5.31E-03                     |
| Z-BKG-SOIL-SF-12   | 6.18E-01                      | 6.46E-01                     | 4.92E-01                     | 8.13E-01                     | 6.55E-01                     | 6.38E-01                     | 1.56E+01                   | 8.56E-02                    | 9.79E-03                     |
| Z-BKG-SOIL-SF-13   | 4.73E-01                      | 5.74E-01                     | 4.50E-01                     | 1.22E+00                     | 5.67E-01                     | 5.67E-01                     | 1.52E+01                   | -4.03E-02                   | 2.93E-02                     |
| Z-BKG-SOIL-SF-14   | 4.93E-01                      | 5.05E-01                     | 3.71E-01                     | 4.82E-01                     | 5.99E-01                     | 6.45E-01                     | 1.11E+01                   | 2.69E-01                    | 1.13E-02                     |
| Z-BKG-SOIL-SF-15   | 5.68E-01                      | 6.04E-01                     | 4.82E-01                     | 9.40E-01                     | 4.55E-01                     | 4.66E-01                     | 1.28E+01                   | 9.54E-02                    | 3.82E-03                     |
| Average            | 5.20E-01                      | 5.30E-01                     | 4.45E-01                     | 6.05E-01                     | 5.43E-01                     | 5.44E-01                     | 1.40E+01                   | 9.83E-02                    | 6.61E-03                     |
| Standard Deviation | 1.02E-01                      | 8.94E-02                     | 8.78E-02                     | 4.68E-01                     | 9.21E-02                     | 1.10E-01                     | 2.00E+00                   | 1.16E-01                    | 2.15E-02                     |
| 95% Upper CL       | 5.66E-01                      | 5.70E-01                     | 4.85E-01                     | 8.18E-01                     | 5.85E-01                     | 5.94E-01                     | 1.49E+01                   | 1.51E-01                    | 1.64E-02                     |

a Bold values are greater than the MDA.  
b Italicized values are less than the MDA

Attachment 7-13 Subsurface Soil Results – Primary Nuclides

| Sample             | <sup>228</sup> Ac – (pCi/g) |                    |          | <sup>234</sup> Th - (pCi/g) |                    |          | <sup>235</sup> U – (pCi/g) |                    |          | <sup>137</sup> Cs – (pCi/g) |                    |          |
|--------------------|-----------------------------|--------------------|----------|-----------------------------|--------------------|----------|----------------------------|--------------------|----------|-----------------------------|--------------------|----------|
|                    | Result                      | Error<br>(2-sigma) | MDA      | Result                      | Error<br>(2-sigma) | MDA      | Result                     | Error<br>(2-sigma) | MDA      | Result                      | Error<br>(2-sigma) | MDA      |
| Z-BKG-SOIL-DP-01   | 5.63E-01                    | 1.15E-01           | 1.36E-01 | 8.40E-01                    | 5.09E-01           | 9.02E-01 | 7.38E-02                   | 1.63E-01           | 2.67E-01 | 1.54E-02                    | 2.51E-02           | 4.57E-02 |
| Z-BKG-SOIL-DP-02   | 4.20E-01                    | 9.65E-02           | 1.15E-01 | -6.15E-02                   | 3.99E-01           | 6.74E-01 | 3.49E-02                   | 1.27E-01           | 2.11E-01 | -1.23E-02                   | 2.10E-02           | 3.59E-02 |
| Z-BKG-SOIL-DP-03   | 3.68E-01                    | 1.42E-01           | 2.14E-01 | -1.33E-01                   | 4.26E-01           | 7.24E-01 | 1.84E-01                   | 2.07E-01           | 2.45E-01 | -6.58E-03                   | 2.48E-02           | 4.12E-02 |
| Z-BKG-SOIL-DP-04   | 4.70E-01                    | 1.14E-01           | 1.39E-01 | 3.28E-01                    | 4.86E-01           | 8.45E-01 | 1.17E-01                   | 1.56E-01           | 2.49E-01 | 9.48E-03                    | 2.41E-02           | 4.10E-02 |
| Z-BKG-SOIL-DP-05   | 5.45E-01                    | 3.08E-01           | 3.71E-01 | 3.68E-01                    | 7.36E-01           | 1.18E+00 | -1.88E-03                  | 2.25E-01           | 3.67E-01 | -3.47E-02                   | 4.83E-02           | 7.37E-02 |
| Z-BKG-SOIL-DP-06   | 3.63E-01                    | 1.05E-01           | 1.18E-01 | 7.32E-01                    | 6.18E-01           | 6.37E-01 | 7.08E-02                   | 1.41E-01           | 2.27E-01 | 4.71E-03                    | 2.30E-02           | 3.93E-02 |
| Z-BKG-SOIL-DP-07   | 6.52E-01                    | 1.22E-01           | 1.29E-01 | 8.34E-01                    | 7.20E-01           | 7.73E-01 | 2.37E-02                   | 1.61E-01           | 2.64E-01 | -2.80E-03                   | 2.67E-02           | 4.12E-02 |
| Z-BKG-SOIL-DP-08   | 6.25E-01                    | 1.07E-01           | 1.40E-01 | 7.61E-01                    | 6.37E-01           | 7.31E-01 | -6.06E-02                  | 1.51E-01           | 2.43E-01 | 1.46E-02                    | 2.37E-02           | 4.33E-02 |
| Z-BKG-SOIL-DP-09   | 5.32E-01                    | 1.21E-01           | 1.30E-01 | 1.39E+00                    | 5.36E-01           | 8.91E-01 | -6.42E-02                  | 1.71E-01           | 2.53E-01 | -1.48E-02                   | 2.38E-02           | 3.94E-02 |
| Z-BKG-SOIL-DP-10   | 5.50E-01                    | 1.19E-01           | 1.46E-01 | 3.59E-01                    | 4.81E-01           | 8.38E-01 | 1.09E-01                   | 1.49E-01           | 2.47E-01 | -1.83E-02                   | 2.36E-02           | 3.87E-02 |
| Z-BKG-SOIL-DP-11   | 5.86E-01                    | 2.13E-01           | 2.62E-01 | 1.41E+00                    | 1.28E+00           | 1.10E+00 | -6.16E-02                  | 2.37E-01           | 3.90E-01 | -4.04E-03                   | 4.62E-02           | 7.74E-02 |
| Z-BKG-SOIL-DP-12   | 3.72E-01                    | 1.11E-01           | 1.60E-01 | 1.86E-01                    | 4.75E-01           | 8.42E-01 | 4.65E-02                   | 1.32E-01           | 2.24E-01 | -8.59E-03                   | 2.42E-02           | 4.21E-02 |
| Z-BKG-SOIL-DP-13   | 2.42E-01                    | 8.11E-02           | 9.95E-02 | 5.04E-02                    | 3.23E-01           | 5.60E-01 | 1.65E-01                   | 1.11E-01           | 1.85E-01 | 1.10E-02                    | 1.80E-02           | 3.37E-02 |
| Z-BKG-SOIL-DP-14   | 5.38E-01                    | 1.42E-01           | 1.76E-01 | 1.09E+00                    | 8.69E-01           | 8.67E-01 | 8.89E-02                   | 1.49E-01           | 2.54E-01 | 3.91E-02                    | 2.96E-02           | 5.33E-02 |
| Z-BKG-SOIL-DP-15   | 4.79E-01                    | 1.25E-01           | 1.48E-01 | 4.53E-01                    | 4.64E-01           | 8.27E-01 | 6.36E-02                   | 1.28E-01           | 2.18E-01 | -2.14E-02                   | 2.25E-02           | 3.71E-02 |
| Average            | 4.87E-01                    | 1.45E-01           | 1.66E-01 | 5.74E-01                    | 6.40E-01           | 8.26E-01 | 5.26E-02                   | 1.64E-01           | 2.56E-01 | -1.95E-03                   | 2.82E-02           | 4.55E-02 |
| Standard Deviation | 1.14E-01                    |                    |          | 4.87E-01                    |                    |          | 7.70E-02                   |                    |          | 1.83E-02                    |                    |          |
| 95% Upper CL       | 5.39E-01                    |                    |          | 7.95E-01                    |                    |          | 8.76E-02                   |                    |          | 6.35E-03                    |                    |          |

a    Bold values are greater than the MDA.  
b    Italicized values are less than the MDA



Attachment 7-14 Subsurface Soil Results wt Progeny

| Sample             | <sup>232</sup> Th Decay Chain |                              |                              | <sup>238</sup> U Decay Chain |                              |                              | <sup>40</sup> K<br>(pCi/g) | <sup>235</sup> U<br>(pCi/g) | <sup>137</sup> Cs<br>(pCi/g) |
|--------------------|-------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|----------------------------|-----------------------------|------------------------------|
|                    | <sup>228</sup> Ac<br>(pCi/g)  | <sup>212</sup> Pb<br>(pCi/g) | <sup>208</sup> Tl<br>(pCi/g) | <sup>234</sup> Th<br>(pCi/g) | <sup>214</sup> Pb<br>(pCi/g) | <sup>214</sup> Bi<br>(pCi/g) |                            |                             |                              |
| Z-BKG-SOIL-DP-01   | 5.63E-01                      | 5.57E-01                     | 4.97E-01                     | 8.40E-01                     | 7.64E-01                     | 6.70E-01                     | 1.39E+01                   | 7.38E-02                    | 1.54E-02                     |
| Z-BKG-SOIL-DP-02   | 4.20E-01                      | 4.23E-01                     | 3.58E-01                     | -6.15E-02                    | 5.34E-01                     | 5.10E-01                     | 1.20E+01                   | 3.49E-02                    | -1.23E-02                    |
| Z-BKG-SOIL-DP-03   | 3.68E-01                      | 4.33E-01                     | 4.96E-01                     | -1.33E-01                    | 5.52E-01                     | 5.04E-01                     | 1.27E+01                   | 1.84E-01                    | -6.58E-03                    |
| Z-BKG-SOIL-DP-04   | 4.70E-01                      | 5.05E-01                     | 4.05E-01                     | 3.28E-01                     | 6.01E-01                     | 6.49E-01                     | 1.50E+01                   | 1.17E-01                    | 9.48E-03                     |
| Z-BKG-SOIL-DP-05   | 5.45E-01                      | 4.80E-01                     | 4.16E-01                     | 3.68E-01                     | 4.98E-01                     | 5.33E-01                     | 1.28E+01                   | -1.88E-03                   | -3.47E-02                    |
| Z-BKG-SOIL-DP-06   | 3.63E-01                      | 4.45E-01                     | 3.94E-01                     | 7.32E-01                     | 4.82E-01                     | 4.90E-01                     | 1.18E+01                   | 7.08E-02                    | 4.71E-03                     |
| Z-BKG-SOIL-DP-07   | 6.52E-01                      | 6.10E-01                     | 5.91E-01                     | 8.34E-01                     | 7.99E-01                     | 8.01E-01                     | 1.74E+01                   | 2.37E-02                    | -2.80E-03                    |
| Z-BKG-SOIL-DP-08   | 6.25E-01                      | 6.73E-01                     | 5.43E-01                     | 7.61E-01                     | 8.56E-01                     | 8.32E-01                     | 1.66E+01                   | -6.06E-02                   | 1.46E-02                     |
| Z-BKG-SOIL-DP-09   | 5.32E-01                      | 6.28E-01                     | 5.01E-01                     | 1.39E+00                     | 8.91E-01                     | 8.18E-01                     | 1.68E+01                   | -6.42E-02                   | -1.48E-02                    |
| Z-BKG-SOIL-DP-10   | 5.50E-01                      | 6.43E-01                     | 4.70E-01                     | 3.59E-01                     | 7.92E-01                     | 7.60E-01                     | 1.62E+01                   | 1.09E-01                    | -1.83E-02                    |
| Z-BKG-SOIL-DP-11   | 5.86E-01                      | 5.44E-01                     | 4.90E-01                     | 1.41E+00                     | 6.38E-01                     | 7.37E-01                     | 1.39E+01                   | -6.16E-02                   | -4.04E-03                    |
| Z-BKG-SOIL-DP-12   | 3.72E-01                      | 5.37E-01                     | 3.87E-01                     | 1.86E-01                     | 4.74E-01                     | 5.25E-01                     | 1.21E+01                   | 4.65E-02                    | -8.59E-03                    |
| Z-BKG-SOIL-DP-13   | 2.42E-01                      | 1.91E-01                     | 1.81E-01                     | 5.04E-02                     | 1.40E-01                     | 1.59E-01                     | 5.67E+00                   | 1.65E-01                    | 1.10E-02                     |
| Z-BKG-SOIL-DP-14   | 5.38E-01                      | 6.98E-01                     | 4.62E-01                     | 1.09E+00                     | 5.56E-01                     | 5.56E-01                     | 1.40E+01                   | 8.89E-02                    | 3.91E-02                     |
| Z-BKG-SOIL-DP-15   | 4.79E-01                      | 9.91E-02                     | 4.33E-01                     | 4.53E-01                     | 5.71E-01                     | 5.40E-01                     | 1.24E+01                   | 6.36E-02                    | -2.14E-02                    |
| Average            | 4.87E-01                      | 4.98E-01                     | 4.42E-01                     | 5.74E-01                     | 6.10E-01                     | 6.06E-01                     | 1.36E+01                   | 5.26E-02                    | -1.95E-03                    |
| Standard Deviation | 1.14E-01                      | 1.68E-01                     | 9.56E-02                     | 4.87E-01                     | 1.92E-01                     | 1.76E-01                     | 2.89E+00                   | 7.70E-02                    | 1.83E-02                     |
| 95% Upper CL       | 5.39E-01                      | 5.74E-01                     | 4.85E-01                     | 7.95E-01                     | 6.97E-01                     | 6.86E-01                     | 1.49E+01                   | 8.76E-02                    | 6.35E-03                     |

a Bold values are greater than the MDA.  
b Italicized values are less than the MDA

| Attachment 7-15 Sample QA / QC Results |                              |                              |                              |                              |                              |                              |                            |                             |                              |
|--|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|----------------------------|-----------------------------|------------------------------|
| Sample                                 | <sup>228</sup> Ac<br>(pCi/g) | <sup>212</sup> Pb<br>(pCi/g) | <sup>208</sup> Tl<br>(pCi/g) | <sup>234</sup> Th<br>(pCi/g) | <sup>214</sup> Pb<br>(pCi/g) | <sup>214</sup> Bi<br>(pCi/g) | <sup>40</sup> K<br>(pCi/g) | <sup>235</sup> U<br>(pCi/g) | <sup>137</sup> Cs<br>(pCi/g) |
| Z-BKG-SOIL-SF-10                       | 4.20E-01                     | 5.23E-01                     | 5.65E-01                     | 9.60E-01                     | 5.71E-01                     | 6.44E-01                     | 1.52E+01                   | 2.16E-01                    | 1.49E-02                     |
| Z-BKG-SOIL-DUP-SF-10                   | 4.17E-01                     | 5.79E-01                     | 4.20E-01                     | 1.24E+00                     | 7.08E-01                     | 6.34E-01                     | 1.41E+01                   | 4.31E-02                    | -6.07E-03                    |
| RPD                                    | 0.7%                         | 10.2%                        | 29.4%                        | 25.5%                        | 21.4%                        | 1.6%                         | 7.5%                       | NA                          | NA                           |
| Z-BKG-SOIL-DP-10                       | 5.50E-01                     | 6.43E-01                     | 4.70E-01                     | 3.59E-01                     | 7.92E-01                     | 7.60E-01                     | 1.62E+01                   | 1.09E-01                    | -1.83E-02                    |
| Z-BKG-SOIL-DUP-DP-10                   | 7.78E-01                     | 6.62E-01                     | 6.06E-01                     | 5.44E-01                     | 7.99E-01                     | 9.16E-01                     | 1.85E+01                   | -3.55E-02                   | -9.02E-03                    |
| RPD                                    | 34.3%                        | 2.9%                         | 25.3%                        | NA                           | 0.9%                         | 18.6%                        | 13.3%                      | NA                          | NA                           |
| Z-BKG-SOIL-DP-10                       | 5.50E-01                     | 6.43E-01                     | 4.70E-01                     | 3.59E-01                     | 7.92E-01                     | 7.60E-01                     | 1.62E+01                   | 1.09E-01                    | -1.83E-02                    |
| Z-BKG-SOIL-DP-10 (LD)                  | 5.64E-01                     | 5.76E-01                     | 5.16E-01                     | 6.35E-01                     | 7.50E-01                     | 6.96E-01                     | 1.75E+01                   | 2.01E-01                    | 1.77E-02                     |
| RPD                                    | 2.5%                         | 11.0%                        | 9.3%                         | NA                           | 5.4%                         | 8.8%                         | 7.7%                       | NA                          | NA                           |
| Z-BKG-SOIL-SF-15                       | 5.68E-01                     | 6.04E-01                     | 4.82E-01                     | 9.40E-01                     | 4.55E-01                     | 4.66E-01                     | 1.28E+01                   | 9.54E-02                    | 3.82E-03                     |
| Z-BKG-SOIL-SF-15 (LD)                  | 5.28E-01                     | 5.55E-01                     | 4.81E-01                     | 5.92E-01                     | 5.06E-01                     | 5.09E-01                     | 1.35E+01                   | 1.30E-01                    | 1.92E-02                     |
| RPD                                    | 7.3%                         | 8.5%                         | 0.2%                         | NA                           | 10.6%                        | 8.8%                         | 5.3%                       | NA                          | NA                           |
| Z-BKG-ASPHALT-SYS-01                   | 5.78E-02                     | 1.05E-01                     | 1.31E-01                     | -9.45E-02                    | 8.38E-02                     | 1.01E-01                     | 3.36E+00                   | 3.15E-02                    | 2.04E-05                     |
| Z-BKG-ASPHALT-DUP-01                   | 1.80E-01                     | 2.02E-01                     | 1.39E-01                     | -8.32E-02                    | 1.90E-01                     | 1.19E-01                     | 5.40E+00                   | 5.96E-02                    | -5.63E-03                    |
| RPD                                    | NA                           | NA                           | 5.9%                         | NA                           | 77.6%                        | 16.4%                        | 46.6%                      | NA                          | NA                           |
| Z-BKG-ASPHALT-SYS-01                   | 5.78E-02                     | 1.05E-01                     | 1.31E-01                     | -9.45E-02                    | 8.38E-02                     | 1.01E-01                     | 3.36E+00                   | 3.15E-02                    | 2.04E-05                     |
| Z-BKG-ASPHALT-SYS-01 (LD)              | 8.46E-02                     | 7.76E-02                     | 1.93E-01                     | 4.17E-01                     | 8.76E-02                     | 1.18E-01                     | 3.59E+00                   | 3.85E-02                    | 9.84E-03                     |
| RPD                                    | NA                           | 30.0%                        | 38.3%                        | NA                           | NA                           | 15.5%                        | 6.6%                       | NA                          | NA                           |
| Z-BKG-ICEHOUSE-CONC-SYS-1              | 5.68E-01                     | 6.52E-01                     | 4.95E-01                     | 5.80E-01                     | 4.45E-01                     | 4.13E-01                     | 1.08E+01                   | 3.67E-02                    | 3.06E-02                     |
| Z-BKG-ICEHOUSE-CONC-SYS-1 (LD)         | 5.37E-01                     | 6.39E-01                     | 5.56E-01                     | 6.38E-03                     | 3.97E-01                     | 4.64E-01                     | 1.08E+01                   | 3.40E-02                    | 3.40E-02                     |
| RPD                                    | 5.6%                         | 2.0%                         | 11.6%                        | NA                           | 11.4%                        | 11.6%                        | 0.0%                       | NA                          | NA                           |
| Z-BKG-CONC-SYS-1                       | 2.78E-01                     | 2.57E-01                     | 2.19E-01                     | 9.73E-02                     | 2.81E-01                     | 2.47E-01                     | 4.89E+00                   | 1.50E-02                    | -1.80E-03                    |
| Z-BKG-CONC-DUP-1                       | 2.66E-01                     | 2.14E-01                     | 2.17E-01                     | 1.21E-01                     | 2.40E-01                     | 2.00E-01                     | 4.70E+00                   | 4.59E-02                    | 2.00E-02                     |
| RPD                                    | 4.4%                         | 18.3%                        | 0.9%                         | NA                           | 15.7%                        | 21.0%                        | 4.0%                       | NA                          | NA                           |

a Bold values are greater than the MDA.  
b Italicized values are less than the MDA  
c Sample ID’s with an (LD) indicate a laboratory generated split sample. All other samples splits as indicated with –DUP- in the sample ID are site generated split samples.