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DO-03-005, *Hydrogeological Parameters Report*
EO-04-001, *Site Wide Gamma Walkover Survey*
DO-03-006, *Distribution Coefficient Report*

VOLUME I

Determination of Distribution Coefficients for Radionuclides of Concern at the Westinghouse Hematite Facility

REV. 0

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ABBREVIATIONS AND ACRONYMS

ASTM	American Society for Testing and Materials
bgs	below ground surface
CSSG	clayey silty sandy gravel
DCGL	derived concentration guideline level
DOE	U.S. Department of Energy
DQO	data quality objective
DSCC	deep silty-clay/clay
EC&HS	Environmental Compliance and Health and Safety
EPA	U.S. Environmental Protection Agency
GEO	GEO Consultants, LLC
HU	hydrostratigraphic unit
IDW	investigation-derived waste
ISCORS	Interagency Steering Committee on Radiation Standards
JCD	Jefferson City Dolomite
LSC	Liquid scintillation counting
K_d	distribution coefficient
KPA	kinetic phosphorescence analysis
MCAWW	Methods for Chemical Analysis of Water and Wastes
NAD83	North American Datum of 1983
NSSC	near surface silt, silty clay
ORP	oxidation reduction potential
QA	quality assurance
QC	quality control
RESRAD	Residual Radioactivity, a computer code for evaluating radioactive sites
SAP	Sampling and Analysis Plan
SAIC	Science Applications International Corporation

EXECUTIVE SUMMARY

The nuclear manufacturing facility at Hematite, Missouri was used for the production of nuclear fuels from natural, depleted, and enriched uranium. More than 45 years of processing nuclear materials and formerly authorized on-site disposal of process waste has resulted in radionuclide contamination of surface and near-surface soils at the Hematite Site. As part of the decommissioning process by Westinghouse, derived concentration guideline levels (DCGLs) for residual soils must be determined for radionuclides of concern. DCGLs will be calculated using the Residual Radioactivity (RESRAD) model, in which the soil distribution coefficient or K_d is an input parameter for simulating radionuclide leaching from contaminated soils. The primary objective of the study described in this report is to determine appropriate K_d factors for uranium (U), technetium (Tc), thorium (Th), plutonium (Pu), americium (Am), and neptunium (Np) to be used for modeling radionuclide leaching from unconsolidated soils at the Hematite Site. Because higher-than-background levels of U isotopes (^{234}U , ^{235}U , and ^{238}U) and Tc (as ^{99}Tc) have been measured during previous characterization events, site-specific K_d factors for these radionuclides were measured in the laboratory using soil samples collected from the Hematite Site. Th, Pu, Am, and Np are contaminants of concern based on site history but have not been detected during previous characterization efforts. Thus, it was deemed sufficient to obtain K_d factors for these radionuclides from the published literature.

Site-specific measurements for K_d were performed on samples collected from areas of concern within the Hematite Site. Six boreholes were drilled to refusal or bedrock (~30 to 35 ft), and 18 soil samples (3 depth intervals per borehole) were collected for K_d testing, radionuclide analysis, and general soil characterization procedures. Groundwater used for the K_d tests was taken from an uncontaminated background monitoring well. All samples collected from the site consisted of very fine-grained, brown silty clay. The sand/gravel unit described in previous characterization efforts was encountered in four out of six boreholes but at a thickness of less than 1 ft, not enough to obtain representative samples for K_d testing. The fine-grained nature of the soil samples was confirmed by particle size distribution measurements, which showed the soils to consist of >96% silt and clay sized fractions and ~30% clay. Soil pH ranged from 5.8 to 8.3, total organic carbon ranged from 2.2 to 14 g/kg and iron (extracted through hot-acid digestion) ranged from 11.1 to 21.2 g/kg. Uranium activities were detected at significant levels in samples from the restricted areas, and in shallowest sample from the Tile Barn/Cistern Burn Pit area. Except for one sample from the restricted areas, technetium was not detected above the laboratory reporting limits in the samples collected for this study.

K_d testing was performed following ASTM 4319-93, Standard Test Method for Distribution Ratios by the Short-term Batch Method, as recommended in the RESRAD data collection handbook. Two types of K_d tests were performed: (1) desorption tests where a measured mass of soil was contacted with a measured volume of uncontaminated groundwater over a period of 14 days, and (2) adsorption tests where soil was contacted with uncontaminated groundwater spiked to predetermined levels of U (as the uranyl ion or UO_2^{2+}) and ^{99}Tc (as the pertechnetate ion TcO_4^-). For uranium, lower overall K_d values were observed in the adsorption tests, when compared to the desorption tests. Average K_d s from the adsorption and desorption tests were calculated, and the mean of the averages was considered the "best" estimate for U K_d for the Hematite Site. Although the desorption tests are likely to be more representative of contaminant leaching under field conditions, the adsorption data were still considered to yield a reasonable but conservative site-specific K_d for uranium. For Tc, significant removal of Tc was observed from the liquid phase of the soil/water mixtures within 3 days. This "apparent" sorption could be due

to the reduction of Tc(VII) to Tc(VI) and adsorption or precipitation of the latter, rather than electrostatic interactions of Tc(VII) with soil mineral surfaces. The resulting K_d s for Tc are significantly higher than published values, but the validity of K_d obtained from this study is supported by results that were repeated in multiple soil samples at several time intervals, and recovery of the Tc on the solid residues.

The following table shows recommended K_d values for radionuclides of interest to the Hematite Site. The U and Tc K_d values are site-specific in that these were measured using soil samples collected from the site. Because there were no distinct trends with depth in the K_d measurements for both U and Tc, spatial variability is best addressed by assuming that the unconsolidated sediments overlying bedrock at the Hematite Site can be characterized by a single K_d parameter that has either a log-normal (for U) or uniform (for Tc) distribution. The K_d values for the rest of the radionuclides are based on published literature values.

Radionuclides of Concern	Recommended K_d value (mL/g)	Remarks
Uranium	175	Site specific measurement with range of 6.6 and 471.4 mL/g; grossly approximates a lognormal distribution.
Technetium	106	Site specific measurement with range of 15.1 and 172.9 mL/g; approximates a uniform distribution between 0 and 200 mL/g.
Plutonium	2000	RESRAD default value, reasonable when compared to published literature.
Thorium	60000	RESRAD default value, reasonable when compared to published literature.
Neptunium	2	At low end of published literature values.
Americium	1000	Consistent with published literature values, more reasonable than default K_d of 20.

1. INTRODUCTION

1.1 BACKGROUND

The nuclear manufacturing facility at Hematite, Missouri, referred to in this report as the Hematite Site, was formerly used for the production of nuclear fuels from natural, depleted, and enriched uranium. The Hematite Site consists of 228 acres of property, 8 acres of which were used for operations. After taking ownership of the facility in 2000, Westinghouse Electric Company ceased operations and is proceeding with plant decommissioning.

More than 45 years of processing nuclear materials and formerly authorized on-site disposal of process waste has resulted in radionuclide contamination of surface and near-surface soils at the Hematite Site. These soils or unconsolidated sediments consist of a fine-grained silty clay/clay layer and a sand-gravel unit, with a total thickness of approximately 30 to 40 ft beneath the site [LBG 2003]. As part of the decommissioning process by Westinghouse, derived concentration guideline levels (DCGLs) for residual soils must be determined for radionuclides of concern in accordance with the requirements of 10CFR20, Subpart E. DCGLs will be calculated using the Residual Radioactivity (RESRAD) model [Yu et al. 2001], in which the soil distribution coefficient or K_d is an input parameter for simulating radionuclide leaching from contaminated soils. The K_d factor is defined as the concentration of a chemical species on the solid fraction divided by the concentration in the aqueous phase:

$$K_d = \frac{S}{C_w},$$

where S is mass of chemical species sorbed per unit mass of soil, and C_w is mass of chemical species per volume of solution. When the K_d parameter is used to model the leaching of chemicals from contaminated soils, the underlying assumption is that rapid equilibrium is reached between the dissolved and sorbed concentrations of a chemical species, and that these two concentrations are linearly related through the K_d factor. In theory, the K_d factor is used to characterize the *reversible* adsorption of a chemical species on solid surfaces including soil minerals and organic matter. However, other chemical processes, including mineral precipitation, diffusion into dead-end pores and attachment to microbes, can influence the experimental measurement of K_d . Although research efforts have attempted to differentiate adsorption from these other processes, there are no universally accepted standard methods for doing so.

There are two laboratory approaches for measuring K_d : the "batch" and the "column" methods. The "batch" method for measuring K_d consists of equilibrating a measured mass of soil with a selected contact solution (e.g., synthetic or site groundwater). In the more commonly used adsorption mode for K_d testing, the contact solution is spiked with a measured mass of the chemical species of interest which then adsorbs onto the soil during equilibration. It is also possible to use contaminated soils, in which case the chemical species of interest desorbs from the soil into the contact solution. The concentration of the chemical species is then monitored in the contact liquid over time. When this concentration reaches a steady state, it is assumed that the liquid and solid concentrations are in equilibrium, and K_d is calculated from their ratio. The liquid concentration is directly measured, while the solid concentration is usually inferred from a mass balance knowing the initial mass of chemical species in the soil/water mixture. In the "column" procedure for measuring K_d , a soil column (i.e., a cylinder packed with soil) is flushed

with the contact solution under a controlled flow rate. The K_d factor is then determined by analyzing the breakthrough of the chemical species of interest at the effluent end of the soil column. The "column" procedure is a closer simulation of the physical processes occurring in the field, however the experimental set-up and data interpretation are more difficult when compared to the "batch" procedure. Moreover, batch and column loading of uranyl complexes was compared in one study and no significant differences were observed [Bostick et al. 2002]. Thus, the "batch" procedure is more commonly used when a large number tests are needed to characterize spatial variability. K_d measurements in this study were performed using a "batch" procedure.

1.2 STUDY OBJECTIVES AND REPORT ORGANIZATION

The primary objective of the study described in this report is to determine appropriate K_d factors for uranium (U), technetium (Tc), thorium (Th), plutonium (Pu), americium (Am), and neptunium (Np) to be used for modeling radionuclide leaching from unconsolidated soils at the Hematite Site. Because higher-than-background levels of U isotopes (^{234}U , ^{235}U , and ^{238}U) and Tc (as ^{99}Tc) have been measured during previous characterization events, site-specific K_d factors for these radionuclides were measured in the laboratory using soil samples collected from the Hematite Site. The laboratory K_d measurements were conducted following ASTM D 4319-93, *Standard Test Method for Distribution Ratios by the Short-Term Batch Method*, which is the procedure recommended in the RESRAD data collection manual [Yu et al., 1993]. Th, Pu, Am, and Np are contaminants of concern based on site history but have not been detected during previous characterization efforts. Thus, it was deemed sufficient to obtain K_d factors for these radionuclides from the published literature.

A secondary objective for the activities described in this report is to obtain radionuclide contamination data as well as basic geochemical and physical properties of soil samples collected from selected areas of concern within the Hematite Site. These data were used in assessing the laboratory-measured U and Tc K_d factors, through comparisons with published studies on similar soils, and in selecting K_d factors for Th, Pu, Am, and Np from literature values.

This report describes the site-specific laboratory measurement of K_d factors for U and Tc on soil samples collected from the Hematite Site. It also includes the selection of appropriate K_d factors for Th, Pu, Am, and Np from literature K_d values. The report is organized as follows:

- Section 2 contains the methods used to collect and characterize soil and groundwater samples from the Hematite Site for this study and the laboratory procedures followed to measure site-specific K_d factors for U and Tc.
- Section 3 describes results of physical, geochemical, and radionuclide (U isotopes and ^{99}Tc) analyses of soil and groundwater samples collected from the Hematite Site for this study.
- Section 4 provides results of laboratory U and Tc K_d measurements and a discussion of these results in comparison with published literature values.
- Section 5 contains literature K_d values for the other radionuclides (Th, Am, Pu, Np).
- Section 6 summarizes the primary findings from this study and includes a table containing K_d values for U, Tc, Th, Pu, Am, and Np recommended for use in RESRAD modeling and DCGL calculations for the Hematite Site.

2. PROCEDURES FOR DETERMINING SITE-SPECIFIC URANIUM AND TECHNETIUM DISTRIBUTION COEFFICIENTS

2.1 SOIL AND GROUNDWATER SAMPLE COLLECTION METHODS

Laboratory K_d measurements for U and Tc were performed on soil samples collected from areas of concern within the Hematite site. A bulk sample of groundwater from a background well was collected and used in preparing contact solutions for the K_d tests. Details regarding soil and groundwater sample collection are described below.

2.1.1 Borehole locations

Soil samples were collected from six boreholes located based on site history, previous subsurface characterization [LBG 2003], and a recently conducted gamma walkover survey [SAIC 2003]. Coordinates of these boreholes were measured via a Global Positioning System and are shown in Table 1. Areas surrounding borehole locations are described below (see Fig. 1 for borehole location map):

1. Duels Mountain (Borehole BHKD1) - Refers to a pile of excavated and potentially contaminated soil stored along the southeast corner of the fence line.
2. Burial Pits (Borehole BHKD2) - Approximately 40 burial pits are known to exist outside the fenced area based on available plant documentation.
3. Tile Barn Cistern Burn Pit (Borehole BHKD3) - The roof of the Red Room (referring to Building 240, Area 240-2 formerly used for highly enriched U conversion processes) was reportedly buried in an area south of the Tile Barn.
4. Restricted Area No.1 (Borehole BHKD4) - This borehole is located in "restricted areas" where elevated gamma radiation was detected during the walkover survey [SAIC 2003].
5. Restricted Area No. 2 (Borehole BHKD5) - This borehole is also located in "restricted areas" where elevated gamma radiation was detected during the walkover survey [SAIC 2003].
6. Evaporation Pond (Borehole BHKD6) - Past waste management practices have included the disposal of water containing trichloroethylene and ^{99}Tc from cylinder washing.

Table 1. Borehole coordinates in MO-East State Plane (NAD83) coordinate system

Borehole ID	Area	EASTING (ft)	NORTHING (ft)
BHKD 1	Duel's Mountain	827489.34	864930.41
BHKD 2	Burial Pits	827677.93	864996.11
BHKD 3	Tile Barn Cistern Burn Pit	826723.31	864800.19
BHKD 4	Restricted Area #1	827245.45	864663.76
BHKD 5	Restricted Area #2	827255.37	864725.49
BHKD 6	Evaporation Ponds	827320.86	864645.66

*NAD83: North American Datum of 1983

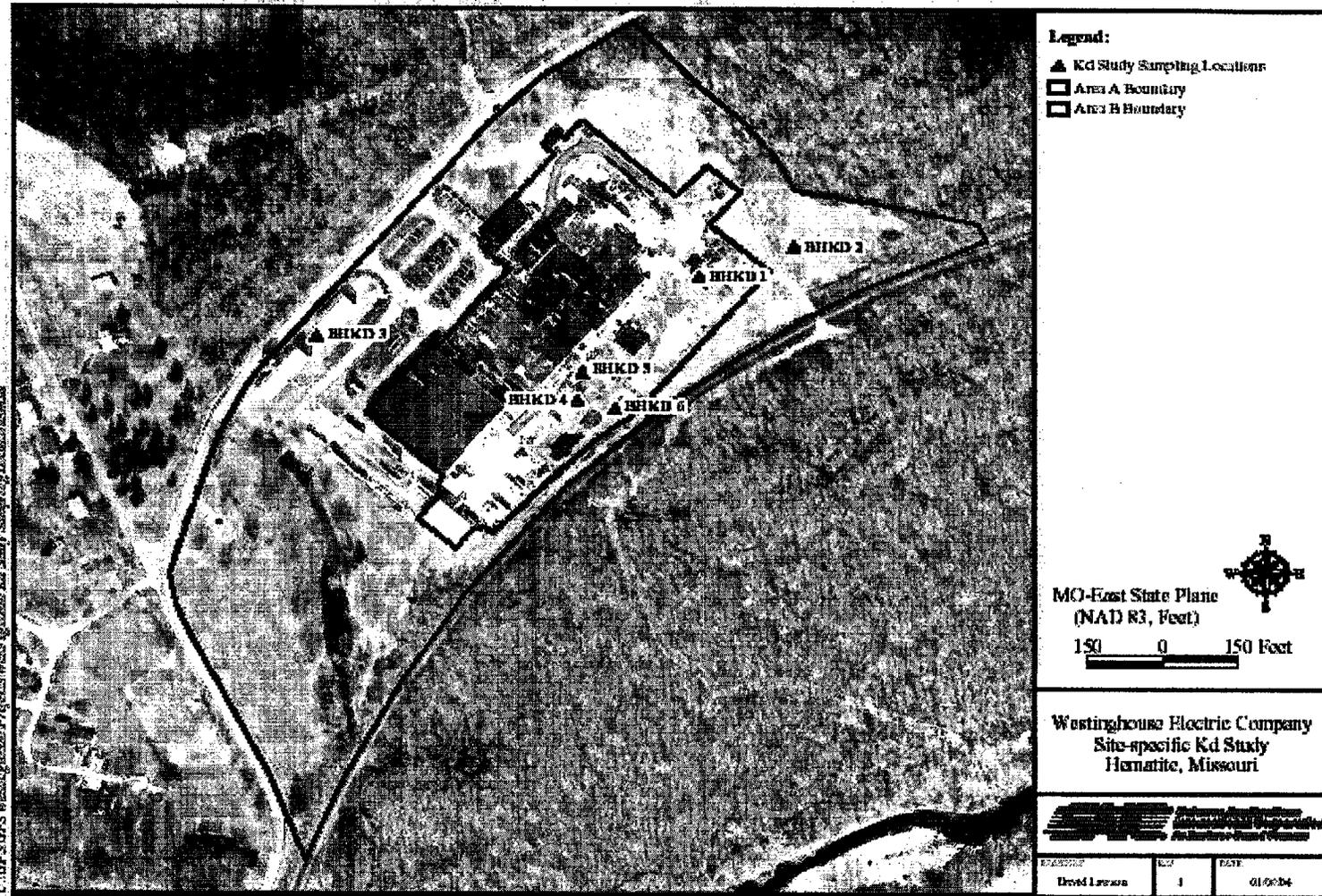


Fig. 1. Locations of boreholes where samples were collected for laboratory K_d measurements

2.1.2 Borehole Drilling and Soil Coring Procedures

Continuous soil cores were collected in 3 to 4 ft long, 2-in diameter acetate sleeves using a direct-push drill rig. This coring method was chosen over auger drilling because it is more economical and capable of collecting relatively intact samples from unconsolidated sediments at depths anticipated for the Hematite Site (<35 ft). In addition, this method of drilling/coring minimized the amount of investigation-derived waste (IDW) generated during the project.

Immediately after collection, cores contained in acetate sleeves were laid out on field tables and sleeves were cut for better visual examination. Gross gamma and beta scanning of the soil cores was performed to delineate contaminated zones within each core and allow collection of contaminated soil samples needed for the desorption K_d tests (see Section 2.2). Geologic descriptions were logged, with particular attention to mottling and appearance of iron oxide in order to estimate probable redox conditions of the soil. Water saturation of the cores were visually examined, recorded, and used to estimate the location of the water table.

Field geologists attempted to delineate the hydrostratigraphic units (HU) described during previous site investigations. Within the unconsolidated sediments, these units included a “near-surface silt/silty clay” unit (NSSC), a “deeper silty-clay/clay” unit (DSSC), and a “clayey, silty, sandy-gravel” unit (CSSG) [LBG 2003]. An attempt was made to collect samples for K_d measurements from each HU within each borehole. However, as will be shown later (Section 3.1), it was impossible to visually differentiate between the NSSC and the DSSC layers in the field. Furthermore, the CSSG layer was not encountered at a significant thickness before drill refusal. Soil samples (~1 kg) were collected from each borehole from three depths, focusing on intervals with elevated gamma and/or beta radiation from the core scans. This approach was used to increase the likelihood of collecting contaminated samples for desorption K_d measurements (see Section 2.2).

The soil samples were collected using pre-cleaned spatulas and placed in 1-L, wide-mouth, pre-cleaned polyethylene bottles. The bottles were then sealed with a chain-of-custody label affixed over the cap, and the bottles were labeled with the following information:

- borehole number
- sample label
- sampling depth interval
- date and time collected
- sampler name

Samples were labeled according to the following scheme: BHKD1-03, where the first field (BHKD1) corresponds to the borehole number, and the second field (03) corresponds to the upper limit of the sampling interval (e.g., 3 ft below ground surface). The soil samples were then packaged in ice and transported within 24 hours to the laboratory, together with completed chain-of-custody forms. A second 1-kg sample of soil was also collected for archiving, and labeled as BHKD1-03-ARCH. In total, 36 soil samples were collected, 18 of which were sent immediately to the laboratory for K_d measurements and other analyses while the remainder were archived and stored on site.

2.1.3 Groundwater Sample Collection and Field Analyses

Groundwater uncontaminated by radionuclides needed for preparing contact solutions in the laboratory K_d tests was collected from OB-1, a background-monitoring well located approximately 1000 to 1200 ft south/southwest from the center of the Hematite plant's main area. OB-1 is a 2-in diameter polyvinyl chloride (PVC) well with a depth of 26.2 ft and 16.2-ft well screen located within the unconsolidated sediments. Groundwater from this well was collected using a peristaltic pump and directly placed in a 20-L container. The headspace of the 20-L container was purged with nitrogen gas, immediately capped and a chain-of-custody seal affixed to the cap. Smaller volume groundwater samples were also collected in 40-mL vials for ^{234}U , ^{235}U , ^{238}U , ^{99}Tc activity analyses, major cation (Ca, K, Mg, Na) and anion (Cl^- , NO_3^- , SO_4^{2-}) analyses. The groundwater samples were brought to the laboratory where they were stored at $\sim 4^\circ\text{C}$ prior to analyses or use in K_d tests. The samples for cation analyses were preserved with nitric acid as soon as they were received in the laboratory. The purpose of nitrogen gas purging (for the 20-L sample) and cool storage is to maintain, to the extent possible, the dissolved oxygen content of the groundwater as well as minimize biological activity and chemical processes that can alter the water chemistry.

2.1.4 Field Analyses

Gross gamma/beta scans were performed on the soil cores in the field using zinc sulfide (alpha/beta) and 2" x 2" sodium iodide (gamma) hand-held meters. The field radiological measurements were used to determine sampling locations within each boring.

A number of groundwater parameters (pH, temperature, oxidation reduction potential (ORP), specific conductivity, and dissolved oxygen) were measured in the field at monitoring well OB-1 using a multi-parameter water quality instrument. Alkalinity and dissolved Fe were measured within 24 hours using single parameter test kits. Groundwater parameters were also measured in WS-14, a 2-in diameter PVC well screened within the unconsolidated sediments and located within 50 ft of BHKD2 in the Burial Pits area. Of the six boreholes, only BHKD2 was located near an existing groundwater monitoring well.

2.2 LABORATORY METHODS

2.2.1 Radionuclide Analysis

Upon receipt, the laboratory collected sub-samples from each of the 18 soil samples for isotopic U analysis via alpha spectroscopy following NAS/DOE 3050, and ^{99}Tc analysis via liquid scintillation counting (LSC) following DOE TC-02-RC. A sub-sample of the groundwater sample from OB-1 was analyzed for total U via kinetic phosphorescence analysis (KPA) following ASTM D5174, and ^{99}Tc via LSC following DOE TC-02-RC.

2.2.2 Distribution Coefficient Measurement

K_d factors for U and ^{99}Tc were measured following ASTM 4319-93, *Standard Test Method for Distribution Ratios by the Short-term Batch Method*, as recommended in the RESRAD data collection handbook [Yu, et al., 1993]. The ASTM method uses the term "distribution ratio" (or

R_d) instead of "distribution coefficient" (or K_d) to avoid implying that equilibrium is attained in the measurements. In this study, the tests were performed for a maximum of 14 days, at which point steady-state concentrations in the contact solutions was observed in most of the tests and assumed to represent equilibrium conditions.

Two types of K_d tests were performed: (1) desorption tests where a measured mass of soil (20 g) was contacted with a measured volume of OB-1 groundwater (80 mLs) over a period of 14 days, and (2) adsorption tests where 20 g of soil was contacted with 80-mLs of OB-1 groundwater spiked to predetermined levels of U (as the uranyl ion or UO_2^{2+}) and ^{99}Tc (as the pertechnetate ion TcO_4^-).

Although the adsorption test protocol is more commonly applied in research and practice due to the ability to control and accurately quantify radionuclide levels in the soil/water mixtures, the desorption tests more closely simulate radionuclide leaching from contaminated soils in the field. Before the K_d tests were initiated, the field-sampled radionuclide levels were reviewed to select soil samples containing U and ^{99}Tc at high enough levels such that detectable radionuclide levels would likely be present in the contact solution. Furthermore, the K_d tests were performed in two batches to allow modifications in the K_d test procedures (e.g., spike levels) between batches to improve test measurements. Initially, desorption tests were performed on four of the samples with the highest levels of U. Two additional soil samples were later determined to have a sufficient amount of U that would possibly result in measurable U levels in the contact solutions during a desorption K_d test, based on the K_d factors measured from Batch 1. These two samples were subjected to desorption K_d testing in Batch 2. None of the soil samples collected for this study contained ^{99}Tc that exceeded the laboratory-reporting limit (10 pCi/g). Table 2 shows the samples that were used for each type of K_d test. The target spike levels in Batch 1 were 10,000 $\mu\text{g/L}$ and 150 pCi/L for U and ^{99}Tc , respectively, and 1000 $\mu\text{g/L}$ and 25,000 pCi/L for U and ^{99}Tc , respectively, in Batch 2. The values shown in Table 2 are based on analyses of the contact solutions. The actual Tc concentration in Batch 1 is higher than the target level, suspected to be due to errors in dispensing the minute volume of Tc standard solution when the contact solutions were prepared.

Table 2. Test conditions for distribution coefficient measurements

Type of K_d Test	Samples	Radionuclide levels in contact solution*
Batch 1		
Desorption test	BHKD3-8 BHKD5-1; -19; -27	Unspiked*
Adsorption test	BHKD2-4; -13; -23	10,000 $\mu\text{g/L}$ U; 600 pCi/L ^{99}Tc
Batch 2		
Desorption test	BHKD4-14 BHKD6-1	Unspiked*
Adsorption test	BHKD1-4; -23; -28 BHKD3-16; -23 BHKD4-2; 24 BHKD6-11; 26	950 $\mu\text{g/L}$ U; 27,800 pCi/L

*A bulk groundwater sample (20 L) from a background well (OB-1) was used for preparing contact solutions. Refer to Table 8 for radionuclide levels in groundwater sample.

Although visual observations of soil samples and field analyses in this study indicate mildly reducing conditions (discussed in Section 3), there are no available site-wide redox measurements. Thus, no attempts were made to strictly control the oxidizing conditions during the K_d tests. Furthermore, measured K_d factors under oxidizing conditions should be lower (and more conservative) because it will be unlikely for U (VI) (the oxidation state of U in UO_2^{2+}) to reductively precipitate as U (IV). Table 3 summarizes procedural details on how ASTM D 4319 was applied to K_d measurements on the Hematite samples, including any deviations from the recommended procedures.

For each soil sample, eight soil/water mixtures were prepared to enable sacrificial sampling of each mixture for ^{99}Tc and U analysis of the supernatant at eight predetermined time intervals (Days 3, 7, 10, 14, 21, 28, 35, 45). However, Batch 1 test results indicated steady-state U and ^{99}Tc levels in the contact liquid (see Section 4.1) were achieved in 14 days. Thus, the supernatant in the soil/water mixtures were analyzed on Days 3, 7, 10, and 14 in both Batch 1 and Batch 2 K_d tests. ^{99}Tc and total U in the supernatant/contact liquids were quantified through LSC and KPA, respectively.

Table 3. Procedural details regarding application of ASTM* D 4319, "Standard Test Method for Distribution Ratios by the Short-term Batch Method," to Hematite samples. (Specific procedures are given in Section 7 of ASTM D 4319)

ASTM Method Subsection	Notes regarding application to Hematite samples
7.1	Soil samples were disaggregated using a ball mill grinder to maximize homogenization and minimize variability between soil/water mixtures prepared for each soil sample.
7.2	Organic matter was not removed prior to K_d testing. This step is not necessary since the intent of the measurements was to obtain model parameters for leaching from field soils with its natural organic content.
7.3	Characterization of soil samples prior to K_d tests included: pH, total and organic carbon, moisture content, particle size distribution, total Fe and Mn, U isotopes and ^{99}Tc (refer to Section 2.2.1 and 2.2.3 for methods). Characterization of OB-1 groundwater used as contact solution included: pH, DO, ORP, dissolved Fe, alkalinity, specific conductivity, NO_3^- , Cl^- , SO_4^- , Ca, K, Mg, Na).
7.4	Bulk samples were ground to ensure homogeneity among subsamples collected for preparing soil/water mixtures. Soil samples were air-dried before disaggregation (Section 7.1). Air-drying was deemed acceptable since <i>in situ redox</i> conditions at Hematite are largely unknown.
7.5	OB-1 groundwater was used to pre-treat/pre-wash soil samples in Batch 1. This step was eliminated in Batch 2 to avoid loss of natural U from the soil samples, which could bias K_d estimates if the field-sampled U concentration were used in calculations.
7.6	Two types of treatment solution/contact liquid were used: (1) unspiked OB-1 groundwater for desorption tests, and (2) OB-1 groundwater spiked with U and ^{99}Tc using certified standard solutions (refer to Table 2 for concentrations). The pH of soil/liquid mixtures was adjusted to 6.6, value measured for OB-1 in the field.
7.7	Specific conductance of each solution was not measured nor required in this study.
7.8	Contact periods for each soil sample were 3, 7, 10, and 14 days. Steady-state conditions were achieved within 14 days.
7.9	pH of mixtures was measured in Batch 2 samples. Eh measurement was not necessary since mixtures were kept under atmospheric conditions
7.10	Analysis of total U and ^{99}Tc in the supernatant were measured via KPA and LSC, respectively.
7.11	Supernatant liquids were filtered before analysis.
7.12	Mass balance was assessed through solid residue analyses of Day 14 soil/water mixtures (see 7.13 below).
7.13	Filtered residues for Day 14 were measured in selected soil samples to assess mass balance.

*American Society for Testing Materials

2.2.3 Laboratory Measurement of Other Soil and Groundwater Parameters

Other soil and groundwater parameters measured in the laboratory include the following.

Moisture content	MCAWW 160.3 MOD
Soil pH	SW846 9045A
Particle Size Distribution	ASTM D422
Total organic carbon/soil	SW846 9060
Total carbon/soil	SW846 9060
Total Fe/soil	SW846 6010B
Total Mn/soil	SW846 6010B
Major cations/groundwater	SW846 6010B
Major anions/groundwater	SW846 9056A

Except for the particle size distribution, all parameters were measured in all 18-soil samples collected from the boreholes. Particle size distributions were measured in soil samples from two boreholes (BHKD5 and BHKD6).

2.3 QUALITY CONTROL PROCEDURES

Established field quality control (QC) procedures were followed to ensure that field activities comply with the approved Quality Assurance (QA) Program Plan. Field Technical Procedures used for this project were listed in the project SAP [GEO and SAIC, 2003]. The laboratory adhered to all the QA/QC requirements specified in the analysis methods used in this study.

Data validation technical reviews were performed in accordance with the *Contract Laboratory Program Data Validation Functional Guidelines for Evaluating Inorganic Analytical Data*, and the *Laboratory Data Validation Guidelines for Evaluating Radionuclide Analyses and Radiochemical Data Verification and Validation*. These reviews were based on the information and documentation supplied by the laboratory. There were only minor findings in these reviews, none of which affected the accuracy of the K_d values calculated from the analytical data. Complete data validation reports can be found in Appendix A.

3. PHYSICAL AND CHEMICAL CHARACTERISTICS OF STUDY SOIL SAMPLES

3.1 SOIL TYPES AND PARTICLE SIZE DISTRIBUTIONS

Soil samples were collected from three depth intervals from each borehole and were described as brown silty clay with increasing degrees of limonite and gray mottling and the presence of chert and/or limestone fragments at lower depths (see Table 4 and complete boring logs in Appendix B). Gray mottling indicates dissolution of ferric iron (i.e., Fe^{3+} in iron oxides) as ferrous iron (Fe^{2+}), a microbial process that requires anaerobic conditions under normal environmental pH conditions. Thus, it appears the soils are poorly aerated, consistent with the fine soil texture (i.e., poorly draining soil) observed in the samples. Note that the samples are assumed to be representative of soils from areas of concern within the Hematite Site.

The NSSC and DSCC layers previously identified by LBG [2003] could not be distinguished in the field. What appears to be the sand/gravel unit identified by LBG [2003] was encountered in four of the six boreholes (see Table 4 and complete boring logs in Appendix B), but all were observed to have a thickness of less than 1 ft before drill refusal. Drill refusal in all six boreholes occurred between 27 and 33 ft below ground surface, and was assumed to correspond to the depth of the Jefferson City Dolomite bedrock. Particle size distribution analyses in 6 samples from 2 boreholes (Table 5 and Appendix C) supports the field descriptions, with 5 out of six of the samples containing more than 96% silt/clay (~30% clay). One sample with coarser grained particles was taken from the lowest sampling interval in BHKD6, also consistent with the noted presence of clayey sand gravel in the last 6 in of this interval (see Table 4). Water saturation was encountered at 21 to 22 ft in BHKD2 and BHKD3 and at 28 ft in BHKD4 and BHKD5. Soil was moist but not saturated throughout the drilled depths of BHKD1 (33 ft) and BHKD6 (30 ft).

3.2 SOIL CHEMICAL CHARACTERISTICS

Chemical characteristics of soil samples collected from the Hematite site for this study are shown in Table 6. Soil pH ranged from 6.5 to 7.5 for a majority of the soil samples. The lowest soil pH (5.8 and 6.0) were measured in the shallowest samples from BHKD4 and BHKD6, respectively. The highest pH values (8.1 and 8.3) were measured in mid-depth and deepest samples collected from BHKD1. Total and organic carbons levels were less than 1% in most of the measurements. In some samples, organic carbon levels were higher than total carbon (which consists of both organic and inorganic carbon). This was attributed to sub-sample heterogeneity coupled with low levels of inorganic carbon in the soil. In general, the chemical characteristics of the soil samples did not vary significantly among the soil samples, and no trends were observed when these parameters were plotted vs sample depth (see Appendix D for graphs).

Table 4. Field descriptions of soil samples collected for K_d testing and other analyses

Borehole	Location	Sample Interval (ft)		Field Description
		Upper Limit	Lower Limit	
BHKD1	Duels Mt	4	8.6	Silty clay, brown with 10% gray mottling
		23	28	Silty clay, brown with 5% mottling and limestone or dolomite fragments
		28	33*	Silty clay, brown with 5% mottling and limestone or dolomite fragments
BHKD2	Burial Pits	4	10	Silty clay, brown with 5% mottling
		13	17	Silty clay, brown with 15% mottling
		23	34*	Silty clay, brown with 15% mottling with chert fragments; silty sand gravel from 33.5-34 ft (bottom)
BHKD3	Tile Barn/Cistern Burn Pit	8	13	Silty clay, brown with 15% iron oxide gray mottling
		16	20	Silty clay, brown with 5% iron oxide mottling
		23	27*	Silty clay, brownish gray with 10% mottling and dolomite fragments
BHKD4	Restricted Area #1	2	14	Silty clay, brown with manganese (Mn) and chert nodules
		14	21	Silty clay, brown and 10% mottling
		24	30*	Silty clay, grayish brown with 15 mottling; sand with gravel 29.5-30
BHKD5	Restricted Area #2	1	12	Silty clay, brown with Mn nodules
		19	24	Silty clay, brown Mn nodules and 15% iron oxide mottling
		27	31*	Silty clay, brownish gray with 20% iron oxide mottling; clayey sand with gravel from 30.5- 31
BHKD6	Evaporation Pond	1	8	Silty clay, brown with iron oxide mottling
		11	16	Silty clay, brown with iron oxide mottling
		26	30*	Silty clay, brown with iron oxide mottling, clayey sand with gravel from 29-30 ft

*Total depth of boreholes

Table 5. Particle size distribution analyses results

Sample ID	Location	Sample Interval (ft)	%Gravel	%Sand	%Silt	% Clay
BHKD5-01	Restricted Area #2	1-12	0	3.5	66.3	30
BHKD5-19	Restricted Area #2	19-24	0	2.8	66.2	31
BHKD5-27	Restricted Area #2	27-31	3	39.2	32.8	25
BHKD6-01	Evaporation Ponds	1-8	0	3	67	30
BHKD6-11	Evaporation Ponds	11-16	0	2.4	69.5	28
BHKD6-26	Evaporation Ponds	26-30	0	1.9	68.1	30

Table 6. Physical and chemical characteristics of soil samples collected for K_d testing

Sample ID	PH	Moisture (%)	Total Carbon (g/kg)	Total Organic Carbon (g/kg)	Iron (g/kg)	Manganese (g/kg)
BHKD1-4	6.6	21.3%	1.36	2.26	19.8	1.5
-23	8.1	28.0%	4.12	4.64	22.2	1.55
-28	8.3	13.0%	1.49	2.32	16.3	0.458
BHKD2-4	7.3	19.8%	2.45	3.2	19.4	0.367
-13	6.6	21.3%	1.36	2.26	17.1	0.577
-23	6.7	24.2%	8.9	14.9	19	0.311
BHKD3-8	7.3	20.8%	5.55	3.93	20.3	0.955
-16	7.4	22.3%	2.7	3.78	22	0.364
-23	7.5	24.0%	3.75	3.74	22.2	1.04
BHKD4-2	6.0	18.8%	2.56	2.207	22	0.449
-14	7.2	22.0%	2.26	2.98	19.9	0.623
-24	7.1	23.7%	2.55	4.27	17.9	1.12
BHKD5-1	7.2	20.6%	3.45	3.32	20.8	0.535
-19	6.6	23.1%	3.07	3.4	20.9	0.283
-27	7.0	24.8%	6.25	5.35	11.1	0.216
BHKD6-1	5.8	20.0%	2.35	6.88	21.2	1.85
-11	6.8	21.2%	1.99	2.58	14.3	0.479
-26	7.7	22.0%	9.49	14	11.1	0.221
Minimum	5.8	13%	1.36	2.2	11.1	0.216
Maximum	8.3	28%	9.49	14	21.2	1.85

3.3 URANIUM AND TECHNETIUM ACTIVITIES IN SOIL SAMPLES

Soil samples collected from the restricted areas (BHKD5) contained the highest uranium concentrations (see Fig. 2) and highest radioactivity from ^{234}U and ^{235}U (see Table 7). Elevated U was also detected in the shallowest sample from the Tile Barn/Cistern Burn Pit area (BHKD3-8). Slightly elevated total U was measured in BHKD4-14 (from restricted area #1) and BHKD6-1 (from the Evaporation Ponds); elevated activities from ^{234}U and ^{235}U were also observed in these samples (see Table 7).

^{99}Tc activity was not detected (0.5 pCi/g detection limit) in any of the samples from BHKD2 (Burial Pits) and BHKD3 (Tile Barn/Cistern Burn Pit). Activities were higher than the detection limit in the rest of the samples, but all were still below the laboratory's reporting limit (10 pCi/g). The highest ^{99}Tc activity was measured in BHKD4-14.

All samples from BHKD5 and the shallowest sample from BHKD3 were deemed to have sufficient U levels for desorption testing in the first batch of K_d measurements. BHKD4-14 and BHKD6-1 were subjected to desorption testing in the second batch of K_d measurements because these had sufficient U to result in quantifiable levels in the contact solutions based on K_d s measured in the first batch. ^{99}Tc was not measured in the first batch of desorption tests because the field-sampled activities in the soil samples (see Table 7) were below the reporting limit and were unlikely to be reliable for K_d calculations based on mass balance.

Table 7. Uranium isotope and Technetium-99 activities in soil samples

Borehole	Location	Upper Limit of Samp Int (ft)	Lower Limit of Samp Int (ft)	^{234}U (pCi/g)	^{235}U (pCi/g)	^{238}U (pCi/g)	^{99}Tc (pCi/g)
BHKD1	Duels Mt	4	8.6	6.14	0.26	1.48	6.6
		23	28	1.79	N.D.	1.04	6.23
		28	33	0.92	N.D.	0.73	2.84
BHKD2	Burial Pits	4	10	4.97	0.18	1.22	N.D.
		13	17	0.85	N.D.	0.93	N.D.
		23	34	0.72	N.D.	0.78	N.D.
BHKD3	Tile Barn/Cistern Burn Pit	8	13	21.5	1.31	12	N.D.
		16	20	1.48	0.15	0.93	N.D.
		23	27	1.63	0.24	1.01	N.D.
BHKD4	Restricted Area #1	2	14	3	N.D.	0.99	2.8
		14	21	20.2	0.66	3.32	13.8
		24	30	1.38	N.D.	0.94	0.82
BHKD5	Restricted Area #2	1	12	218	9.8	33.6	2.52
		19	24	90	4.12	14.5	1.18
		27	31	75.8	2.67	6.57	0.91
BHKD6	Evaporation Pond	1	8	11.6	0.45	2.06	2.55
		11	16	1	N.D.	0.91	2
		26	30	1.14	N.D.	0.66	5.86

Note: Shaded values are below the method-reporting limit (1 pCi/g for U isotopes and 10 pCi/g for ^{99}Tc) but above the detection limit (0.1 pCi/g for U isotopes and 1 pCi/g for ^{99}Tc). N.D.: not detected; value was below the method detection limit.

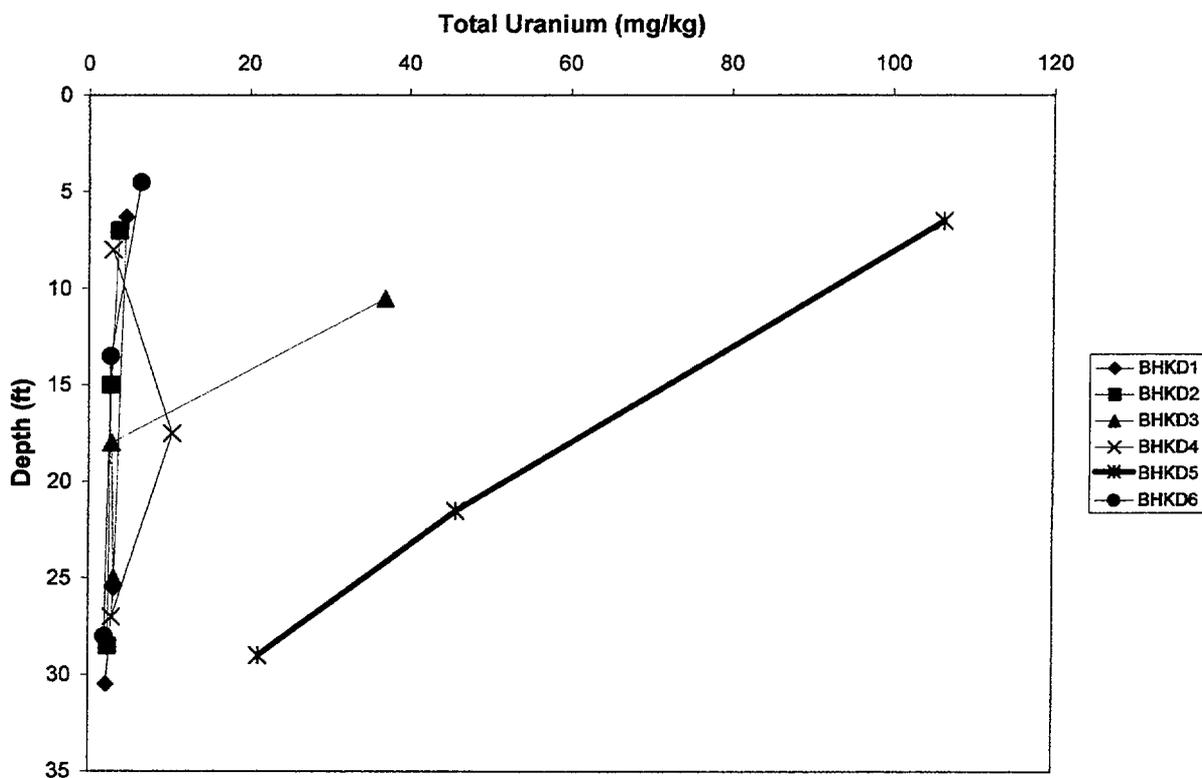


Fig. 2. Total uranium concentration in soil samples calculated from isotopic activities (Table 7) using the following conversion factors: 6.2×10^{-3} Ci/g ^{234}U , 2.2×10^{-6} Ci/g ^{235}U , and 3.3×10^{-7} Ci/g ^{238}U .

3.4 GROUNDWATER CHARACTERISTICS

Table 8 shows characteristics of groundwater used as contact solution for the K_d tests (OB-1). It also contains field parameters measured in WS-14, the only well located within 50 ft of one of the boreholes (BHKD2) drilled for this study. Note that the concentration of U in the OB-1 groundwater is significantly lower than the spike levels used in the adsorption K_d tests (see Table 2). The ORP in both wells indicated mildly reducing conditions, consistent with the presence of dissolved iron (Fe^{2+}), but appear were inconsistent with the high dissolved oxygen measurements. It is suspected that the latter was affected by handling of the samples that can artificially aerate the groundwater.

Table 8. Characteristics of Groundwater samples collected for this study

Parameter	OB-1	WS-14
PH	6.57	5.93
Temperature °C	16.5	16.7
Oxidation Reduction Potential (ORP, mV)	27	57
Dissolved oxygen (mg/L)	1.42	4.79
Specific conductivity (mS/cm)	1.61	0.28
²³⁴ U (pCi/L)*	1.27	Not measured
²³⁵ U (pCi/L)*	0.03	Not measured
²³⁸ U (pCi/L)*	0.66	Not measured
⁹⁹ Tc (pCi/L)	0.2	Not measured
Ca (mg/L)	83.5	Not measured
K (mg/L)	1.6	Not measured
Mg (mg/L)	28.1	Not measured
Na (mg/L)	19	Not measured
Cl (mg/L)	5	Not measured
NO ₃ (mg/L)	3.5	Not measured
SO ₄ (mg/L)	40.1	Not measured
Total Depth (ft)	27.1	Not measured
Depth to water (ft)	16.5	Not measured
Fe** (mg/L)	0.18	0.42
Alkalinity** (mg/L)	150	14

*Calculated total U = 2.6 µg/L

**Measured 24 hours later

4. RESULTS OF SITE-SPECIFIC K_d STUDY FOR URANIUM AND TECHNETIUM-99

4.1 DESORPTION AND ADSORPTION KINETICS

Steady-state conditions were achieved within 14 days for both desorption and adsorption K_d tests (see Tables 9 and 10, Figs. 3 to 10). As mentioned in Section 2, the K_d tests were done in two batches to allow procedure modifications based on results of the first batch of tests. Tc was not quantified in the Batch 1 desorption tests because Tc activities were below the reporting limit in the soil samples (see Section 3.3 and Table 7). In addition, the Day 3 U analyses for BHKD2-4, -13, -23, BHKD4-14, and BHKD6-1 were not included in Figs. 4 and 5 because these were inconsistent with analyses on subsequent days (i.e., values were significantly higher or lower) and were deemed likely to be in error.

Table 9. Uranium concentrations in contact solutions during K_d tests

Sample ID	Batch No. and Test Type*	Initial U in contact solution ($\mu\text{g/L}$)	Uranium in contact solution ($\mu\text{g/L}$)					
			Day 3	Day 7	Day 10	Day 14	Average Day 7-14	Std. Dev Day 7-14
BHKD1-4	2, Ads	950	175	254	242	177	224	41
-23	2, Ads	950	491	420	321	335	359	54
-28	2, Ads	950	141	348	253	318	306	49
BHKD2-4	1, Ads	10000	0.606	9300	10100	10100	9833	462
-13	1, Ads	10000	0.291	9400	9900	9300	9533	321
-23	1, Ads	10000	0.291	8400	8700	9100	8733	351
BHKD3-8	1, Des	0	127	168	184	191	181	12
-16	2, Ads	950	28	12	19.3	18.7	17	4
-23	2, Ads	950	162	190	157	192	180	20
BHKD4-2	2, Ads	950	185	174	121	148	148	27
-14	2, Des	0	850	163	137	127	142	19
-24	2, Ads	950	40	34	20.9	8.83	21	13
BHKD5-1	1, Des	0	675	760	730	679	723	41
-19	1, Des	0	252	102	108	79.2	96	15
-27	1, Des	0	73.8	84	73.6	65.6	74	9
BHKD6-1	2, Des	0	840	7.7	4.5	7.79	7	2
-11	2, Ads	950	26	31	21.1	9.21	20	11
-26	2, Ads	950	13	16	6.51	4.88	9	6

*Ads: adsorption; Des: desorption

Table 10. Tc activities in contact solutions during K_d tests

Sample ID	Batch No. and Test Type*	Initial Tc in contact solution (pCi/L)	Tc in contact solution (pCi/L)					
			Day 3	Day 7	Day 10	Day 14	Average (Day 7-14)	Std. Dev. (Day 7-14)
BHKD1-4	2, Ads	27800	1370	916	990	938	948	38
-23	2, Ads	27800	2610	3540	13200	724	5821	6543
-28	2, Ads	27800	565	548	635	6270	2484	3279
BHKD2-4	1, Ads	600	27	27	6.5	7.2	14	12
-13	1, Ads	600	64	68	29.7	4.8	34	32
-23	1, Ads	600	36	12	6.7	8.2	9	3
BHKD3-8	1, Des	0	N.A.	N.A.	N.A.	N.A.	-----	-----
-16	2, Ads	27800	1380	718	710	694	707	12
-23	2, Ads	27800	688	697	585	638	640	56
BHKD4-2	2, Ads	27800	3090	1300	1080	859	1080	221
-14	2, Des	0	N.A.	N.A.	-9.1	-15	-----	-----
-24	2, Ads	27800	1850	1250	1110	760	1040	252
BHKD5-1	1, Des	0	N.A.	N.A.	N.A.	N.A.	-----	-----
-19	1, Des	0	N.A.	N.A.	N.A.	N.A.	-----	-----
-27	1, Des	0	N.A.	N.A.	N.A.	N.A.	-----	-----
BHKD6-1	2, Des	0	N.A.	N.A.	10	-6	-----	-----
-11	2, Ads	27800	2160	1860	1330	1300	1497	315
-26	2, Ads	27800	1170	783	618	550	650	120

*N.A. = Not applicable

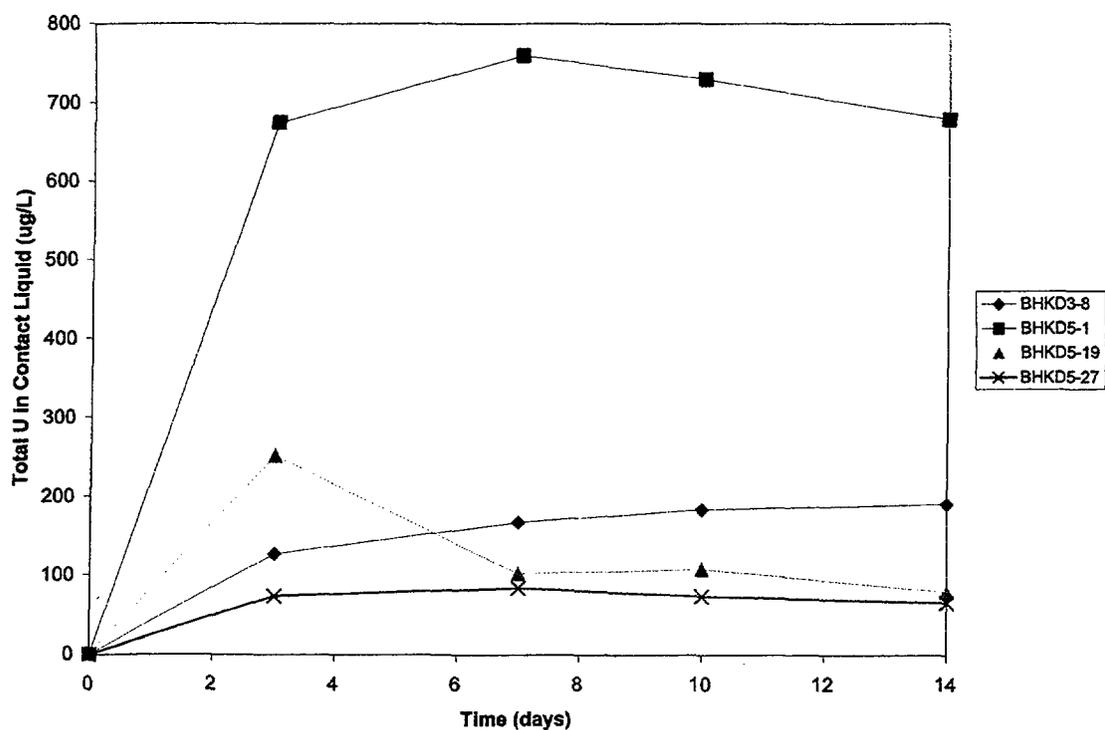


Fig. 3. Total U concentration in contact solutions vs time for Batch 1 desorption tests. Contact solutions consisted of groundwater from well OB-1 considered as a background well (U and ⁹⁹Tc at 2.6 $\mu\text{g/L}$ and 0.2 pCi/L, respectively)

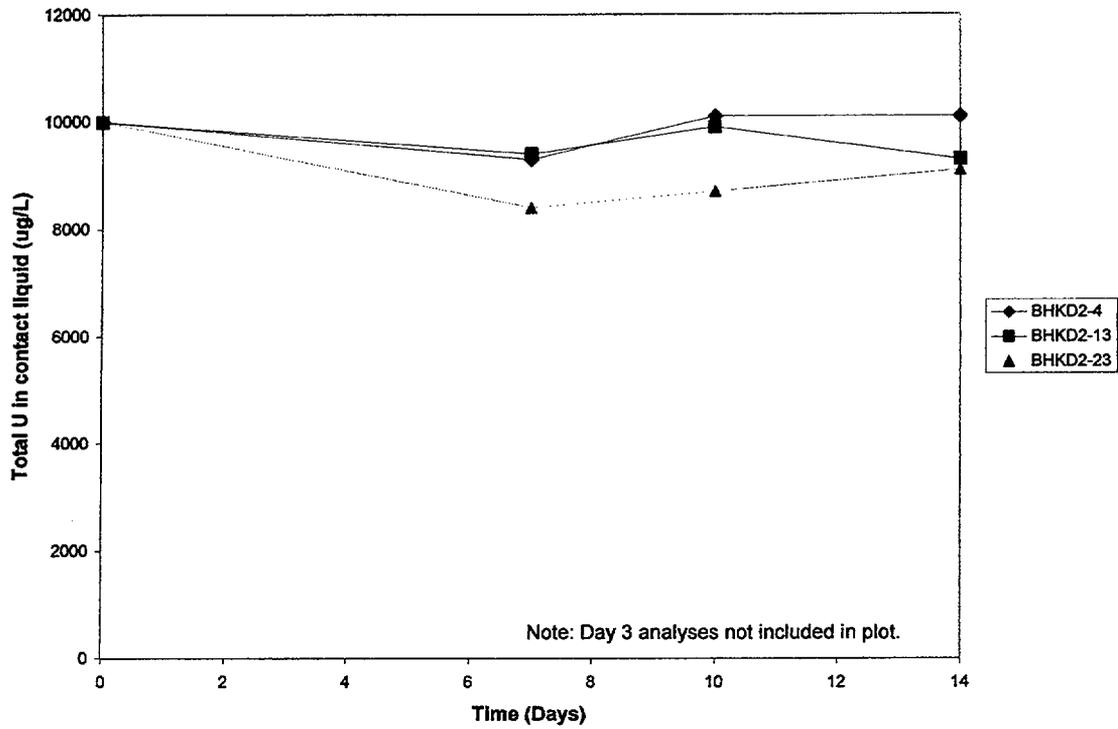


Fig. 4. Total U concentration in contact solutions vs time for Batch 1 adsorption tests. Contact solutions consisted of groundwater from background well OB-1 spiked with standard solutions to achieve initial uranium and technetium concentrations of 10,000 $\mu\text{g/L}$ and 600 pCi/L .

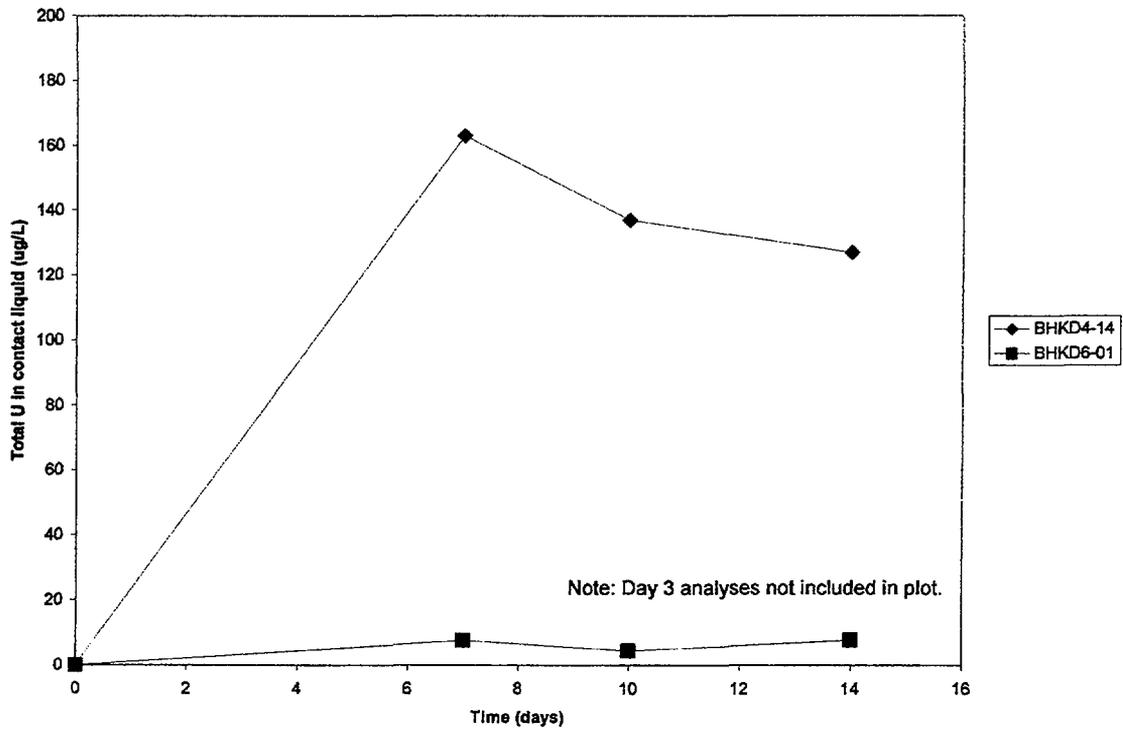


Fig. 5. Total U concentration in contact solutions vs time for Batch 2 desorption tests. Contact solutions consisted of groundwater from well OB-1 considered as a background well (U and ⁹⁹Tc at 2.6 µg/L and 0.2 pCi/L, respectively).

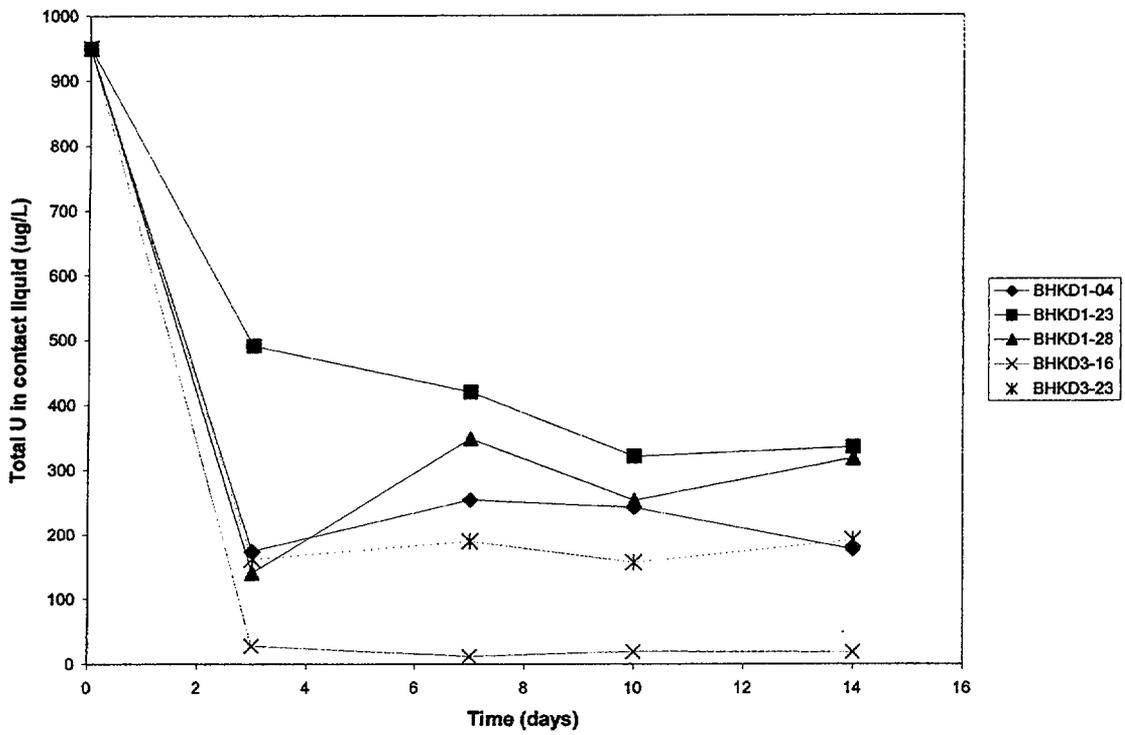


Fig. 6. Total uranium concentration in contact solutions vs time for Batch 2 adsorption tests on samples from BHKD1 and BHKD3. Contact solutions consisted of groundwater from background well OB-1 spiked with standard solutions to achieve initial uranium and technetium concentrations of 950 $\mu\text{g/L}$ and 27,800 pCi/L, respectively.

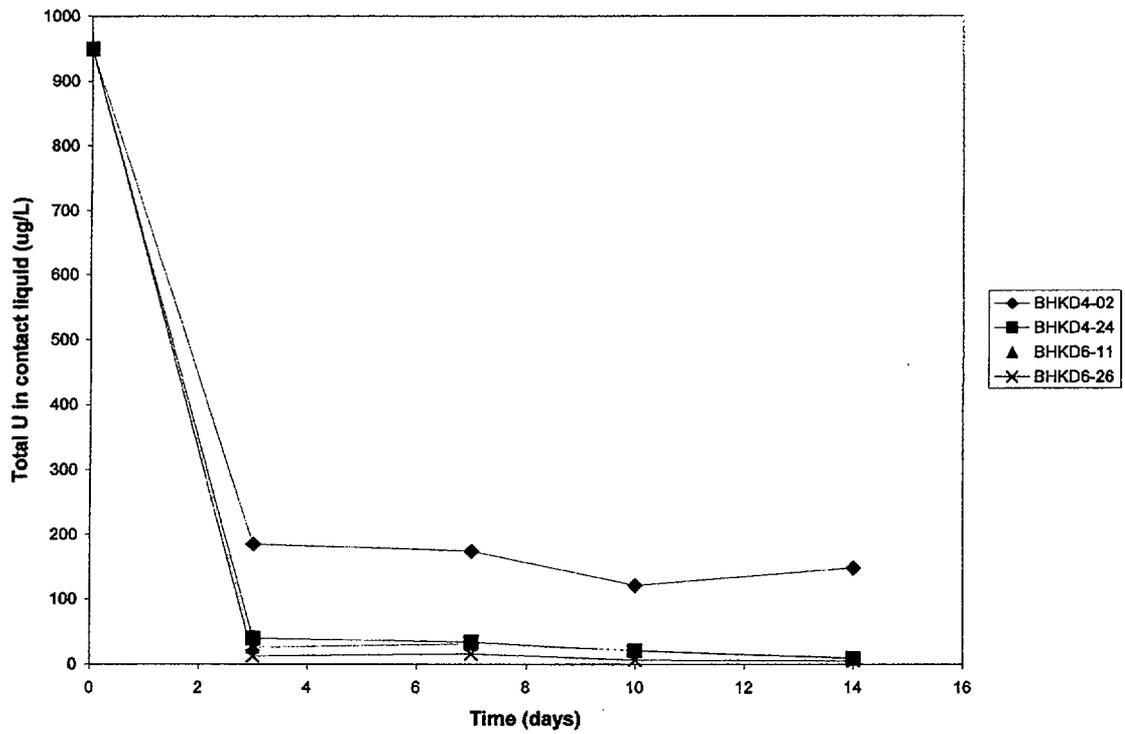


Fig. 7. Total U concentration in contact solutions vs time for Batch 2 adsorption tests on samples from BHKD4 and BHKD6. Contact solutions consisted of groundwater from background well OB-1 spiked with standard solutions to achieve initial U and Tc concentrations of 950 $\mu\text{g/L}$ and 27,800 pCi/L, respectively.

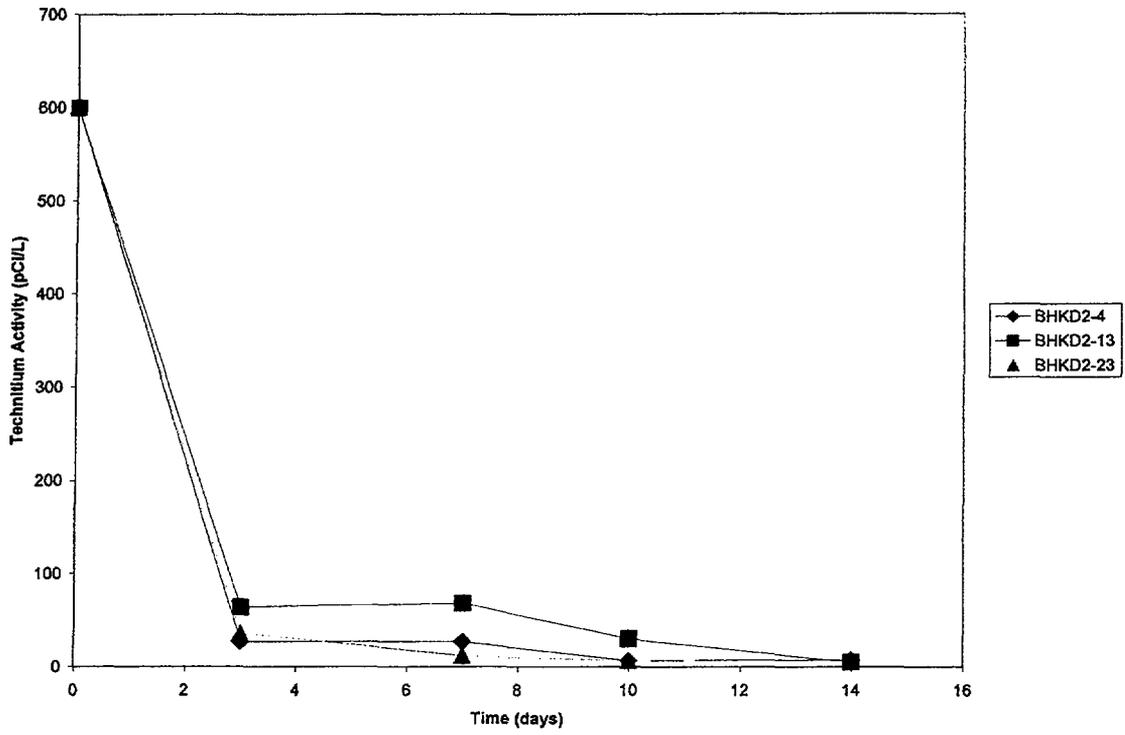


Fig. 8. Tc activities in contact solutions vs time for Batch 1 adsorption tests on samples from BHKD2. Contact solutions consisted of groundwater from background well OB-1 spiked with standard solutions to achieve initial U and Tc concentrations of 10,000 $\mu\text{g/L}$ and 600 pCi/L, respectively.

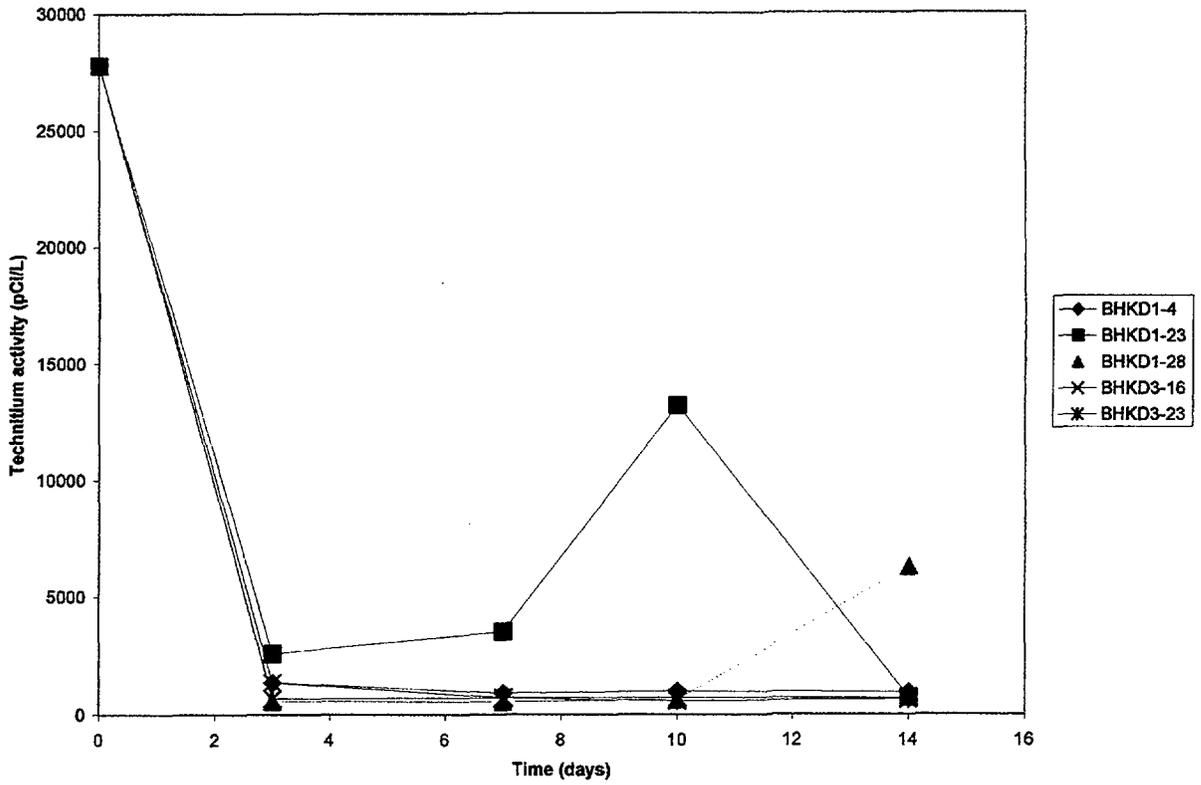


Fig. 9. Tc activities in contact solutions vs time for Batch 2 adsorption tests on samples from BHKD1 and BHKD3. Contact solutions consisted of groundwater from background well OB-1 spiked with standard solutions to achieve initial U and Tc concentrations of 950 $\mu\text{g/L}$ and 27,800 pCi/L, respectively.

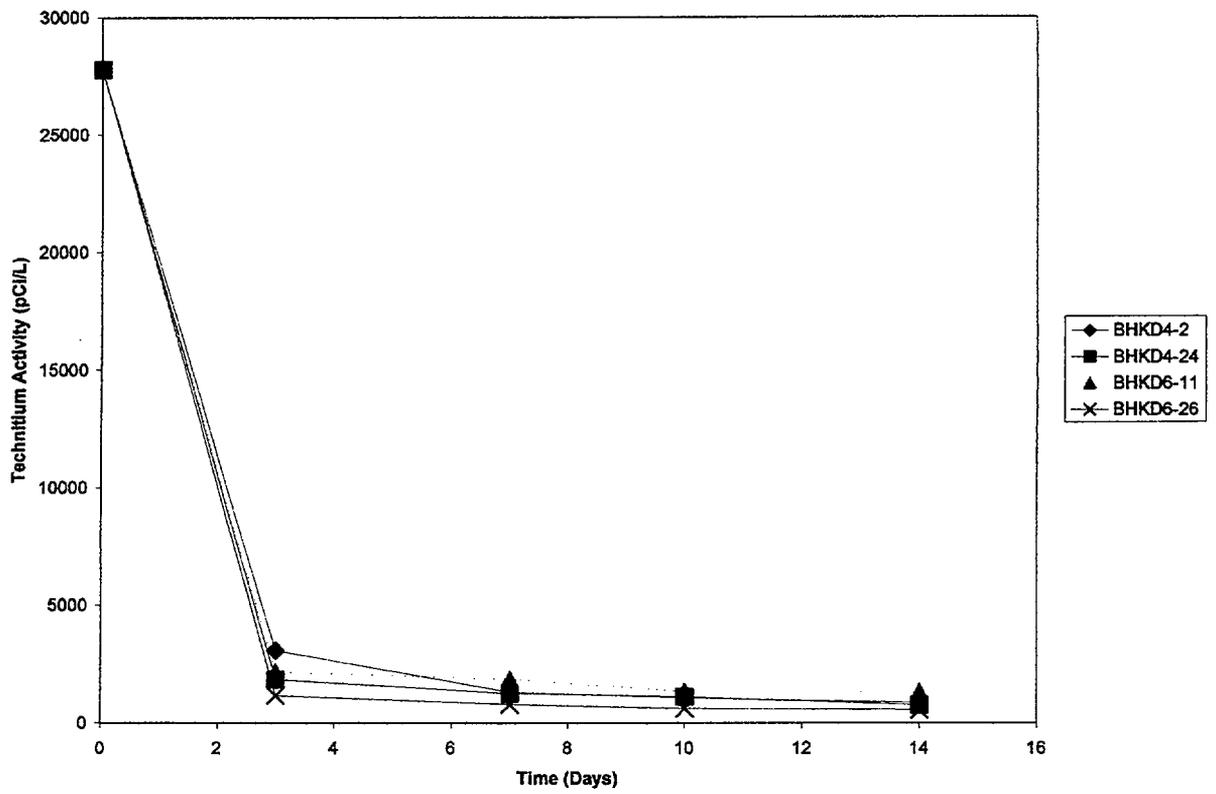


Fig. 10. Tc activities in contact solutions vs time for Batch 2 adsorption tests on samples from BHKD4 and BHKD6. Contact solutions consisted of groundwater from background well OB-1 spiked with standard solutions to achieve initial U and Tc concentrations of 950 $\mu\text{g/L}$ and 27,800 pCi/L, respectively.

A relatively high U spike level (10,000 µg/L) was selected for the Batch 1 adsorption tests, in anticipation of K_d values that can be as high as 10,000 mL/g [EPA 1999]. If the K_d factor were this high, then a high spike level would be required to adequately quantify U in the contact solutions after equilibration with the soil samples. Measured U concentrations in the contact solutions did not vary much from the spike level in the Batch 1 adsorption tests (see Table 9, BHKD2-4, 13, and 23, and Fig. 4), indicating very little to no adsorption onto the soil. On the other hand, Batch 1 desorption samples exhibited K_d factors that were greater than 100 mL/g. When the spike level was reduced to 950 µg/L U in Batch 2, adsorption was observed in all samples (see Figs. 6 and 7). It is possible that the low adsorption observed in Batch 1 was due to the high U concentration in the contact solution that led to saturation of the active sites on the solid surfaces. Table 11 shows results of U analyses on select Day 14 solid residues, as well as mass balance calculations that show good recovery in most of the samples.

Table 11. Mass balance calculations for U in soil/water mixtures

Sample ID	As-sampled U in soil (mg/kg)	Initial U in contact solution (ug/L)	Initial Mass of U in soil/water mixture (mg)	U in solid residue on Day 14* (mg/kg)	U in contact solution on Day 14 (ug/L)	Mass of U in soil/water mixture on Day 14 (mg)	Mass Balance**
BHKD1-4	4.60	950	0.168	7.4	177	0.162	96%
-23	3.15	950	0.139	8.2	335	0.192	138%
-28	2.21	950	0.120	5.4	318	0.134	111%
BHKD2-4	3.78	10000	0.876	N.M.	10100	----	----
-13	2.82	10000	0.856	N.M.	9300	----	----
-23	2.36	10000	0.847	N.M.	9100	----	----
BHKD3-8	36.96	0	0.739	30.2	191	0.618	84%
-16	2.89	950	0.134	7.9	18.7	0.160	120%
-23	3.17	950	0.139	7.9	192	0.174	124%
BHKD4-2	3.00	950	0.136	9.2	148	0.195	144%
-14	10.36	0	0.207	10.8	127	0.225	109%
-24	2.85	950	0.133	5.5	8.83	0.110	83%
BHKD5-1	106.31	0	2.126	116.0	679	2.375	112%
-19	45.83	0	0.917	36.8	79.2	0.742	81%
-27	21.13	0	0.423	22.1	65.6	0.447	106%
BHKD6-1	6.45	0	0.129	6.4	7.79	0.129	100%
-11	2.76	950	0.131	6.1	9.21	0.123	94%
-26	2.00	950	0.116	6.7	4.88	0.134	116%

*These were corrected for dissolved U in the water phase of the solid residue samples. The moisture content in the solid residues (~45%) were measured and used for these corrections, together with measured U in Day 14 contact solutions.

**Mass balance = Ratio between mass of U on Day 14 and initial mass of U in soil/water mixtures.

The Tc activities in the contact solutions from the Batch 1 adsorption K_d tests (Table 10, Fig. 8) were significantly lower than the initial contact solution activity of 600 pCi/L, indicating that Tc was being removed from solution in the soil/water mixtures. Published studies on TcO_4^- adsorption are fairly consistent in that all show very low K_d values (0.1 to 1 mL/g, Krupka and Serne 2002) under aerobic conditions. The negative TcO_4^- ion is not expected to adsorb on soil surfaces that are predominantly negatively charged under typical pH values found in the subsurface environment. Because 600 pCi/L is equivalent to a mass concentration of ~ 35 ng/L, it was thought that the observed disappearance of Tc from solution was a “concentration effect”, and that there were enough positively charged sites on the soil surfaces to interact electrostatically with the minute amount of Tc in solution. For Batch 2, the Tc spike level was increased to 27,800 pCi/L (~ 1.6 $\mu\text{g/L}$).

Even at this elevated concentration, Tc was still removed from solution, dropping by an order of magnitude by Day 14 in most of the samples. The Day 14 Tc activities in the deeper samples from BHKD1 were the exception to this trend (Table 10, Fig. 9). The Tc activities in the contact solutions for BHKD1-23 were erratic, with values that fluctuated between a minimum of 724 pCi/L on Day 14, and a maximum of 13,200 pCi/L on Day 10. Tc activities in BHKD1-28 on Days 3, 7 and 10 were relatively consistent (548 to 635 pCi/L), but Tc activity was much higher on Day 14 (6,270 pCi/L). These results could be due to heterogeneity among subsamples collected from a bulk sample used to prepare the soil/water mixtures. Nevertheless, 10 out of 12 Tc adsorption tests showed significant removal of Tc from solution by Day 3, and relatively monotonic Tc activities that either leveled off or decreased gradually through Day 14 (Table 10, Figs. 8-10).

Determining the actual mechanism by which Tc was being removed from solution is beyond the scope of this study. However, published experimental studies on the behavior of Tc in geologic media can shed light on the observations in this study. The Tc added to the contact solutions was in the +7 oxidation state [Tc (VII)] in the form of TcO_4^- . The latter is known to be very soluble and not strongly adsorbed at neutral and basic pH conditions (Krupka and Serne 2002). Significant removal of Tc in this study could be due to chemical reduction of Tc (VII) to Tc(IV) which is more highly sorbed and can form relatively insoluble Tc oxides. Chemical reduction of Tc (VII) has been observed by others through biotic processes (e.g., aided by metal reducing bacteria) and abiotic reactions (e.g., interaction with reduced iron) (Krupka and Serne 2002).

It is somewhat surprising that Tc (VII) reduction occurred in the soil/water mixtures prepared for this study because the mixtures were not kept under anaerobic conditions, which is typically done in experiments where Tc (VII) reduction was observed (e.g., Sheppard, Sheppard and Evenden, 1990). However, significant recovery of Tc in the solid residues (see Table 12) from filtration of the soil/water mixtures is consistent with its removal from solution. Thus, the evidence from this study points towards TcO_4^- being removed from solution and “adhering” to the Hematite soil samples, either through adsorption or chemical reduction followed by precipitation.

Table 12. Mass balance calculations for Tc in soil/water mixtures

Sample ID	As-sampled ⁹⁹ Tc in soil (pCi/g)	Initial ⁹⁹ Tc in contact solution (pCi/L)	Total ⁹⁹ Tc activity in soil/water mixture (pCi)	⁹⁹ Tc in solid residue on Day 14* (pCi/g)	⁹⁹ Tc in contact solution on Day 14 (pCi/L)	Total ⁹⁹ Tc activity in soil/water mixture on Day 14 (pCi)	Mass Balance**
BHKD1-4	6.60	27800	2356	71.4	938	1503.7	64%
-23	6.23	27800	2349	86.6	724	1790.1	76%
-28	2.84	27800	2281	67.7	6270	1855.0	81%
BHKD2-4	0.00	600	48	N.M.	7.2	----	----
-13	0.00	600	48	N.M.	4.8	----	----
-23	0.00	600	48	N.M.	8.2	----	----
BHKD3-8	0.00	0	0	N.M.	N.M.	----	----
-16	0.00	27800	2224	100.4	694	2064.2	93%
-23	0.00	27800	2224	87.3	638	1796.6	81%
BHKD4-2	2.80	27800	2280	81.5	859	1698.7	75%
-14	13.80	0	276	N.M.	-15	----	----
-24	0.82	27800	2240	74.0	760	1540.4	69%
BHKD5-1	2.52	0	50.4	N.M.	----	----	----
-19	1.18	0	23.6	N.M.	----	----	----
-27	0.91	0	18.2	N.M.	----	----	----
BHKD6-1	2.55	0	51	N.M.	-6	----	----
-11	2.00	27800	2264	89.9	1300	1902.7	84%
-26	5.86	27800	2341	73.2	550	1507.0	64%

*These were corrected for dissolved ⁹⁹Tc in the water phase of the solid residue samples. The moisture content in the solid residues (~48%) were measured and used for these corrections, together with measured ⁹⁹Tc in Day 14 contact solutions.

**Mass balance = Ratio between total ⁹⁹Tc activity on Day 14 and initial total ⁹⁹Tc activity in soil/water mixtures.

4.2 CALCULATED DISTRIBUTION COEFFICIENTS

Distribution coefficients (K_d) were calculated from the ratio between the U or Tc adsorbed onto the soil (S) and the average of Day 7, 10, and 14 U or Tc concentration in the contact solutions (C_w , Table 9 and 10 for U and Tc, respectively). For the desorption tests, the adsorbed U or Tc concentration was calculated via mass balance as follows:

$$S = \frac{S_i M - C_w V}{M}, \quad [1]$$

where S_i is the field-sampled U or Tc concentration in the soil samples (Table 7), V is the volume of contact solution (0.08 L) and M is the mass of soil (0.02 kg) used in the K_d tests. Because the U or Tc soil concentrations (S_i) were measured following hot acid digestion of the soil samples, it is possible that a fraction of the field-sampled U or Tc in the soil is in precipitated form or occluded in the soil's mineral structure and not *reversibly* sorbed onto the soil. Thus, using the total (acid-digested) U and Tc soil concentration in calculations for the desorption tests can result in overestimated K_d factors. Researchers have used methods for selective extraction of defined U fractions (e.g., Kaplan and Serkiz, 2000, Senko et al, 2002, Sowder et al. 2003), however use of these methods was beyond the scope of this project. The initial contaminant concentrations to be used in RESRAD modeling will also consist of analyses results from acid-digested samples. Thus, calculating K_d s from the desorption test results assuming that the acid-digested U or Tc represents the "leachable" fraction in contaminated soil is a reasonable approach.

For the adsorption tests, the U or Tc concentrations sorbed onto the soil (S) was calculated as follows:

$$S = \frac{(C_{wi} - C_w)V}{M},$$

where C_{wi} is the initial U or Tc concentration in the spiked contact solution. Neglecting the contribution of the initial U or Tc in the soil samples to the final concentration in the contact solution is a conservative approach, resulting in a lower estimate for S and lower calculated K_d .

4.2.1 Uranium

The average U K_d factors from the adsorption and desorption tests are 117.8 and 232.7 mL/g, respectively (Table 13). These averages were calculated without K_d values from BHKD2 and BHKD6-1. As mentioned previously (Section 4.1), it is suspected that results from BHKD2 were compromised by the high U concentration in the Batch 1 contact solution (10,000 $\mu\text{g/L}$). The K_d value from BHKD6-1 is more than twice the next lower value and was not considered when calculating the average K_d (a conservative approach). Significant variability in the measured K_d s is reflected by standard deviations that are comparable to the average values (see Table 13). The degree of variability is not entirely surprising, and has been observed by others [EPA 1999, Krupka and Serne 2002]. Higher average K_d values in the desorption tests can be due to the sorbed U concentration in the soil-water mixtures being estimated from the U extracted from the soil samples via acid digestion. This digestion procedure extracts not only U that is adsorbed on to the soil (e.g., through electrostatic interactions with soil surfaces), but also likely

dissolves some U that is in precipitated form or occluded in the soil minerals. The latter should not, in theory, be included in the initial soil concentration (S_i) when estimating sorbed concentration, S (see Eqn. [1]). Higher K_d values in the desorption tests can also be due to an "aging effect" in field-contaminated samples, as described by Kaplan et al. [2001] who also measured K_d factors via desorption that were higher than K_d values based on adsorption measurements. Desorption from field-contaminated samples more closely simulates the leaching of radionuclides from contaminated soils, the process that is being modeled by RESRAD in DCGL calculations.

The lower average K_d in the adsorption tests can also be from soil samples with low potential for adsorption being fortuitously selected for adsorption testing. For example, all three samples from BHKD1 were subjected to adsorption testing and exhibited low K_d values. In a histogram of adsorption K_d s (excluding data from BHKD2 suspected to have been compromised by high U spike in Batch 1 contact solution), 3 out of 5 data points in the 0-100 mL/g range were results from one borehole (BHKD1, Fig. 11). There were no other consistent trends with borehole location or depth in the K_d measurements (see Fig. 12).

The "best" estimate for uranium K_d applicable to the Hematite Site is 175 mL/g, which is the mean of the averages from the adsorption and desorption test samples (excluding data from BHKD2 and BHKD6-1, discussed earlier in this subsection). This approach for estimating the "best" K_d was chosen over averaging the entire data set (158.8 mL/g), which unduly weights the adsorption K_d values (9 data points) over the desorption K_d values (5 data point). The approach used to arrive at the "best" estimate for Uranium K_d balances the more conservative estimation of K_d in the adsorption tests (i.e., by neglecting the contribution of the field-sampled U in the soil), with the less conservative approach (i.e., by using U in acid-digested soil samples) in calculating K_d factors from the desorption tests.

Histograms of measured K_d values for U (Fig. 11) from both adsorption and desorption tests (excluding data from BHKD2 and BHKD6-1, justification discussed earlier in this subsection) shows a more skewed distribution for the adsorption tests when compared to the desorption tests. If RESRAD modeling will include uncertainty analysis, it is recommended that parameters for characterizing the statistical distribution of K_d be obtained from a data set that consists of (1) the adsorption test results from this study excluding the 3 data from BHKD2, and the two highest and the two lowest K_d values, and (2) the desorption test results excluding K_d from BHKD6-1. This trimmed data set, which consists of an equal number of adsorption and desorption data points, grossly approximates a lognormal distribution (Fig. 11). Because there were no distinct depth trends in the K_d measurements (Fig. 12), spatial variability is best addressed by assuming that the unconsolidated sediments overlying bedrock at the Hematite Site can be characterized by a single K_d parameter that has a lognormal distribution.

The range and "best" estimate for U K_d from this study are compared with published literature values in Table 14. The latter include (1) a compilation by Sheppard and Thibbault (1990), where the K_d values are categorized according to soil texture, (2) a compilation by EPA (1999), where a look-up table, based on a large number of published experimental results, is formulated with pH as the independent variable, and (3) measurements by Kaplan and Serkiz (2001) following a desorption procedure using field-contaminated soil from the Department of Energy's Savannah River Site. The ranges for loam (>80% silt-sized and smaller fractions) and clay (>35% clay-sized fractions) from Sheppard and Thibbault (1990) are given in Table 14, because these textures best describe the soil collected from the Hematite Site for this study. K_d ranges for pH 6, 7 and 8 from EPA (1999) are shown in Table 14, also based on the characteristics of soil and groundwater from the Hematite Site (see Section 3). The Interagency

Steering Committee on Radiation Standards (ISCORS) recently performed a RESRAD dose modeling effort for radionuclides in sewage sludge used for agricultural and land reclamation. The baseline K_d value for U in the ISCORS model in this modeling study is also shown in Table 14. Note that the K_d range from this study is near the lower end of the published range of K_d values in Table 14. Thus, the K_d values in this study, including the best estimate for Uranium K_d for RESRAD modeling, appear to be reasonable and conservative.

Table 13. Calculated distribution coefficients for U based on average U concentration in contact solutions on Days 7, 10, and 14

Sample ID	Location	Adsorption Test K_d (mL/g)	Desorption Test K_d (mL/g)	Remarks
BHKD1-4	Duel's Mountain	12.9	-----	Initial U at 950 $\mu\text{g/L}$
-23		6.6	-----	Initial U at 950 $\mu\text{g/L}$
-28		8.4	-----	Initial U at 950 $\mu\text{g/L}$
BHKD2-4	Burial Pits	0.1*	-----	Initial U at 10,000 $\mu\text{g/L}$
-13		0.2*	-----	Initial U at 10,000 $\mu\text{g/L}$
-23		0.6*	-----	Initial U at 10,000 $\mu\text{g/L}$
BHKD3-8	Tile Barn/ Cistern Burn Pit	-----	200.2	Unspiked
-16		224.0	-----	Initial U at 950 $\mu\text{g/L}$
-23		17.2	-----	Initial U at 950 $\mu\text{g/L}$
BHKD4-2	Restricted Area #1	21.7	-----	Initial U at 950 $\mu\text{g/L}$
-14		-----	68.8	Unspiked
-24		174.9	-----	Initial U at 950 $\mu\text{g/L}$
BHKD5-1	Restricted Area #2	-----	143.0	Unspiked
-19		-----	471.4	Unspiked
-27		-----	280.1	Unspiked
BHKD6-1	Evaporation Ponds	-----	963.8**	Unspiked
-11		181.9	-----	Initial U at 950 $\mu\text{g/L}$
-26		412.2	-----	Initial U at 950 $\mu\text{g/L}$
Average		117.8	232.7	Excludes BHKD2 and BHKD6-1
Std. dev.		141.4	154.2	Excludes BHKD2 and BHKD6-1
Mean of adsorption and desorption averages		175		Excludes BHKD2 and BHKD6-1

*Very low adsorption in these tests suspected to have been due to high initial U in contact solution, resulting in saturation of adsorption sites on soil surfaces.

**This value is very high compared to other values.

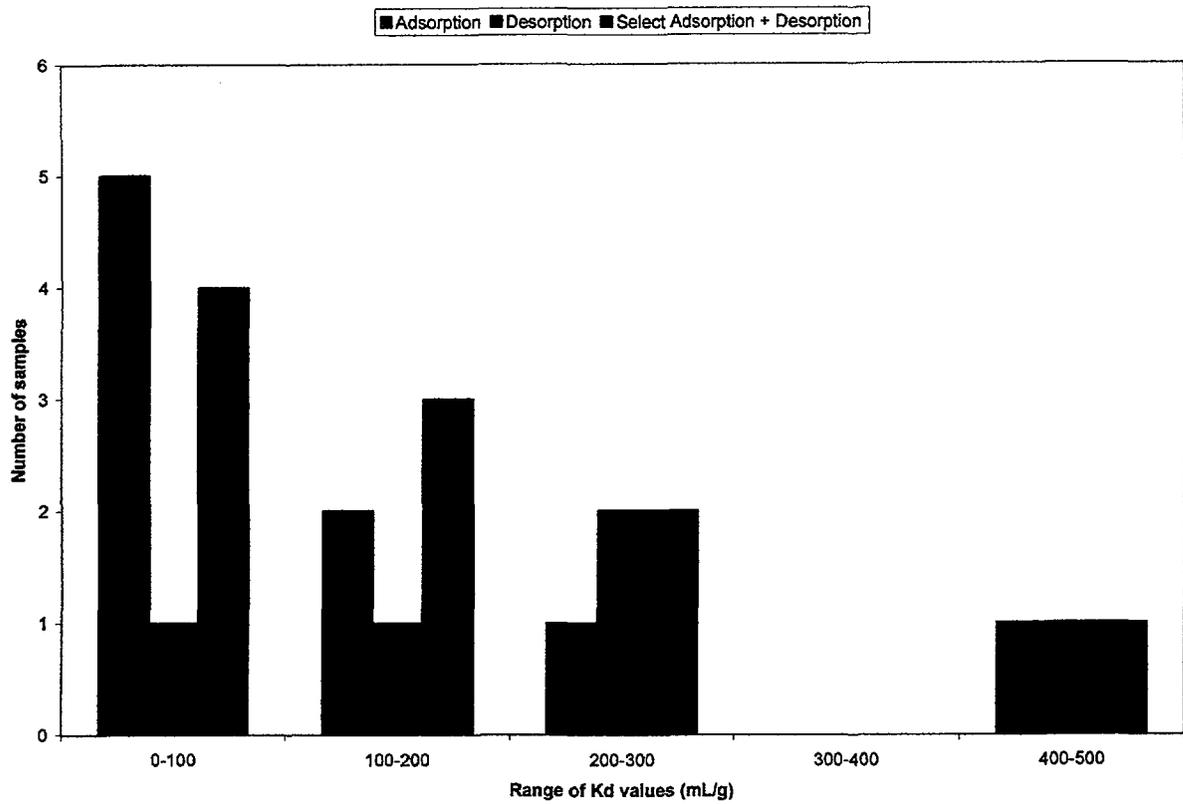


Fig. 11. Histograms of measured distribution coefficients (K_d) for U. “Adsorption” and “desorption” data sets exclude data from BHKD2 and BHKD6-1. “Select Adsorption + Desorption” data set consists of adsorption results excluding data from BHKD2, two highest and two lowest values, and desorption results excluding data from BHKD6-1.

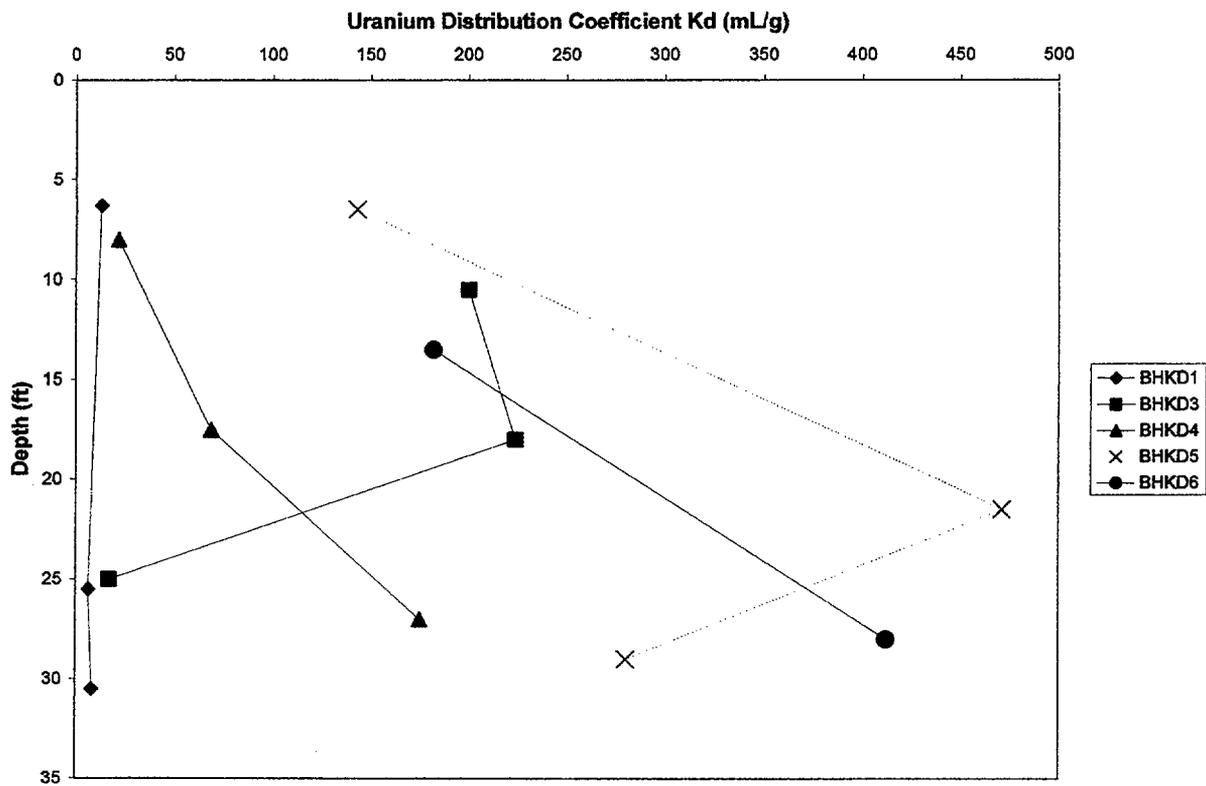


Fig. 12. Distribution coefficients (K_d) for uranium measured in Hematite Site soil samples plotted vs sample depth. Note that both adsorption and desorption test results are shown in the graph, and results from BHKD2 and BHKD6-1 are not plotted.

Table 14. Comparison of measured distribution coefficients for U in this study with published values

Source	Soil Type or Characteristic	Minimum K_d (mL/g)	Maximum K_d (mL/g)	"Best" Estimate for K_d (mL/g)
This Study*	>96% silt-sized and smaller particles pH 5.8-8.3	6.6	471.4	175
RESRAD default	-----	-----	-----	50
Sheppard and Thibault, 1990	Loam	0.2	4,500	15**
Sheppard and Thibault, 1990	Clay	46	395,100	1600**
EPA 1999	pH 6	100	1,000,000	-----
EPA 1999	pH 7	63	6,300,000	-----
EPA 1999	pH 8	0.4	250,000	-----
Kaplan et al, 2001	pH 4-5.8 (desorption tests) 20%-40% silt-sized and smaller particles	170	6493	-----
ISCORS***, 2003	-----	-----	-----	126

*Data set excludes data from BHKD2 and BHKD6-1 (see Section 4.2.1 for justification). "Best" estimate for K_d is the mean of the average K_d s from the adsorption and desorption tests.

**Geometric mean; data observed to be log normally distributed.

***Interagency Steering Committee on Radiation Standards

4.2.2 Technetium

The K_d values measured for Tc ranged from 15.1 to 172.9 mL/g and one data point at 263.7 mL/g (Table 15). The values appear to be relatively uniformly distributed between 0 and 200 mL/g, as shown by the histogram in Fig. 13. The lowest K_d values were obtained from BHKD1-23 and BHKD1-28, which were the samples that exhibited fluctuating concentrations in the contact solutions (Fig. 9). As a result, the Tc contact solution activity averaged over Day 7, 10, and 14 (used to calculate K_d) had a large standard deviation reflecting significant uncertainty in the K_d obtained from these time-averaged Tc activities. Exclusion of these data points was considered, but was eventually ruled out because the K_d s from these samples were on the low end and inclusion of these data points would constitute a conservative approach. Aside from BHKD1 samples exhibiting the lowest K_d values, no other trends were observed with borehole location or depth (Fig. 14).

Based on the measured K_d values (excluding data from the BHKD2-23), the best estimate for Tc K_d applicable to the Hematite site is 106 mL/g. Although this is significantly higher than published literature values measured under aerobic conditions, this value is considered to be valid based on the general consistency of the results (i.e., out of 9 samples, 7 exhibited significant and consistent removal of Tc from solution over 4 time intervals spanning 14 days, see Figs. 8-10) as well as recovery of Tc in the solid residues (Table 12).

Determining the mechanism for the removal of TcO_4^- from solution is beyond the scope of this study, but a mechanism can be hypothesized based on published literature. Because TcO_4^- is known to be highly soluble due to its negative charge and the negative character of soil surfaces at neutral pH, removal of Tc from contact solutions and its association with the soil is unlikely to be an electrostatic process, but is more likely from a reduction reaction where Tc(VII) is reduced to less soluble Tc(IV) either through abiotic reactions with reduced chemical species (e.g., Fe^{2+}) or microbial processes. The rapid removal of Tc (within 3 days) is more indicative of abiotic reactions, rather than biological processes particularly for metal-reducing bacteria that are active mainly under anaerobic conditions. It is also possible that Tc removal from solution observed in this study is due to the very low concentration of Tc used in these studies (maximum of 1,600 ng/L in the contact solution equivalent to a soil concentration 0.0064 mg/kg for 20 g: 80 mL soil:water mixtures). Gu and Dowlen (1996) conducted their experiments under similar Tc soil concentrations, while Sheppard et al. (1990b) applied Tc to their study soils at an effective soil concentration of 3.9 mg/kg. Note that historical Tc levels in groundwater at the Hematite site are significantly lower than the lowest contact solution spike level in this study (600 pCi/L).

If uncertainty analysis will be performed during RESRAD modeling, it is recommended that statistical parameters be obtained from the range of values shown in Table 15, excluding the high value from BHKD2-23. The histogram in Fig. 13 grossly approximates a uniform distribution between 0 and 200 mL/g. Because there were no distinct trends with depth in the K_d measurements (Fig. 14), spatial variability is best addressed by assuming that the unconsolidated sediments overlying bedrock at the Hematite Site can be characterized by a single K_d parameter that has a uniform distribution.

Table 15. Calculated distribution coefficients for Technetium based on average Tc concentration in contact solutions on Days 7, 10, and 14

Sample ID	Location	K_d (mL/g)	Remarks
BHKD1-4	Duel's Mountain	113.3	Initial ^{99}Tc at 27,800 pCi/L
-23		15.1	Initial ^{99}Tc at 27,800 pCi/L
-28		40.8	Initial ^{99}Tc at 27,800 pCi/L
BHKD2-4	Burial Pits	172.9	Initial ^{99}Tc at 600 pCi/L
-13		66.2	Initial ^{99}Tc at 600 pCi/L
-23		263.7	Initial ^{99}Tc at 600 pCi/L
BHKD3-8	Tile Barn/ Cistern Burn Pit	N.M.	Used for U desorption testing
-16		153.2	Initial ^{99}Tc at 27,800 pCi/L
-23		169.8	Initial ^{99}Tc at 27,800 pCi/L
BHKD4-2	Restricted Area #1	99.0	Initial ^{99}Tc at 27,800 pCi/L
-14		N.M.	Used for U desorption testing
-24		102.9	Initial ^{99}Tc at 27,800 pCi/L
BHKD5-1	Restricted Area #2	N.M.	Used for U desorption testing
-19		N.M.	Used for U desorption testing
-27		N.M.	Used for U desorption testing
BHKD6-1	Evaporation Ponds	N.M.	Used for U desorption testing
-11		70.3	Initial ^{99}Tc at 27,800 pCi/L
-26		167.0	Initial ^{99}Tc at 27,800 pCi/L
Average		106	Excludes BHKD2-23 (high compared to other data)
Std. Dev.		54.7	Excludes BHKD2-23 (high compared to other data)

*N.M. = Not measured

Table 16. Comparison of measured distribution coefficients for technetium in this study with published values

Source	Soil Type or Characteristic	Minimum K_d (mL/g)	Maximum K_d (mL/g)	"Best" Estimate for K_d (mL/g)
This Study*	>96% silt-sized and smaller particles pH 5.8-8.3	15.1	172.9	106
RESRAD default	-----	-----	-----	0
Sheppard and Thibault, 1990	Loam	0.01	0.4	0.1*
Sheppard and Thibault, 1990	Clay	1.16	1.32	1*
Sheppard, Sheppard and Evenden, 1990	Clay-Loam, aerobic	-----	-----	-0.2**
Sheppard, Sheppard and Evenden, 1990	Clay-Loam, anaerobic	-----	-----	50
Gu and Dowlen 1996	Silty and sandy clay, aerobic	-----	-----	No sorption; K_d s not reported
Gu and Dowlen 1996	Silty and sandy clay, anaerobic	20	100	-----

*Geometric mean, based on assumed log-normal distribution for K_d

**Negative values have been reported elsewhere and attributed to ion exclusion

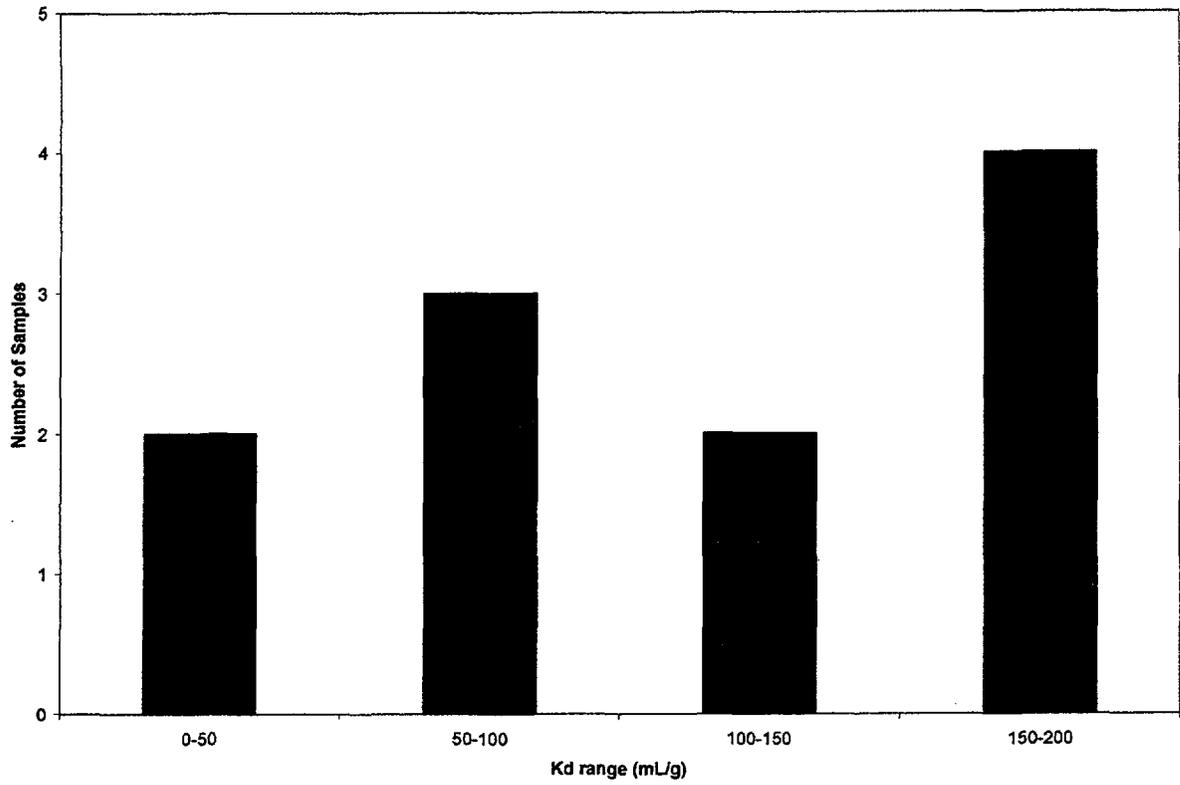


Fig. 13. Histogram of Technetium K_d values, excluding high value from BHKD2-23. All K_d values obtained via adsorption testing.

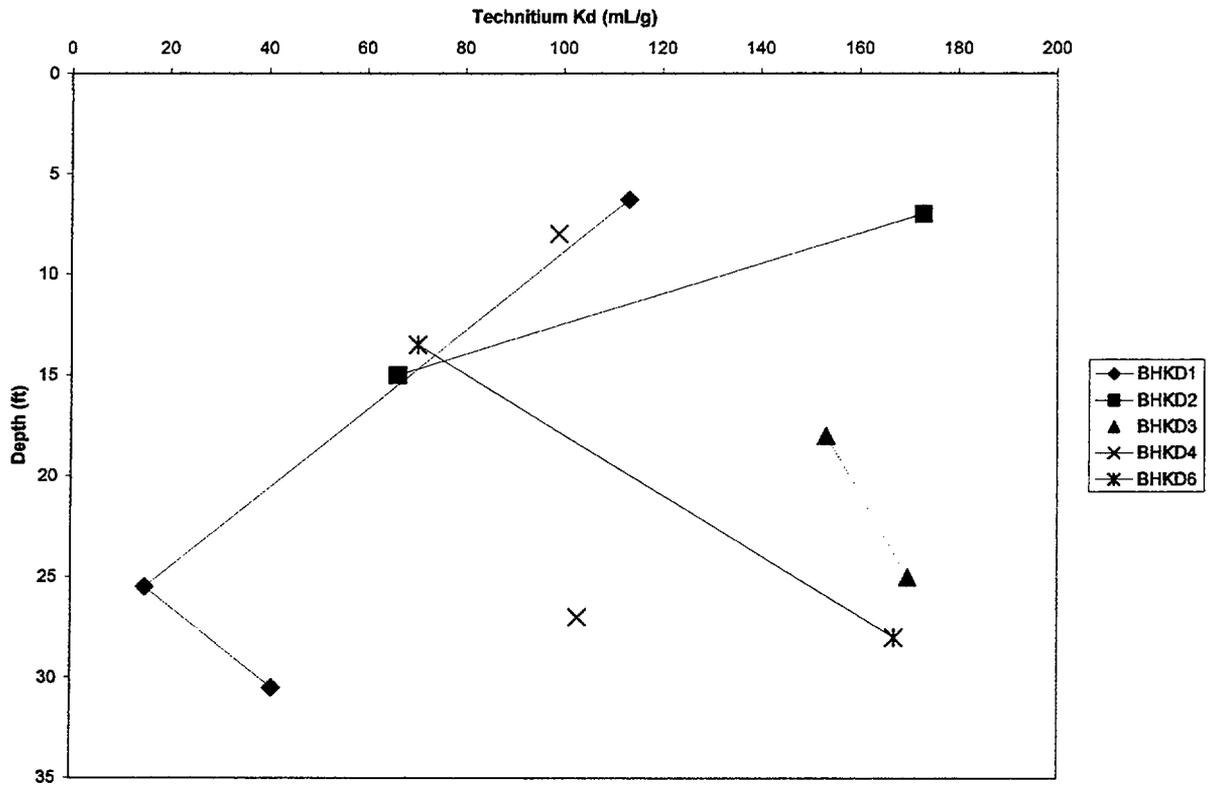


Fig. 14. Distribution coefficients (K_d) for technetium measured in Hematite Site soil samples plotted vs sample depth. High value from BHKD2-23 not plotted.

5. LITERATURE K_d VALUES FOR OTHER RADIONUCLIDES

The published compilation of distribution coefficients by Sheppard and Thibault (1990) was primarily used to select appropriate K_d values for Pu, Th, Np, and Am based on soil characteristics of the samples collected from the Hematite Site (Section 3). Sheppard and Thibault (1990) categorized the data by the texture of the soils used in the measurements. These categories were "sand" (containing > 70% sand-sized particles), clay (containing >35% clay-sized particles), "loam" (containing an even distribution of sand- clay- and silt-sized particles or consisted of up to 80% silt-sized particles), and "organic soils" (contained >30% organic matter). This categorization is consistent with the positive correlation between soil texture and specific surface area, and adsorption being a chemical interaction between a chemical species and chemically active surfaces on soil particles. For each category, Sheppard and Thibault (1990) provide the number of data points, geometric mean, minimum and maximum K_d measurements included in the data compilation. Given the particle size distribution measurements (Section 3.1), the samples from this study can be classified under the "clay" category. However, since the clay-sized fraction in the Hematite samples (~30%) is near the boundary for clay soils selected by Sheppard and Thibault (1990), K_d values for "loam" were also considered as shown below. Note that the "loam" K_d values are typically lower, and that inclusion of Sheppard and Thibault's "loam" data in selecting K_d values for the Hematite Site is a conservative approach.

EPA's compilation of K_d measurements (EPA 1999) was also considered when selecting K_d values for Pu and Th. Np and Am were not included in the EPA (1999) compilation but are covered in a forthcoming report (EPA 2003 unpublished).

5.1 PLUTONIUM

Table 17 shows summary statistics for Pu K_d values for loam and clay from Sheppard and Thibault (1990), and the range of values in EPA (1999) where a look-up table (with clay content and soluble carbonate as independent variables) is formulated based on one study that included 17 soil samples from 9 different locations within the Department of Energy complex. Given these published values, the RESRAD default value appears reasonable for application at the Hematite Site. This value is between Sheppard and Thibault's (1990) geometric means for loam and clay, and is within the range of K_d s for soils with 31 to 50% clay in EPA's look-up table. The baseline K_d value for Pu used in the ISCORS dose modeling effort for sewage sludge is also shown in Table 17.

Table 17. Published K_d values for plutonium

Source	Soil Type or Characteristic	Minimum K_d (mL/g)	Maximum K_d (mL/g)	"Best" Estimate for K_d (mL/g)
Sheppard and Thibault (1990)	Loam (21 data points)	100	5933	1200*
Sheppard and Thibault (1990)	Clay (18 data points)	316	190000	5100*
EPA 1999	Soluble carbonate 0.1 – 6 meq/L; clay (31-50%)	380	2700	----
ISCORS 2003	-----	-----	-----	953
RESRAD default	-----	----	----	2000

*Geometric mean, based on assumed lognormal distribution

5.2 THORIUM

Table 18 shows summary statistics for Thorium (Th) K_d values in clay from Sheppard and Thibault (1990), and the range of values in EPA (1999) where a look-up table (with pH as the independent variable) was formulated based on several published studies. The RESRAD default value of 60000 mL/g is recommended for application at Hematite. Although it is an order of magnitude higher than the geometric mean for clay in Sheppard and Thibault (1990), it is well within the range in EPA's look-up table, which is based on several studies and many more data points when compared to 5 data points used by Sheppard and Thibault for calculating their geometric mean. The baseline K_d value for Th used in the ISCORS dose modeling effort for sewage sludge is also shown in Table 18.

Table 18. Published K_d values for thorium

Source	Soil Type or Characteristic	Minimum K_d (mL/g)	Maximum K_d (mL/g)	"Best" Estimate for K_d (mL/g)
Sheppard and Thibault (1990)	Loam (no data)	---	---	---
Sheppard and Thibault (1990)	Clay (5 data points)	244	160000	5800*
EPA 1999	pH 5-8	1700	170000	----
ISCORS 2003	-----	-----	-----	5884
RESRAD default	-----	----	----	60000

*Geometric mean, based on an assumed lognormal distribution

5.3 NEPTUNIUM

Table 19 shows summary statistics for neptunium (Np) K_d values in loam and clay from Sheppard and Thibault (1990), as well as results from a number of studies found in the literature. The baseline K_d value for Np used in the ISCORS dose modeling effort for sewage sludge is also shown in Table 19. Note that the "default" K_d value in RESRAD is -1, which is a flag that invokes calculation of the default value using a correlation with the plant root uptake transfer factor [Yu et al., 2001]. In current version of RESRAD (v.6), the correlation for a loamy soil is used and results in a calculated K_d for Neptunium of 257. For the Hematite Site, a value of 2 mL/g is recommended which is near the low end of K_d s shown in Table 19. If the calculated DCGL based on this conservative K_d is significantly smaller than in situ Np levels and will require significant clean-up efforts, site-specific laboratory measurements may be warranted.

Table 19. Published K_d values for neptunium

Source	Soil Type or Characteristic	Minimum K_d (mL/g)	Maximum K_d (mL/g)	"Best" Estimate for K_d (mL/g)
Sheppard and Thibault (1990)	Loam (11 data points)	1.3	79	25*
Sheppard and Thibault (1990)	Clay (4 data points)	79	2575	55*
EPA 1999	Not included in compendium	----	----	----
Kaplan et al., 1996	Silty loam and coarse sand, pH 8.3	2.17	19.86	----
Kaplan et al., 1995	Loamy sand and silt loam	2.4	21.7	
Turner et al., 1998	Montmorillonite clay, maximum at pH 8-8.5 in presence of atmospheric CO ₂	----	100 mL/g	---
ISCORS 2003	-----	-----	-----	17
RESRAD default	-----	----	----	-1**

*Geometric mean, based on an assumed log-normal distribution

**This is a flag that invokes the calculation of a default K_d value using correlations with plant/soil concentration ratios. This results in a default K_d of 257 mL/g in the current version of RESRAD (v.6).

5.4 AMERICIUM

Table 20 shows summary statistics for americium (Am) K_d values in loam and clay from Sheppard and Thibault (1990), as well as results from a study referenced by Cantrell et al. (2000) where K_d values were measured in sandy material from the Department of Energy's Hanford Site. The baseline K_d value for Np used in the ISCORS dose modeling effort for sewage sludge is also shown in Table 20. The default RESRAD K_d value is very low (20 mL/g), and is outside the range of K_d s for loam and clay reported by Sheppard and Thibault (1990). For the Hematite site, it is recommended that 1000 mL/g be used. This value is more consistent with the published values referenced in Table 20, but is still conservative given that it is much lower than the geometric means for loam and clay in Sheppard and Thibault (1990).

Table 20. Published K_d values for Americium

Source	Soil Type or Characteristic	Minimum K_d (mL/g)	Maximum K_d (mL/g)	"Best" Estimate for K_d (mL/g)
Sheppard and Thibault (1990)	Loam (20 data points)	400	48309	9600*
Sheppard and Thibault (1990)	Clay (11 data points)	25	40000	8400*
EPA 1999	Not included in compendium	----	----	----
Cantrell et al. (2000)	Sandy material	----	----	>1200 mL/g
ISCORS 2003	-----	-----	-----	825
RESRAD default	-----	----	----	20

*Geometric mean, based on an assumed log-normal distribution

6. SUMMARY AND RECOMMENDATIONS

Site-specific measurements for K_d were performed on samples collected from areas of concern within the Hematite Site. A total of six boreholes were drilled to refusal or bedrock (~30 to 35 ft), and 18 soil samples (3 depth intervals per borehole) were collected for K_d testing, radionuclide analysis and general soil characterization procedures. The following is a summary of primary findings from this study:

1. All samples collected consisted of very fine-grained, brown silty clay, likely corresponding to the NSSC and DSSC HU identified in previous characterization reports [LBG 2003]. However, these two layers could not be visually distinguished in the field. Furthermore, the sand/gravel HU described by LBG (2003) was encountered in four out of six boreholes but at a thickness of less than 1 ft, not enough to obtain representative samples for K_d testing. The fine-grained nature of the soil samples was confirmed by particle size distribution measurements, which showed the soils to consist of >96% silt and clay sized fractions and ~30% clay.
2. General soil characteristics did not vary significantly over the site as shown in the summary table below. Furthermore, there were no observable trends with depth in these parameters.

Table 21. Summary of Hematite soil properties measured in this study

	pH	Moisture (%)	Total Carbon (g/kg)	Total Organic Carbon (g/kg)	Iron (g/kg)	Manganese (g/kg)
Minimum	5.8	13%	1.36	2.2	11.1	0.216
Maximum	8.3	28%	9.49	14	21.2	1.85

3. Uranium activities were detected at significant levels in samples from the restricted areas (BHKD5), and in shallowest sample from the Tile Barn/Cistern Burn Pit (BHKD3-8). Slightly elevated U activities were also observed in the mid-depth sample from another location in the restricted areas (BHKD4-14) and the shallowest sample from the Evaporation Ponds (BHKD6-1). Technetium was not detected at significant levels in any of the samples collected for this study.
4. K_d testing was performed following ASTM 4319-93, Standard Test Method for Distribution Ratios by the Short-term Batch Method, as recommended in the RESRAD data collection handbook. Two types of K_d tests were performed: (1) desorption tests where a measured mass of soil was contacted with a measured volume of uncontaminated groundwater over a period of 14 days, and (2) adsorption tests where soil was contacted with uncontaminated groundwater spiked to predetermined levels of U (as the uranyl ion or UO_2^{2+}) and ^{99}Tc (as the pertechnetate ion TcO_4^-). The K_d tests were performed in two

batches, to enable modifications in procedures for the second batch of tests based on the first batch of results.

5. In general, steady-state conditions were achieved in the soil/water mixtures within 14 days during the K_d tests. For Uranium, lower overall K_d values were observed in the adsorption tests, when compared to the desorption tests. Average K_{ds} from the adsorption and desorption tests were calculated (excluding data suspected to have been compromised by high U in the contact solution prepared for the first group of tests, and one K_d measurement that was much higher than the rest of the data) and the mean of the averages was considered the “best” estimate for U K_d for the Hematite Site. Although the desorption tests are likely to be more representative of contaminant leaching under field conditions, the adsorption data was still considered to achieve a reasonable but conservative site-specific K_d for Uranium.

For Tc, significant removal of Tc was observed from the liquid phase of the soil/water mixtures within 3 days. This “apparent” sorption could be due to the combined reduction of Tc (VII) to Tc (VI) and adsorption or precipitation of the latter, rather than electrostatic interactions of Tc (VII) with soil mineral surfaces. The resulting K_{ds} for Tc are significantly higher than published values, but the validity of K_d obtained from this study is supported by results that were repeated in multiple soil samples at several time intervals, and recovery of the Tc on the solid residues.

6. The following table shows the recommended K_d values for radionuclides of interest to the Hematite Site. The U and Tc K_d values are site-specific in that these were measured using soil samples collected from the site. Because there were no distinct trends with depth in the K_d measurements for both U and Tc, spatial variability is best addressed by assuming that the unconsolidated sediments overlying bedrock at the Hematite Site can be characterized by a single K_d parameter that has either a log-normal (for U) or uniform (for Tc) distribution. The K_d values for the rest of the radionuclides are based on published literature values.

Table 22. Recommended K_d values for RESRAD modeling at Hematite Site

Radionuclides of Concern	Recommended K_d value (mL/g)	Remarks
Uranium	175	Site specific measurement with range of 6.6 and 471.4 mL/g; grossly approximates a lognormal distribution.
Technetium	106	Site specific measurement with range of 15.1 and 172.9 mL/g; approximates a uniform distribution between 0 and 200 mL/g.
Plutonium	2000	RESRAD default value, reasonable when compared to published literature.
Thorium	60000	RESRAD default value, reasonable when compared to published literature.
Neptunium	2	At low end of published literature values.
Americium	1000	Consistent with published literature values, more reasonable than default K_d of 20.

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APPENDIX A

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Appendix A
Data Validation Reports

DATA VALIDATION REPORT

Date:

September 4, 2003

To: Steve Passig	From: Jerry Everett
Laboratory: Severn Trent – St. Louis	SDG #: F3H010120

Attached you will find the results from the data validation technical review for the Westinghouse/Hematite samples and analyses that are associated with the above referenced laboratory and sample delivery group (SDG) number. These data points have been selected for data validation and the sample index on the following page specifically identifies the samples and analyses associated with this validation review.

The FUSRAP validation technical review was performed in accordance with the *Contract Laboratory Program Data Validation Functional Guidelines for Evaluating Inorganic Analytical Data*, and the *Laboratory Data Validation Guidelines for Evaluating Radionuclide Analyses and Radiochemical Data Verification and Validation*. It was based on the information and documentation supplied by the associated laboratory. The analyses were evaluated against criteria established in the related analytical procedures and the Westinghouse/Hematite data quality requirements.

Attachment A to this report provides the Sample Data Summary Sheets for the samples associated with the above referenced request. These summary sheets identify the analytical values and the qualifiers for each sample and parameter. Attachment B outlines the validation qualifiers and reason codes used in the validation of the data.

Report Summary	
Total Number of Samples	14
Total Number of Data Points	108
Total Number of Rejected Data Points	0
Percent Completeness (approval to rejection ratio)	100.0%

Sample Index

Date:

September 4, 2003

Laboratory:

Severn Trent – St. Louis

SDG #:

F3H010120

WESTINGHOUSE Sample ID	Target Analyses
BHKD4-02	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD4-14	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD4-24	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD5-01	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD5-19	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD5-27	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD6-01	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD6-11	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, Ph
BHKD6-26	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
OB-1-KD	Isotopic Uranium, Technetium-99
OB-1-ANION	Chloride, Nitrate, Sulfate
OB-1-CATION	Calcium, Potassium, Magnesium, Sodium
WS-14-ANION	Chloride, Nitrate, Sulfate
WS-14-CATION	Calcium, Potassium, Magnesium, Sodium

ANALYTICAL CATEGORY: Anions

- Chloride, Nitrate, and Sulfate were determined by SW846 Method 9056A.
- 1. The following items (as applicable) have been addressed during the validation review:
 - sample custody, integrity & preservation
 - sample handling & preparation
 - holding times
 - instrument calibration & performance
 - dilution factors
 - detection limits
 - laboratory background & carry-over
 - appearance & interpretation of chromatography[†]
 - retention times[†]
 - overall appearance of the data
 - Quality Control:
 - calibration checks & blanks
 - laboratory blanks (method, TCLP)
 - laboratory control samples
 - matrix spike samples
 - matrix duplicates
 - field blanks (if available)
 - field duplicates (if available)

[†] - for ion chromatography only.

- 2. The above items were found to be acceptable, except as follows:

- None

- 3. Additional comments:

- Contamination with chloride was seen in the calibration blanks. Calibration blanks are run to verify that carry over does not occur and that no contamination is being introduced during the run. Chloride data associated with the bracketed samples were greater than five times the contamination level. Therefore, qualification of the chloride data were not necessary.

ANALYTICAL CATEGORY: Metals

- Metals were analyzed by Inductively Coupled Plasma (ICP).

1. The following items (as applicable) have been addressed during the validation review:

- sample custody, integrity & preservation
- sample handling & preparation
- holding times
- instrument calibration & performance
- dilution factors
- detection limits
- laboratory background & carry-over
- overall appearance of the data
- Quality Control:
 - calibration checks & blanks
 - laboratory blanks (method, TCLP)
 - laboratory control samples
 - matrix spike samples
 - matrix duplicates
 - field blanks (if available)
 - field duplicates (if available)
 - CRDL standards
 - interference check standards
 - analytical bench spikes
 - serial dilutions

2. The above items were found to be acceptable, except as follows:

- Blank Contamination

The continuing calibration blank was contaminated with potassium at a concentration of 1600 ug/l. This is evidence of possible laboratory contamination. The positive potassium result in sample OB-1-CATION was less than five times the contamination level. The reported sample concentration was qualified with a *U*.

3. Additional comments:

- Contamination with iron and manganese were seen in the calibration blanks. Calibration blanks are run to verify that carry over does not occur and that no contamination is being introduced during the run. Iron and manganese data associated with the bracketed samples were greater than five times the contamination level. Therefore, qualification of iron and manganese were not necessary.
- Detection limits in samples OB-1-CATION and WS-14-CATION have been changed.

ANALYTICAL CATEGORY: Miscellaneous

- Total Organic Carbon and Total Carbon were determined by SW846 Method 9060; pH was determined by SW846 Method 9045A; and percent moisture was determined by MCAWW 160.3.

1. The following items (as applicable) have been addressed during the validation review:

- sample custody, integrity & preservation
- sample handling & preparation
- holding times
- instrument calibration & performance
- dilution factors
- detection limits
- laboratory background & carry-over
- overall appearance of the data
- Quality Control:
 - calibration checks & blanks
 - laboratory blanks (method, TCLP)
 - laboratory control samples
 - matrix spike samples
 - matrix duplicates
 - field blanks (if available)
 - field duplicates (if available)

2. The above items were found to be acceptable, except as follows:

- None.

3. Additional comments:

- None.

ANALYTICAL CATEGORY: Radiochemical

- Isotopic uranium was determined by alpha spectroscopy (NAS/DOE 3050/RP), and technetium was determined by Liquid scintillation counters (DOE TC-02-RC).

1. The following items (as applicable) have been addressed during the validation review:

- sample custody, integrity & preservation
- sample handling & preparation
- holding times
- instrument calibration & performance
- dilution factors
- detection limits
- laboratory background & carry-over
- overall appearance of the data
- Quality Control:
 - calibration checks & background
 - preparation blanks
 - laboratory control samples
 - field blanks (if available)
 - field duplicates (if available)

2. The above items were found to be acceptable, except as follows:

- Instrument Counting Error

Several samples have reported results that are less than the MDA and the uncertainty is greater than the result. The non-detect results for these samples were qualified *UU*.

Several samples have reported results that are greater than the MDA and the sample uncertainty is 50% to 100% of the sample result. The reported values for these samples were qualified with a *J*.

- Blank Contamination

Uranium-234 was present in the associated method blank at 0.1 ± 0.11 pCi/g. This may indicate that contamination could have been introduced during the laboratory preparation. The normalized absolute difference between the sample OB-1-KD and the method blank was less than 2.58 and was qualified as estimated, *J*.

3. Additional comments:

- MDC values for Isotopic uranium in sample BHKD6-01 have been changed.

ATTACHMENT A

WESTINGHOUSE Sample Data Summary Sheets

ATTACHMENT B

KEY TO THE WESTINGHOUSE DATA VALIDATION QUALIFIERS

QUALIFIERS	
=	Indicates that the data met all QA/QC requirements, and that the parameter has been positively identified and the associated concentration value is accurate.
U	Indicates that the data met all QA/QC requirements, and that the parameter was analyzed for but was not detected above the reported sample quantitation limit.
J	Indicates that the parameter was positively identified; the associated numerical value is the approximate concentration of the parameter in the sample.
UJ	Indicates that the parameter was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
N	The analysis indicates the presence of a parameter for which there is presumptive evidence to make a "tentative identification."
R	Indicates that the sample results for the parameter are rejected or unusable due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the parameter cannot be verified.

Data Validation Reason Codes

Holding Times

- A01 Extraction holding times were exceeded.
- A02 Extraction holding times were grossly exceeded.
- A03 Analysis holding times were exceeded.
- A04 Analysis holding times were grossly exceeded.
- A05 Samples were not preserved properly.
- A06 Professional judgment was used to qualify the data.

GC/MS Tuning

- B01 Mass calibration was in error, even after applying expanded criteria.
- B02 Mass calibration was not performed every 12 hours.
- B03 Mass calibration did not meet ion abundance.
- B04 Professional judgment was used to qualify the data.

Initial/Continuing Calibration – Organics

- C01 Initial calibration RRF was <0.05 .
- C02 Initial calibration RSD was $>30\%$.
- C03 Initial calibration sequence was not followed as required.
- C04 Continuing calibration RRF was <0.05 .
- C05 Continuing calibration %D was $>25\%$.
- C06 Continuing calibration was not performed at the required frequency.
- C07 Resolution criteria were not met.
- C08 RPD criteria were not met.
- C09 RSD criteria were not met.
- C10 Retention time of compounds was outside windows.
- C11 Compounds were not adequately resolved.
- C12 Breakdown of endrin or DDT was $>20\%$.
- C13 Combined breakdown of endrin/DDT was $>30\%$.
- C14 Professional judgment was used to qualify the data.

Blanks

- F01 Sample data were qualified as a result of the method blank.
- F02 Sample data were qualified as a result of the field blank.
- F03 Sample data were qualified as a result of the equipment rinsate.
- F04 Sample data were qualified as a result of the trip blank.
- F05 Gross contamination exists.
- F06 Concentration of the contaminant was detected at a level below the CRQL.
- F07 Concentration of the contaminant was detected at a level less than the action limit, but greater than the CRQL.
- F08 Concentration of the contaminant was detected at a level that exceeds the action level.
- F09 No laboratory blanks were analyzed.
- F10 Blank had a negative value $>2x$'s the IDL.
- F11 Blanks were not analyzed at required frequency.
- F12 Professional judgment was used to qualify the data.

Surrogate/Radiological Chemical Recovery

- G01 Surrogate/radiological chemical recovery was above the upper control limit.
- G02 Surrogate/radiological chemical recovery was below the lower control limit.
- G03 Surrogate recovery was <10%.
- G04 Surrogate/radiological chemical recovery was zero.
- G05 Surrogate/radiological chemical recovery was not present.
- G06 Professional judgment was used to qualify the data.
- G07 Radiological chemical recovery was <20%.
- G08 Radiological chemical recovery was >150%.

Matrix Spike/Matrix Spike Duplicate

- H01 MS/MSD recovery was above the upper control limit.
- H02 MS/MSD recovery was below the lower control limit.
- H03 MS/MSD recovery was <10%.
- H04 MS/MSD pairs exceed the RPD limit.
- H05 No action was taken on MS/MSD results.
- H06 Professional judgment was used to qualify the data.
- H07 Radiological MS/MSD recovery was <20%.
- H08 Radiological MS/MSD recovery was >160%.
- H09 Radiological MS/MSD samples were not analyzed at the required frequency.

Laboratory Duplicate

- J01 Duplicate RPD/normalized absolute difference (NAD) was outside the control limit.
- J02 Duplicate sample results were >5x the CRDL.
- J03 Duplicate sample results were <5x the CRDL.
- J04 Professional judgment was used to qualify the data.
- J05 Duplicate was not analyzed at the required frequency.

Target Compound Identification

- M01 Incorrect identifications were made.
- M02 Qualitative criteria were not met.
- M03 Cross contamination occurred.
- M04 Confirmatory analysis was not performed.
- M05 No results were provided.
- M06 Analysis occurred outside 12 hr GC/MS window.
- M07 Professional judgment was used to qualify the data.
- M08 The %D between the two pesticide/PCB column checks was >25%.

Laboratory Control Samples (LCSs)

- P01 LCS recovery was above upper control limit.
- P02 LCS recovery was below lower control limit.
- P03 LCS recovery was <50%.
- P04 No action was taken on the LCS data.
- P05 LCS was not analyzed at required frequency.
- P06 Radiological LCS recovery was <50% for aqueous samples; <40% for solid samples.
- P07 Radiological LCS recovery was >150% for aqueous samples; >160% for solid samples.
- P08 Professional judgment was used to qualify the data.

Field Duplicate

- Q01 No action was taken on the basis of field duplicate RPDs.
- Q02 Radiological field duplicate normalized absolute difference (NAD) was outside the control limit.
- Q03 Duplicate sample results were >5x the CRDL.
- Q04 Duplicate sample results were <5x the CRDL.

Radiological Calibration

- R01 Efficiency calibration criteria were not met.
- R02 Energy calibration criteria were not met.
- R03 Resolution calibration criteria were not met
- R04 Background determination criteria were not met.
- R05 Quench curve criteria were not met.
- R06 Absorption curve criteria were not met.
- R07 Plateau curve criteria were not met.
- R08 Professional judgment was used to qualify the data.

Radiological Calibration Verification

- S01 Efficiency verification criteria were not met.
- S02 Energy verification criteria were not met.
- S03 Resolution verification criteria were not met
- S04 Background verification criteria were not met.
- S05 Cross-talk verification criteria were not met.
- S06 Professional judgment was used to qualify the data.

Radionuclide Quantitation

- T01 Detection limits were not met.
- T02 Analytical uncertainties were not met and/or not reported.
- T03 Inappropriate aliquot sizes were used.
- T04 Professional judgment was used to qualify the data.
- T05 Analytical result is less than the associated MDA, but greater than the counting uncertainty.
- T06 Analytical result is less than both the associated counting uncertainty and MDA.
- T07 Negative analytical result where the absolute value exceeds 2x the associated MDA.

System Performance

- V01 High background levels or a shift in the energy calibration were observed.
- V02 Extraneous peaks were observed.
- V03 Loss of resolution was observed.
- V04 Peak-tailing or peak splitting that may result in inaccurate quantitation were observed.
- V05 Professional judgment was used to qualify the data.

DATA VALIDATION REPORT

Date:

September 4, 2003

To: Steve Passig	From: Jerry Everett
Laboratory: Severn Trent – St. Louis	SDG #: F3G310383

Attached you will find the results from the data validation technical review for the Westinghouse/Hematite samples and analyses that are associated with the above referenced laboratory and sample delivery group (SDG) number. These data points have been selected for data validation and the sample index on the following page specifically identifies the samples and analyses associated with this validation review.

The FUSRAP validation technical review was performed in accordance with the *Contract Laboratory Program Data Validation Functional Guidelines for Evaluating Inorganic Analytical Data*, and the *Laboratory Data Validation Guidelines for Evaluating Radionuclide Analyses and Radiochemical Data Verification and Validation*. It was based on the information and documentation supplied by the associated laboratory. The analyses were evaluated against criteria established in the related analytical procedures and the Westinghouse/Hematite data quality requirements.

Attachment A to this report provides the Sample Data Summary Sheets for the samples associated with the above referenced request. These summary sheets identify the analytical values and the qualifiers for each sample and parameter. Attachment B outlines the validation qualifiers and reason codes used in the validation of the data.

Report Summary	
Total Number of Samples	9
Total Number of Data Points	90
Total Number of Rejected Data Points	0
Percent Completeness (approval to rejection ratio)	100.0%

Sample Index

Date:

September 4, 2003

Laboratory:

Severn Trent – St. Louis

SDG #:

F3G310383

WESTINGHOUSE Sample ID	Target Analyses
BHKD1-04	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD1-23	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD1-28	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD2-04	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD2-13	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD2-23	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD3-08	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD3-16	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD3-23	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH

ANALYTICAL CATEGORY: Metals

- Iron and manganese were analyzed by Inductively Coupled Plasma (ICP).

1. The following items (as applicable) have been addressed during the validation review:

- sample custody, integrity & preservation
- sample handling & preparation
- holding times
- instrument calibration & performance
- dilution factors
- detection limits
- laboratory background & carry-over
- overall appearance of the data
- Quality Control:
 - calibration checks & blanks
 - laboratory blanks (method, TCLP)
 - laboratory control samples
 - matrix spike samples
 - matrix duplicates
 - field blanks (if available)
 - field duplicates (if available)
 - CRDL standards
 - interference check standards
 - analytical bench spikes
 - serial dilutions

2. The above items were found to be acceptable, except as follows:

- None.

3. Additional comments:

- Contamination with iron and manganese were seen in the calibration blanks. Calibration blanks are run to verify that carry over does not occur and that no contamination is being introduced during the run. Iron and manganese data associated with the bracketed samples were greater than five times the contamination level. Therefore, qualification of the iron and manganese data was not necessary.
- The matrix spike recovery for iron was high. The spiked sample analysis is designed to provide information about the effect of each sample matrix on the sample preparation procedures and the measurement methodology. When the sample concentration is greater than 4X the spike concentration spike recoveries are not evaluated. Therefore qualification of the data is not necessary.
- The matrix spike recovery for manganese was low. The spiked sample analysis is designed to provide information about the effect of each sample matrix on the sample preparation procedures and the measurement methodology. When the sample concentration is greater than 4X the spike concentration, spike recoveries are not evaluated. Therefore qualification of the data is not necessary.

ANALYTICAL CATEGORY: Miscellaneous

- Total Organic Carbon and Total Carbon were determined by SW846 Method 9060; pH was determined by SW846 Method 9045A; and percent moisture was determined by MCAWW 160.3.

1. The following items (as applicable) have been addressed during the validation review:

- sample custody, integrity & preservation
- sample handling & preparation
- holding times
- instrument calibration & performance
- dilution factors
- detection limits
- laboratory background & carry-over
- overall appearance of the data
- Quality Control:
 - calibration checks & blanks
 - laboratory blanks (method, TCLP)
 - laboratory control samples
 - matrix spike samples
 - matrix duplicates
 - field blanks (if available)
 - field duplicates (if available)

2. The above items were found to be acceptable, except as follows:

- None.

3. Additional comments:

- The matrix spike recoveries for total carbon and total organic carbon were high. The spiked sample analysis is designed to provide information about the effect of each sample matrix on the sample preparation procedures and the measurement methodology. When the sample concentration is greater than 4X the spike concentration spike recoveries are not evaluated. Therefore qualification of the date is not necessary.

ANALYTICAL CATEGORY: Radiochemical

- Isotopic uranium was determined by alpha spectroscopy (NAS/DOE 3050/RP), and technetium was determined by Liquid scintillation counters (DOE TC-02-RC).

1. The following items (as applicable) have been addressed during the validation review:

- sample custody, integrity & preservation
- sample handling & preparation
- holding times
- instrument calibration & performance
- dilution factors
- detection limits
- laboratory background & carry-over
- overall appearance of the data
- Quality Control:
 - calibration checks & background
 - preparation blanks
 - laboratory control samples
 - field blanks (if available)
 - field duplicates (if available)

2. The above items were found to be acceptable, except as follows:

- Instrument Counting Error

Several samples have reported results that are less than the MDA and the uncertainty is greater than the result. The non-detect results for these samples were qualified *UU*.

Several samples have reported results that are greater than the MDA and the sample uncertainty is 50% to 100% of the sample result. The reported values for these samples were qualified with a *J*.

3. Additional comments:

- Contamination with technetium-99 was seen in the method blank. Method blanks are run to verify that contamination is being introduced during the run. Technetium-99 data associated with the method blank were greater than the contamination level. Therefore, qualification of the data was not necessary.

ATTACHMENT A

WESTINGHOUSE Sample Data Summary Sheets

ATTACHMENT B

KEY TO THE WESTINGHOUSE DATA VALIDATION QUALIFIERS

QUALIFIERS	
=	Indicates that the data met all QA/QC requirements, and that the parameter has been positively identified and the associated concentration value is accurate.
U	Indicates that the data met all QA/QC requirements, and that the parameter was analyzed for but was not detected above the reported sample quantitation limit.
J	Indicates that the parameter was positively identified; the associated numerical value is the approximate concentration of the parameter in the sample.
UJ	Indicates that the parameter was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
N	The analysis indicates the presence of a parameter for which there is presumptive evidence to make a "tentative identification."
R	Indicates that the sample results for the parameter are rejected or unusable due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the parameter cannot be verified.

Data Validation Reason Codes

Holding Times

- A01 Extraction holding times were exceeded.
- A02 Extraction holding times were grossly exceeded.
- A03 Analysis holding times were exceeded.
- A04 Analysis holding times were grossly exceeded.
- A05 Samples were not preserved properly.
- A06 Professional judgment was used to qualify the data.

GC/MS Tuning

- B01 Mass calibration was in error, even after applying expanded criteria.
- B02 Mass calibration was not performed every 12 hours.
- B03 Mass calibration did not meet ion abundance.
- B04 Professional judgment was used to qualify the data.

Initial/Continuing Calibration – Organics

- C01 Initial calibration RRF was <0.05.
- C02 Initial calibration RSD was >30%.
- C03 Initial calibration sequence was not followed as required.
- C04 Continuing calibration RRF was <0.05.
- C05 Continuing calibration %D was >25%.
- C06 Continuing calibration was not performed at the required frequency.
- C07 Resolution criteria were not met.
- C08 RPD criteria were not met.
- C09 RSD criteria were not met.
- C10 Retention time of compounds was outside windows.
- C11 Compounds were not adequately resolved.
- C12 Breakdown of endrin or DDT was >20%.
- C13 Combined breakdown of endrin/DDT was >30%.
- C14 Professional judgment was used to qualify the data.

Blanks

- F01 Sample data were qualified as a result of the method blank.
- F02 Sample data were qualified as a result of the field blank.
- F03 Sample data were qualified as a result of the equipment rinsate.
- F04 Sample data were qualified as a result of the trip blank.
- F05 Gross contamination exists.
- F06 Concentration of the contaminant was detected at a level below the CRQL.
- F07 Concentration of the contaminant was detected at a level less than the action limit, but greater than the CRQL.
- F08 Concentration of the contaminant was detected at a level that exceeds the action level.
- F09 No laboratory blanks were analyzed.
- F10 Blank had a negative value >2x's the IDL.
- F11 Blanks were not analyzed at required frequency.
- F12 Professional judgment was used to qualify the data.

Surrogate/Radiological Chemical Recovery

- G01 Surrogate/radiological chemical recovery was above the upper control limit.
- G02 Surrogate/radiological chemical recovery was below the lower control limit.
- G03 Surrogate recovery was <10%.
- G04 Surrogate/radiological chemical recovery was zero.
- G05 Surrogate/radiological chemical recovery was not present.
- G06 Professional judgment was used to qualify the data.
- G07 Radiological chemical recovery was <20%.
- G08 Radiological chemical recovery was >150%.

Matrix Spike/Matrix Spike Duplicate

- H01 MS/MSD recovery was above the upper control limit.
- H02 MS/MSD recovery was below the lower control limit.
- H03 MS/MSD recovery was <10%.
- H04 MS/MSD pairs exceed the RPD limit.
- H05 No action was taken on MS/MSD results.
- H06 Professional judgment was used to qualify the data.
- H07 Radiological MS/MSD recovery was <20%.
- H08 Radiological MS/MSD recovery was >160%.
- H09 Radiological MS/MSD samples were not analyzed at the required frequency.

Laboratory Duplicate

- J01 Duplicate RPD/normalized absolute difference (NAD) was outside the control limit.
- J02 Duplicate sample results were >5x the CRDL.
- J03 Duplicate sample results were <5x the CRDL.
- J04 Professional judgment was used to qualify the data.
- J05 Duplicate was not analyzed at the required frequency.

Target Compound Identification

- M01 Incorrect identifications were made.
- M02 Qualitative criteria were not met.
- M03 Cross contamination occurred.
- M04 Confirmatory analysis was not performed.
- M05 No results were provided.
- M06 Analysis occurred outside 12 hr GC/MS window.
- M07 Professional judgment was used to qualify the data.
- M08 The %D between the two pesticide/PCB column checks was >25%.

Laboratory Control Samples (LCSs)

- P01 LCS recovery was above upper control limit.
- P02 LCS recovery was below lower control limit.
- P03 LCS recovery was <50%.
- P04 No action was taken on the LCS data.
- P05 LCS was not analyzed at required frequency.
- P06 Radiological LCS recovery was <50% for aqueous samples; <40% for solid samples.
- P07 Radiological LCS recovery was >150% for aqueous samples; >160% for solid samples.
- P08 Professional judgment was used to qualify the data.

Field Duplicate

- Q01 No action was taken on the basis of field duplicate RPDs.
- Q02 Radiological field duplicate normalized absolute difference (NAD) was outside the control limit.
- Q03 Duplicate sample results were >5x the CRDL.
- Q04 Duplicate sample results were <5x the CRDL.

Radiological Calibration

- R01 Efficiency calibration criteria were not met.
- R02 Energy calibration criteria were not met.
- R03 Resolution calibration criteria were not met
- R04 Background determination criteria were not met.
- R05 Quench curve criteria were not met.
- R06 Absorption curve criteria were not met.
- R07 Plateau curve criteria were not met.
- R08 Professional judgment was used to qualify the data.

Radiological Calibration Verification

- S01 Efficiency verification criteria were not met.
- S02 Energy verification criteria were not met.
- S03 Resolution verification criteria were not met
- S04 Background verification criteria were not met.
- S05 Cross-talk verification criteria were not met.
- S06 Professional judgment was used to qualify the data.

Radionuclide Quantitation

- T01 Detection limits were not met.
- T02 Analytical uncertainties were not met and/or not reported.
- T03 Inappropriate aliquot sizes were used.
- T04 Professional judgment was used to qualify the data.
- T05 Analytical result is less than the associated MDA, but greater than the counting uncertainty.
- T06 Analytical result is less than both the associated counting uncertainty and MDA.
- T07 Negative analytical result where the absolute value exceeds 2x the associated MDA.

System Performance

- V01 High background levels or a shift in the energy calibration were observed.
- V02 Extraneous peaks were observed.
- V03 Loss of resolution was observed.
- V04 Peak-tailing or peak splitting that may result in inaccurate quantitation were observed.
- V05 Professional judgment was used to qualify the data.

DATA VALIDATION REPORT

Date:

November 14, 2003

To: Steve Passig	From: Carol Johnson
Laboratory: Severn Trent – St. Louis	SDG #: F3I230103

Attached you will find the results from the data validation technical review for the Westinghouse/Hematite samples and analyses that are associated with the above referenced laboratory and sample delivery group (SDG) number. These data points have been selected for data validation and the sample index on the following page specifically identifies the samples and analyses associated with this validation review.

The Westinghouse/Hematite validation technical review was performed in accordance with the *Contract Laboratory Program Data Validation Functional Guidelines for Evaluating Inorganic Analytical Data*, and the *Laboratory Data Validation Guidelines for Evaluating Radionuclide Analyses and Radiochemical Data Verification and Validation*. It was based on the information and documentation supplied by the associated laboratory. The analyses were evaluated against criteria established in the related analytical procedures and the Westinghouse/Hematite data quality requirements.

Attachment A to this report provides the Sample Data Summary Sheets for the samples associated with the above referenced request. These summary sheets identify the analytical values and the qualifiers for each sample and parameter. Attachment B outlines the validation qualifiers and reason codes used in the validation of the data.

Report Summary	
Total Number of Samples	8
Total Number of Data Points	26
Total Number of Rejected Data Points	0
Percent Completeness (approval to rejection ratio)	100.0%

Sample Index

Date:

November 14, 2003

Laboratory:

Severn Trent – St. Louis

SDG #:

F3I230103

WESTINGHOUSE Sample ID	Target Analyses
BHKD5-01	Total Uranium, Conductivity, pH
BHKD5-19	Total Uranium, Conductivity, pH
BHKD5-27	Total Uranium, Conductivity, pH
BHKD3-08	Total Uranium, Conductivity, Ph
BHKD2-04	Total Uranium, Technetium-99, Conductivity, pH
BHKD2-13	Total Uranium, Technetium-99, Conductivity, pH
BHKD2-23	Total Uranium, Technetium-99, Conductivity, pH
OB-1	Total Uranium, Technetium-99

ANALYTICAL CATEGORY: Miscellaneous

- Specific Conductance was determined by SW846 Method 9050; pH was determined by SW846 Method 9045A; and percent moisture was determined by MCAWW 160.3.

1. The following items (as applicable) have been addressed during the validation review:

- sample custody, integrity & preservation
- sample handling & preparation
- holding times
- instrument calibration & performance
- dilution factors
- detection limits
- laboratory background & carry-over
- overall appearance of the data
- Quality Control:
 - calibration checks & blanks
 - laboratory blanks (method, TCLP)
 - laboratory control samples
 - matrix spike samples
 - matrix duplicates
 - field blanks (if available)
 - field duplicates (if available)

2. The above items were found to be acceptable, except as follows:

- Holding Times for Conductivity were exceeded, resulting in the samples being qualified as estimated, *J*.

3. Additional comments:

- None

ANALYTICAL CATEGORY: Radiochemical

- Technetium was determined by Liquid scintillation counters (DOE TC-02-RC), and Total Uranium was determined by Laser Phosphorimetry Method ASTM 5174-91.

1. The following items (as applicable) have been addressed during the validation review:

- sample custody, integrity & preservation
- sample handling & preparation
- holding times
- instrument calibration & performance
- dilution factors
- detection limits
- laboratory background & carry-over
- overall appearance of the data
- Quality Control:
 - calibration checks & background
 - preparation blanks
 - laboratory control samples
 - field blanks (if available)
 - field duplicates (if available)

2. The above items were found to be acceptable, except as follows:

- Instrument Counting Error

Several samples have reported results that are less than the MDA and the uncertainty is greater than the result. The non-detect results for these samples were qualified *UU*.

Method Blank

- Contamination with Technetium-99 and Isotopic Uranium was seen in the method blank. Method blanks are run to verify that contamination is being introduced during the run. Technetium-99 data associated with the method blank did not pass the Normalized Absolute Difference criteria. Samples were qualified as estimated, *J*.

Laboratory Control Sample

The percent recovery for Technetium-99 LCS, was above the upper control limit (UCL). Recoveries above the UCL could be the result of poor preparation or instrumentation problems, and may indicate a high bias to the data. Only positive sample results for qualified as estimated, *J*.

3. Additional comments:

None

ATTACHMENT A

WESTINGHOUSE Sample Data Summary Sheets

ATTACHMENT B

KEY TO THE WESTINGHOUSE DATA VALIDATION QUALIFIERS

QUALIFIERS	
=	Indicates that the data met all QA/QC requirements, and that the parameter has been positively identified and the associated concentration value is accurate.
U	Indicates that the data met all QA/QC requirements, and that the parameter was analyzed for but was not detected above the reported sample quantitation limit.
J	Indicates that the parameter was positively identified; the associated numerical value is the approximate concentration of the parameter in the sample.
UJ	Indicates that the parameter was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
N	The analysis indicates the presence of a parameter for which there is presumptive evidence to make a "tentative identification."
R	Indicates that the sample results for the parameter are rejected or unusable due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the parameter cannot be verified.

Data Validation Reason Codes

Holding Times

- A01 Extraction holding times were exceeded.
- A02 Extraction holding times were grossly exceeded.
- A03 Analysis holding times were exceeded.
- A04 Analysis holding times were grossly exceeded.
- A05 Samples were not preserved properly.
- A06 Professional judgment was used to qualify the data.

GC/MS Tuning

- B01 Mass calibration was in error, even after applying expanded criteria.
- B02 Mass calibration was not performed every 12 hours.
- B03 Mass calibration did not meet ion abundance.
- B04 Professional judgment was used to qualify the data.

Initial/Continuing Calibration – Organics

- C01 Initial calibration RRF was <0.05.
- C02 Initial calibration RSD was >30%.
- C03 Initial calibration sequence was not followed as required.
- C04 Continuing calibration RRF was <0.05.
- C05 Continuing calibration %D was >25%.
- C06 Continuing calibration was not performed at the required frequency.
- C07 Resolution criteria were not met.
- C08 RPD criteria were not met.
- C09 RSD criteria were not met.
- C10 Retention time of compounds was outside windows.
- C11 Compounds were not adequately resolved.
- C12 Breakdown of endrin or DDT was >20%.
- C13 Combined breakdown of endrin/DDT was >30%.
- C14 Professional judgment was used to qualify the data.

Blanks

- F01 Sample data were qualified as a result of the method blank.
- F02 Sample data were qualified as a result of the field blank.
- F03 Sample data were qualified as a result of the equipment rinsate.
- F04 Sample data were qualified as a result of the trip blank.
- F05 Gross contamination exists.
- F06 Concentration of the contaminant was detected at a level below the CRQL.
- F07 Concentration of the contaminant was detected at a level less than the action limit, but greater than the CRQL.
- F08 Concentration of the contaminant was detected at a level that exceeds the action level.
- F09 No laboratory blanks were analyzed.
- F10 Blank had a negative value >2x's the IDL.
- F11 Blanks were not analyzed at required frequency.
- F12 Professional judgment was used to qualify the data.

Surrogate/Radiological Chemical Recovery

- G01 Surrogate/radiological chemical recovery was above the upper control limit.
- G02 Surrogate/radiological chemical recovery was below the lower control limit.
- G03 Surrogate recovery was <10%.
- G04 Surrogate/radiological chemical recovery was zero.
- G05 Surrogate/radiological chemical recovery was not present.
- G06 Professional judgment was used to qualify the data.
- G07 Radiological chemical recovery was <20%.
- G08 Radiological chemical recovery was >150%.

Matrix Spike/Matrix Spike Duplicate

- H01 MS/MSD recovery was above the upper control limit.
- H02 MS/MSD recovery was below the lower control limit.
- H03 MS/MSD recovery was <10%.
- H04 MS/MSD pairs exceed the RPD limit.
- H05 No action was taken on MS/MSD results.
- H06 Professional judgment was used to qualify the data.
- H07 Radiological MS/MSD recovery was <20%.
- H08 Radiological MS/MSD recovery was >160%.
- H09 Radiological MS/MSD samples were not analyzed at the required frequency.

Laboratory Duplicate

- J01 Duplicate RPD/normalized absolute difference (NAD) was outside the control limit.
- J02 Duplicate sample results were >5x the CRDL.
- J03 Duplicate sample results were <5x the CRDL.
- J04 Professional judgment was used to qualify the data.
- J05 Duplicate was not analyzed at the required frequency.

Target Compound Identification

- M01 Incorrect identifications were made.
- M02 Qualitative criteria were not met.
- M03 Cross contamination occurred.
- M04 Confirmatory analysis was not performed.
- M05 No results were provided.
- M06 Analysis occurred outside 12 hr GC/MS window.
- M07 Professional judgment was used to qualify the data.
- M08 The %D between the two pesticide/PCB column checks was >25%.

Laboratory Control Samples (LCSs)

- P01 LCS recovery was above upper control limit.
- P02 LCS recovery was below lower control limit.
- P03 LCS recovery was <50%.
- P04 No action was taken on the LCS data.
- P05 LCS was not analyzed at required frequency.
- P06 Radiological LCS recovery was <50% for aqueous samples; <40% for solid samples.
- P07 Radiological LCS recovery was >150% for aqueous samples; >160% for solid samples.
- P08 Professional judgment was used to qualify the data.

Field Duplicate

- Q01 No action was taken on the basis of field duplicate RPDs.
- Q02 Radiological field duplicate normalized absolute difference (NAD) was outside the control limit.
- Q03 Duplicate sample results were >5x the CRDL.
- Q04 Duplicate sample results were <5x the CRDL.

Radiological Calibration

- R01 Efficiency calibration criteria were not met.
- R02 Energy calibration criteria were not met.
- R03 Resolution calibration criteria were not met.
- R04 Background determination criteria were not met.
- R05 Quench curve criteria were not met.
- R06 Absorption curve criteria were not met.
- R07 Plateau curve criteria were not met.
- R08 Professional judgment was used to qualify the data.

Radiological Calibration Verification

- S01 Efficiency verification criteria were not met.
- S02 Energy verification criteria were not met.
- S03 Resolution verification criteria were not met.
- S04 Background verification criteria were not met.
- S05 Cross-talk verification criteria were not met.
- S06 Professional judgment was used to qualify the data.

Radionuclide Quantitation

- T01 Detection limits were not met.
- T02 Analytical uncertainties were not met and/or not reported.
- T03 Inappropriate aliquot sizes were used.
- T04 Professional judgment was used to qualify the data.
- T05 Analytical result is less than the associated MDA, but greater than the counting uncertainty.
- T06 Analytical result is less than both the associated counting uncertainty and MDA.
- T07 Negative analytical result where the absolute value exceeds 2x the associated MDA.

System Performance

- V01 High background levels or a shift in the energy calibration were observed.
- V02 Extraneous peaks were observed.
- V03 Loss of resolution was observed.
- V04 Peak-tailing or peak splitting that may result in inaccurate quantitation were observed.
- V05 Professional judgment was used to qualify the data.

DATA VALIDATION REPORT

Date:

November 14, 2003

<i>To:</i> Steve Passig	<i>From:</i> Carol Johnson
<i>Laboratory:</i> Severn Trent – St. Louis	<i>SDG #:</i> F3I230107

Attached you will find the results from the data validation technical review for the Westinghouse/Hematite samples and analyses that are associated with the above referenced laboratory and sample delivery group (SDG) number. These data points have been selected for data validation and the sample index on the following page specifically identifies the samples and analyses associated with this validation review.

The Westinghouse/Hematite validation technical review was performed in accordance with the *Contract Laboratory Program Data Validation Functional Guidelines for Evaluating Inorganic Analytical Data*, and the *Laboratory Data Validation Guidelines for Evaluating Radionuclide Analyses and Radiochemical Data Verification and Validation*. It was based on the information and documentation supplied by the associated laboratory. The analyses were evaluated against criteria established in the related analytical procedures and the Westinghouse/Hematite data quality requirements.

Attachment A to this report provides the Sample Data Summary Sheets for the samples associated with the above referenced request. These summary sheets identify the analytical values and the qualifiers for each sample and parameter. Attachment B outlines the validation qualifiers and reason codes used in the validation of the data.

Report Summary	
Total Number of Samples	7
Total Number of Data Points	24
Total Number of Rejected Data Points	0
Percent Completeness (approval to rejection ratio)	100.0%

Sample Index

Date:

November 14, 2003

Laboratory:

Severn Trent – St. Louis

SDG #:

F3I230117

WESTINGHOUSE Sample ID	Target Analyses
BHKD5-01	Total Uranium, Conductivity, pH
BHKD5-19	Total Uranium, Conductivity, pH
BHKD5-27	Total Uranium, Conductivity, pH
BHKD3-08	Total Uranium, Conductivity, Ph
BHKD2-04	Total Uranium, Technetium-99, Conductivity, pH
BHKD2-13	Total Uranium, Technetium-99, Conductivity, pH
BHKD2-23	Total Uranium, Technetium-99, Conductivity, pH

ANALYTICAL CATEGORY: Miscellaneous

- Specific Conductance was determined by SW846 Method 9050; pH was determined by SW846 Method 9045A; and percent moisture was determined by MCAWW 160.3.

1. The following items (as applicable) have been addressed during the validation review:

- sample custody, integrity & preservation
- sample handling & preparation
- holding times
- instrument calibration & performance
- dilution factors
- detection limits
- laboratory background & carry-over
- overall appearance of the data
- Quality Control:
 - calibration checks & blanks
 - laboratory blanks (method, TCLP)
 - laboratory control samples
 - matrix spike samples
 - matrix duplicates
 - field blanks (if available)
 - field duplicates (if available)

2. The above items were found to be acceptable, except as follows:

- Holding Times for Conductivity were exceeded, resulting in the samples being qualified as estimated, *J*.

3. Additional comments:

- None

ANALYTICAL CATEGORY: Radiochemical

- Isotopic uranium was determined by alpha spectroscopy (NAS/DOE 3050/RP), and technetium was determined by Liquid scintillation counters (DOE TC-02-RC), and Total Uranium was determined by Laser Phosphorimetry Method ASTM 5174-91.

1. The following items (as applicable) have been addressed during the validation review:

- sample custody, integrity & preservation
- sample handling & preparation
- holding times
- instrument calibration & performance
- dilution factors
- detection limits
- laboratory background & carry-over
- overall appearance of the data
- Quality Control:
 - calibration checks & background
 - preparation blanks
 - laboratory control samples
 - field blanks (if available)
 - field duplicates (if available)

2. The above items were found to be acceptable, except as follows:

- Instrument Counting Error

Several samples have reported results that are less than the MDA and the uncertainty is greater than the result. The non-detect results for these samples were qualified *UJ*.

Method Blank

- Contamination with Technetium-99 and Isotopic Uranium was seen in the method blank. Method blanks are run to verify that contamination is being introduced during the run. Technetium-99 data associated with the method blank did not pass the Normalized Absolute Difference criteria. Samples were qualified as estimated, *J*.

Laboratory Control Sample

The percent recovery for Technetium-99 LCS, was above the upper control limit (UCL). Recoveries above the UCL could be the result of poor preparation or instrumentation problems, and may indicate a high bias to the data. Only positive sample results for qualified as estimated, *J*.

3. Additional comments:

None

ATTACHMENT A

WESTINGHOUSE Sample Data Summary Sheets

ATTACHMENT B

KEY TO THE WESTINGHOUSE DATA VALIDATION QUALIFIERS

QUALIFIERS	
=	Indicates that the data met all QA/QC requirements, and that the parameter has been positively identified and the associated concentration value is accurate.
U	Indicates that the data met all QA/QC requirements, and that the parameter was analyzed for but was not detected above the reported sample quantitation limit.
J	Indicates that the parameter was positively identified; the associated numerical value is the approximate concentration of the parameter in the sample.
UJ	Indicates that the parameter was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
N	The analysis indicates the presence of a parameter for which there is presumptive evidence to make a "tentative identification."
R	Indicates that the sample results for the parameter are rejected or unusable due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the parameter cannot be verified.

Data Validation Reason Codes

Holding Times

- A01 Extraction holding times were exceeded.
- A02 Extraction holding times were grossly exceeded.
- A03 Analysis holding times were exceeded.
- A04 Analysis holding times were grossly exceeded.
- A05 Samples were not preserved properly.
- A06 Professional judgment was used to qualify the data.

GC/MS Tuning

- B01 Mass calibration was in error, even after applying expanded criteria.
- B02 Mass calibration was not performed every 12 hours.
- B03 Mass calibration did not meet ion abundance.
- B04 Professional judgment was used to qualify the data.

Initial/Continuing Calibration – Organics

- C01 Initial calibration RRF was <0.05.
- C02 Initial calibration RSD was >30%.
- C03 Initial calibration sequence was not followed as required.
- C04 Continuing calibration RRF was <0.05.
- C05 Continuing calibration %D was >25%.
- C06 Continuing calibration was not performed at the required frequency.
- C07 Resolution criteria were not met.
- C08 RPD criteria were not met.
- C09 RSD criteria were not met.
- C10 Retention time of compounds was outside windows.
- C11 Compounds were not adequately resolved.
- C12 Breakdown of endrin or DDT was >20%.
- C13 Combined breakdown of endrin/DDT was >30%.
- C14 Professional judgment was used to qualify the data.

Blanks

- F01 Sample data were qualified as a result of the method blank.
- F02 Sample data were qualified as a result of the field blank.
- F03 Sample data were qualified as a result of the equipment rinsate.
- F04 Sample data were qualified as a result of the trip blank.
- F05 Gross contamination exists.
- F06 Concentration of the contaminant was detected at a level below the CRQL.
- F07 Concentration of the contaminant was detected at a level less than the action limit, but greater than the CRQL.
- F08 Concentration of the contaminant was detected at a level that exceeds the action level.
- F09 No laboratory blanks were analyzed.
- F10 Blank had a negative value >2x's the IDL.
- F11 Blanks were not analyzed at required frequency.
- F12 Professional judgment was used to qualify the data.

Surrogate/Radiological Chemical Recovery

- G01 Surrogate/radiological chemical recovery was above the upper control limit.
- G02 Surrogate/radiological chemical recovery was below the lower control limit.
- G03 Surrogate recovery was <10%.
- G04 Surrogate/radiological chemical recovery was zero.
- G05 Surrogate/radiological chemical recovery was not present.
- G06 Professional judgment was used to qualify the data.
- G07 Radiological chemical recovery was <20%.
- G08 Radiological chemical recovery was >150%.

Matrix Spike/Matrix Spike Duplicate

- H01 MS/MSD recovery was above the upper control limit.
- H02 MS/MSD recovery was below the lower control limit.
- H03 MS/MSD recovery was <10%.
- H04 MS/MSD pairs exceed the RPD limit.
- H05 No action was taken on MS/MSD results.
- H06 Professional judgment was used to qualify the data.
- H07 Radiological MS/MSD recovery was <20%.
- H08 Radiological MS/MSD recovery was >160%.
- H09 Radiological MS/MSD samples were not analyzed at the required frequency.

Laboratory Duplicate

- J01 Duplicate RPD/normalized absolute difference (NAD) was outside the control limit.
- J02 Duplicate sample results were >5x the CRDL.
- J03 Duplicate sample results were <5x the CRDL.
- J04 Professional judgment was used to qualify the data.
- J05 Duplicate was not analyzed at the required frequency.

Target Compound Identification

- M01 Incorrect identifications were made.
- M02 Qualitative criteria were not met.
- M03 Cross contamination occurred.
- M04 Confirmatory analysis was not performed.
- M05 No results were provided.
- M06 Analysis occurred outside 12 hr GC/MS window.
- M07 Professional judgment was used to qualify the data.
- M08 The %D between the two pesticide/PCB column checks was >25%.

Laboratory Control Samples (LCSs)

- P01 LCS recovery was above upper control limit.
- P02 LCS recovery was below lower control limit.
- P03 LCS recovery was <50%.
- P04 No action was taken on the LCS data.
- P05 LCS was not analyzed at required frequency.
- P06 Radiological LCS recovery was <50% for aqueous samples; <40% for solid samples.
- P07 Radiological LCS recovery was >150% for aqueous samples; >160% for solid samples.
- P08 Professional judgment was used to qualify the data.

Field Duplicate

- Q01 No action was taken on the basis of field duplicate RPDs.
- Q02 Radiological field duplicate normalized absolute difference (NAD) was outside the control limit.
- Q03 Duplicate sample results were >5x the CRDL.
- Q04 Duplicate sample results were <5x the CRDL.

Radiological Calibration

- R01 Efficiency calibration criteria were not met.
- R02 Energy calibration criteria were not met.
- R03 Resolution calibration criteria were not met
- R04 Background determination criteria were not met.
- R05 Quench curve criteria were not met.
- R06 Absorption curve criteria were not met.
- R07 Plateau curve criteria were not met.
- R08 Professional judgment was used to qualify the data.

Radiological Calibration Verification

- S01 Efficiency verification criteria were not met.
- S02 Energy verification criteria were not met.
- S03 Resolution verification criteria were not met
- S04 Background verification criteria were not met.
- S05 Cross-talk verification criteria were not met.
- S06 Professional judgment was used to qualify the data.

Radionuclide Quantitation

- T01 Detection limits were not met.
- T02 Analytical uncertainties were not met and/or not reported.
- T03 Inappropriate aliquot sizes were used.
- T04 Professional judgment was used to qualify the data.
- T05 Analytical result is less than the associated MDA, but greater than the counting uncertainty.
- T06 Analytical result is less than both the associated counting uncertainty and MDA.
- T07 Negative analytical result where the absolute value exceeds 2x the associated MDA.

System Performance

- V01 High background levels or a shift in the energy calibration were observed.
- V02 Extraneous peaks were observed.
- V03 Loss of resolution was observed.
- V04 Peak-tailing or peak splitting that may result in inaccurate quantitation were observed.
- V05 Professional judgment was used to qualify the data.

DATA VALIDATION REPORT

Date:

November 14, 2003

<i>To:</i> Steve Passig	<i>From:</i> Carol Johnson
<i>Laboratory:</i> Severn Trent – St. Louis	<i>SDG #:</i> F3I230110

Attached you will find the results from the data validation technical review for the Westinghouse/Hematite samples and analyses that are associated with the above referenced laboratory and sample delivery group (SDG) number. These data points have been selected for data validation and the sample index on the following page specifically identifies the samples and analyses associated with this validation review.

The Westinghouse/Hematite validation technical review was performed in accordance with the *Contract Laboratory Program Data Validation Functional Guidelines for Evaluating Inorganic Analytical Data*, and the *Laboratory Data Validation Guidelines for Evaluating Radionuclide Analyses and Radiochemical Data Verification and Validation*. It was based on the information and documentation supplied by the associated laboratory. The analyses were evaluated against criteria established in the related analytical procedures and the Westinghouse/Hematite data quality requirements.

Attachment A to this report provides the Sample Data Summary Sheets for the samples associated with the above referenced request. These summary sheets identify the analytical values and the qualifiers for each sample and parameter. Attachment B outlines the validation qualifiers and reason codes used in the validation of the data.

Report Summary	
Total Number of Samples	7
Total Number of Data Points	24
Total Number of Rejected Data Points	0
Percent Completeness (approval to rejection ratio)	100.0%

Sample Index

Date:

November 14, 2003

Laboratory:

Severn Trent – St. Louis

SDG #:

F3I230110

WESTINGHOUSE Sample ID	Target Analyses
BHKD5-01	Total Uranium, Conductivity, pH
BHKD5-19	Total Uranium, Conductivity, pH
BHKD5-27	Total Uranium, Conductivity, pH
BHKD3-08	Total Uranium, Conductivity, Ph
BHKD2-04	Total Uranium, Technetium-99, Conductivity, pH
BHKD2-13	Total Uranium, Technetium-99, Conductivity, pH
BHKD2-23	Total Uranium, Technetium-99, Conductivity, pH

ANALYTICAL CATEGORY: Miscellaneous

- Specific Conductance was determined by SW846 Method 9050; pH was determined by SW846 Method 9045A; and percent moisture was determined by MCAWW 160.3.

1. The following items (as applicable) have been addressed during the validation review:

- sample custody, integrity & preservation
- sample handling & preparation
- holding times
- instrument calibration & performance
- dilution factors
- detection limits
- laboratory background & carry-over
- overall appearance of the data
- Quality Control:
 - calibration checks & blanks
 - laboratory blanks (method, TCLP)
 - laboratory control samples
 - matrix spike samples
 - matrix duplicates
 - field blanks (if available)
 - field duplicates (if available)

2. The above items were found to be acceptable, except as follows:

- Holding Times for Conductivity were exceeded, resulting in the samples being qualified as estimated, *J*.

3. Additional comments:

- None

ANALYTICAL CATEGORY: Radiochemical

- Isotopic uranium was determined by alpha spectroscopy (NAS/DOE 3050/RP), and technetium was determined by Liquid scintillation counters (DOE TC-02-RC), and Total Uranium was determined by Laser Phosphorimetry Method ASTM 5174-91.

1. The following items (as applicable) have been addressed during the validation review:

- sample custody, integrity & preservation
- sample handling & preparation
- holding times
- instrument calibration & performance
- dilution factors
- detection limits
- laboratory background & carry-over
- overall appearance of the data
- Quality Control:
 - calibration checks & background
 - preparation blanks
 - laboratory control samples
 - field blanks (if available)
 - field duplicates (if available)

2. The above items were found to be acceptable, except as follows:

- Instrument Counting Error

Several samples have reported results that are less than the MDA and the uncertainty is greater than the result. The non-detect results for these samples were qualified *UJ*.

Method Blank

- Contamination with Technetium-99 and Isotopic Uranium was seen in the method blank. Method blanks are run to verify that contamination is being introduced during the run. Technetium-99 data associated with the method blank did not pass the Normalized Absolute Difference criteria. Samples were qualified as estimated, *J*.

Laboratory Control Sample

The percent recovery for Technetium-99 LCS, was above the upper control limit (UCL). Recoveries above the UCL could be the result of poor preparation or instrumentation problems, and may indicate a high bias to the data. Only positive sample results for qualified as estimated, *J*.

3. Additional comments:

None

ATTACHMENT A

WESTINGHOUSE Sample Data Summary Sheets

ATTACHMENT B

KEY TO THE WESTINGHOUSE DATA VALIDATION QUALIFIERS

QUALIFIERS	
=	Indicates that the data met all QA/QC requirements, and that the parameter has been positively identified and the associated concentration value is accurate.
U	Indicates that the data met all QA/QC requirements, and that the parameter was analyzed for but was not detected above the reported sample quantitation limit.
J	Indicates that the parameter was positively identified; the associated numerical value is the approximate concentration of the parameter in the sample.
UJ	Indicates that the parameter was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
N	The analysis indicates the presence of a parameter for which there is presumptive evidence to make a "tentative identification."
R	Indicates that the sample results for the parameter are rejected or unusable due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the parameter cannot be verified.

Data Validation Reason Codes

Holding Times

- A01 Extraction holding times were exceeded.
- A02 Extraction holding times were grossly exceeded.
- A03 Analysis holding times were exceeded.
- A04 Analysis holding times were grossly exceeded.
- A05 Samples were not preserved properly.
- A06 Professional judgment was used to qualify the data.

GC/MS Tuning

- B01 Mass calibration was in error, even after applying expanded criteria.
- B02 Mass calibration was not performed every 12 hours.
- B03 Mass calibration did not meet ion abundance.
- B04 Professional judgment was used to qualify the data.

Initial/Continuing Calibration – Organics

- C01 Initial calibration RRF was <0.05.
- C02 Initial calibration RSD was >30%.
- C03 Initial calibration sequence was not followed as required.
- C04 Continuing calibration RRF was <0.05.
- C05 Continuing calibration %D was >25%.
- C06 Continuing calibration was not performed at the required frequency.
- C07 Resolution criteria were not met.
- C08 RPD criteria were not met.
- C09 RSD criteria were not met.
- C10 Retention time of compounds was outside windows.
- C11 Compounds were not adequately resolved.
- C12 Breakdown of endrin or DDT was >20%.
- C13 Combined breakdown of endrin/DDT was >30%.
- C14 Professional judgment was used to qualify the data.

Blanks

- F01 Sample data were qualified as a result of the method blank.
- F02 Sample data were qualified as a result of the field blank.
- F03 Sample data were qualified as a result of the equipment rinsate.
- F04 Sample data were qualified as a result of the trip blank.
- F05 Gross contamination exists.
- F06 Concentration of the contaminant was detected at a level below the CRQL.
- F07 Concentration of the contaminant was detected at a level less than the action limit, but greater than the CRQL.
- F08 Concentration of the contaminant was detected at a level that exceeds the action level.
- F09 No laboratory blanks were analyzed.
- F10 Blank had a negative value >2x's the IDL.
- F11 Blanks were not analyzed at required frequency.
- F12 Professional judgment was used to qualify the data.

Surrogate/Radiological Chemical Recovery

- G01 Surrogate/radiological chemical recovery was above the upper control limit.
- G02 Surrogate/radiological chemical recovery was below the lower control limit.
- G03 Surrogate recovery was <10%.
- G04 Surrogate/radiological chemical recovery was zero.
- G05 Surrogate/radiological chemical recovery was not present.
- G06 Professional judgment was used to qualify the data.
- G07 Radiological chemical recovery was <20%.
- G08 Radiological chemical recovery was >150%.

Matrix Spike/Matrix Spike Duplicate

- H01 MS/MSD recovery was above the upper control limit.
- H02 MS/MSD recovery was below the lower control limit.
- H03 MS/MSD recovery was <10%.
- H04 MS/MSD pairs exceed the RPD limit.
- H05 No action was taken on MS/MSD results.
- H06 Professional judgment was used to qualify the data.
- H07 Radiological MS/MSD recovery was <20%.
- H08 Radiological MS/MSD recovery was >160%.
- H09 Radiological MS/MSD samples were not analyzed at the required frequency.

Laboratory Duplicate

- J01 Duplicate RPD/normalized absolute difference (NAD) was outside the control limit.
- J02 Duplicate sample results were >5x the CRDL.
- J03 Duplicate sample results were <5x the CRDL.
- J04 Professional judgment was used to qualify the data.
- J05 Duplicate was not analyzed at the required frequency.

Target Compound Identification

- M01 Incorrect identifications were made.
- M02 Qualitative criteria were not met.
- M03 Cross contamination occurred.
- M04 Confirmatory analysis was not performed.
- M05 No results were provided.
- M06 Analysis occurred outside 12 hr GC/MS window.
- M07 Professional judgment was used to qualify the data.
- M08 The %D between the two pesticide/PCB column checks was >25%.

Laboratory Control Samples (LCSs)

- P01 LCS recovery was above upper control limit.
- P02 LCS recovery was below lower control limit.
- P03 LCS recovery was <50%.
- P04 No action was taken on the LCS data.
- P05 LCS was not analyzed at required frequency.
- P06 Radiological LCS recovery was <50% for aqueous samples; <40% for solid samples.
- P07 Radiological LCS recovery was >150% for aqueous samples; >160% for solid samples.
- P08 Professional judgment was used to qualify the data.

Field Duplicate

- Q01 No action was taken on the basis of field duplicate RPDs.
- Q02 Radiological field duplicate normalized absolute difference (NAD) was outside the control limit.
- Q03 Duplicate sample results were >5x the CRDL.
- Q04 Duplicate sample results were <5x the CRDL.

Radiological Calibration

- R01 Efficiency calibration criteria were not met.
- R02 Energy calibration criteria were not met.
- R03 Resolution calibration criteria were not met
- R04 Background determination criteria were not met.
- R05 Quench curve criteria were not met.
- R06 Absorption curve criteria were not met.
- R07 Plateau curve criteria were not met.
- R08 Professional judgment was used to qualify the data.

Radiological Calibration Verification

- S01 Efficiency verification criteria were not met.
- S02 Energy verification criteria were not met.
- S03 Resolution verification criteria were not met
- S04 Background verification criteria were not met.
- S05 Cross-talk verification criteria were not met.
- S06 Professional judgment was used to qualify the data.

Radionuclide Quantitation

- T01 Detection limits were not met.
- T02 Analytical uncertainties were not met and/or not reported.
- T03 Inappropriate aliquot sizes were used.
- T04 Professional judgment was used to qualify the data.
- T05 Analytical result is less than the associated MDA, but greater than the counting uncertainty.
- T06 Analytical result is less than both the associated counting uncertainty and MDA.
- T07 Negative analytical result where the absolute value exceeds 2x the associated MDA.

System Performance

- V01 High background levels or a shift in the energy calibration were observed.
- V02 Extraneous peaks were observed.
- V03 Loss of resolution was observed.
- V04 Peak-tailing or peak splitting that may result in inaccurate quantitation were observed.
- V05 Professional judgment was used to qualify the data.

DATA VALIDATION REPORT

Date:

November 14, 2003

To: Steve Passig	From: Carol Johnson
Laboratory: Severn Trent – St. Louis	SDG #: F3I230117

Attached you will find the results from the data validation technical review for the Westinghouse/Hematite samples and analyses that are associated with the above referenced laboratory and sample delivery group (SDG) number. These data points have been selected for data validation and the sample index on the following page specifically identifies the samples and analyses associated with this validation review.

The Westinghouse/Hematite validation technical review was performed in accordance with the *Contract Laboratory Program Data Validation Functional Guidelines for Evaluating Inorganic Analytical Data*, and the *Laboratory Data Validation Guidelines for Evaluating Radionuclide Analyses and Radiochemical Data Verification and Validation*. It was based on the information and documentation supplied by the associated laboratory. The analyses were evaluated against criteria established in the related analytical procedures and the Westinghouse/Hematite data quality requirements.

Attachment A to this report provides the Sample Data Summary Sheets for the samples associated with the above referenced request. These summary sheets identify the analytical values and the qualifiers for each sample and parameter. Attachment B outlines the validation qualifiers and reason codes used in the validation of the data.

Report Summary	
Total Number of Samples	11
Total Number of Data Points	65
Total Number of Rejected Data Points	0
Percent Completeness (approval to rejection ratio)	100.0%

Sample Index

Date:

November 14, 2003

Laboratory:

Severn Trent - St. Louis

SDG #:

F31230117

WESTINGHOUSE Sample ID	Target Analyses
BHKD2-04	Isotopic Uranium, Total Uranium, Technetium-99, Conductivity, pH
BHKD2-13	Isotopic Uranium, Total Uranium, Technetium-99, Conductivity, pH
BHKD2-23	Isotopic Uranium, Total Uranium, Technetium-99, Conductivity, pH
BHKD3-08	Isotopic Uranium, Total Uranium, Technetium-99, Conductivity, pH, Percent Moisture
BHKD5-01	Total Uranium, Conductivity, pH, Percent Moisture
BHKD5-19	Isotopic Uranium, Total Uranium, Technetium-99, Conductivity, pH, Percent Moisture
BHKD5-27	Isotopic Uranium, Total Uranium, Technetium-99, Conductivity, pH, Percent Moisture
BHKD5-01	Isotopic Uranium, Technetium-99
BHKD5-19	Isotopic Uranium, Technetium-99, Percent Moisture
BHKD5-27	Isotopic Uranium, Technetium-99, Percent Moisture
BHKD3-08	Isotopic Uranium, Technetium-99, Percent Moisture

ANALYTICAL CATEGORY: Miscellaneous

- Specific Conductance was determined by SW846 Method 9050; pH was determined by SW846 Method 9045A; and percent moisture was determined by MCAWW 160.3.

1. The following items (as applicable) have been addressed during the validation review:

- sample custody, integrity & preservation
- sample handling & preparation
- holding times
- instrument calibration & performance
- dilution factors
- detection limits
- laboratory background & carry-over
- overall appearance of the data
- Quality Control:
 - calibration checks & blanks
 - laboratory blanks (method, TCLP)
 - laboratory control samples
 - matrix spike samples
 - matrix duplicates
 - field blanks (if available)
 - field duplicates (if available)

2. The above items were found to be acceptable, except as follows:

- None.

3. Additional comments:

- None

ANALYTICAL CATEGORY: Radiochemical

- Isotopic uranium was determined by alpha spectroscopy (NAS/DOE 3050/RP), and technetium was determined by Liquid scintillation counters (DOE TC-02-RC), and Total Uranium was determined by Laser Phosphorimetry Method ASTM 5174-91.

1. The following items (as applicable) have been addressed during the validation review:

- sample custody, integrity & preservation
- sample handling & preparation
- holding times
- instrument calibration & performance
- dilution factors
- detection limits
- laboratory background & carry-over
- overall appearance of the data
- Quality Control:
 - calibration checks & background
 - preparation blanks
 - laboratory control samples
 - field blanks (if available)
 - field duplicates (if available)

2. The above items were found to be acceptable, except as follows:

- Instrument Counting Error

Several samples have reported results that are less than the MDA and the uncertainty is greater than the result. The non-detect results for these samples were qualified *UJ*.

Method Blank

- Contamination with Technetium-99 and Isotopic Uranium was seen in the method blank. Method blanks are run to verify that contamination is being introduced during the run. Technetium-99 data associated with the method blank did not pass the Normalized Absolute Difference criteria. Samples were qualified as estimated, *J*.
- Laboratory Control Sample

The percent recovery for Technetium-99 LCS, was above the upper control limit (UCL). Recoveries above the UCL could be the result of poor preparation or instrumentation problems, and may indicate a high bias to the data. Only positive sample results for qualified as estimated, *J*.

3. Additional comments:
None

ATTACHMENT A

WESTINGHOUSE Sample Data Summary Sheets

ATTACHMENT B

KEY TO THE WESTINGHOUSE DATA VALIDATION QUALIFIERS

QUALIFIERS	
=	Indicates that the data met all QA/QC requirements, and that the parameter has been positively identified and the associated concentration value is accurate.
U	Indicates that the data met all QA/QC requirements, and that the parameter was analyzed for but was not detected above the reported sample quantitation limit.
J	Indicates that the parameter was positively identified; the associated numerical value is the approximate concentration of the parameter in the sample.
UJ	Indicates that the parameter was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
N	The analysis indicates the presence of a parameter for which there is presumptive evidence to make a "tentative identification."
R	Indicates that the sample results for the parameter are rejected or unusable due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the parameter cannot be verified.

Data Validation Reason Codes

Holding Times

- A01 Extraction holding times were exceeded.
- A02 Extraction holding times were grossly exceeded.
- A03 Analysis holding times were exceeded.
- A04 Analysis holding times were grossly exceeded.
- A05 Samples were not preserved properly.
- A06 Professional judgment was used to qualify the data.

GC/MS Tuning

- B01 Mass calibration was in error, even after applying expanded criteria.
- B02 Mass calibration was not performed every 12 hours.
- B03 Mass calibration did not meet ion abundance.
- B04 Professional judgment was used to qualify the data.

Initial/Continuing Calibration – Organics

- C01 Initial calibration RRF was <0.05 .
- C02 Initial calibration RSD was $>30\%$.
- C03 Initial calibration sequence was not followed as required.
- C04 Continuing calibration RRF was <0.05 .
- C05 Continuing calibration %D was $>25\%$.
- C06 Continuing calibration was not performed at the required frequency.
- C07 Resolution criteria were not met.
- C08 RPD criteria were not met.
- C09 RSD criteria were not met.
- C10 Retention time of compounds was outside windows.
- C11 Compounds were not adequately resolved.
- C12 Breakdown of endrin or DDT was $>20\%$.
- C13 Combined breakdown of endrin/DDT was $>30\%$.
- C14 Professional judgment was used to qualify the data.

Blanks

- F01 Sample data were qualified as a result of the method blank.
- F02 Sample data were qualified as a result of the field blank.
- F03 Sample data were qualified as a result of the equipment rinsate.
- F04 Sample data were qualified as a result of the trip blank.
- F05 Gross contamination exists.
- F06 Concentration of the contaminant was detected at a level below the CRQL.
- F07 Concentration of the contaminant was detected at a level less than the action limit, but greater than the CRQL.
- F08 Concentration of the contaminant was detected at a level that exceeds the action level.
- F09 No laboratory blanks were analyzed.
- F10 Blank had a negative value $>2x$'s the IDL.
- F11 Blanks were not analyzed at required frequency.
- F12 Professional judgment was used to qualify the data.

Surrogate/Radiological Chemical Recovery

- G01 Surrogate/radiological chemical recovery was above the upper control limit.
- G02 Surrogate/radiological chemical recovery was below the lower control limit.
- G03 Surrogate recovery was <10%.
- G04 Surrogate/radiological chemical recovery was zero.
- G05 Surrogate/radiological chemical recovery was not present.
- G06 Professional judgment was used to qualify the data.
- G07 Radiological chemical recovery was <20%.
- G08 Radiological chemical recovery was >150%.

Matrix Spike/Matrix Spike Duplicate

- H01 MS/MSD recovery was above the upper control limit.
- H02 MS/MSD recovery was below the lower control limit.
- H03 MS/MSD recovery was <10%.
- H04 MS/MSD pairs exceed the RPD limit.
- H05 No action was taken on MS/MSD results.
- H06 Professional judgment was used to qualify the data.
- H07 Radiological MS/MSD recovery was <20%.
- H08 Radiological MS/MSD recovery was >160%.
- H09 Radiological MS/MSD samples were not analyzed at the required frequency.

Laboratory Duplicate

- J01 Duplicate RPD/normalized absolute difference (NAD) was outside the control limit.
- J02 Duplicate sample results were >5x the CRDL.
- J03 Duplicate sample results were <5x the CRDL.
- J04 Professional judgment was used to qualify the data.
- J05 Duplicate was not analyzed at the required frequency.

Target Compound Identification

- M01 Incorrect identifications were made.
- M02 Qualitative criteria were not met.
- M03 Cross contamination occurred.
- M04 Confirmatory analysis was not performed.
- M05 No results were provided.
- M06 Analysis occurred outside 12 hr GC/MS window.
- M07 Professional judgment was used to qualify the data.
- M08 The %D between the two pesticide/PCB column checks was >25%.

Laboratory Control Samples (LCSs)

- P01 LCS recovery was above upper control limit.
- P02 LCS recovery was below lower control limit.
- P03 LCS recovery was <50%.
- P04 No action was taken on the LCS data.
- P05 LCS was not analyzed at required frequency.
- P06 Radiological LCS recovery was <50% for aqueous samples; <40% for solid samples.
- P07 Radiological LCS recovery was >150% for aqueous samples; >160% for solid samples.
- P08 Professional judgment was used to qualify the data.

Field Duplicate

- Q01 No action was taken on the basis of field duplicate RPDs.
- Q02 Radiological field duplicate normalized absolute difference (NAD) was outside the control limit.
- Q03 Duplicate sample results were >5x the CRDL.
- Q04 Duplicate sample results were <5x the CRDL.

Radiological Calibration

- R01 Efficiency calibration criteria were not met.
- R02 Energy calibration criteria were not met.
- R03 Resolution calibration criteria were not met
- R04 Background determination criteria were not met.
- R05 Quench curve criteria were not met.
- R06 Absorption curve criteria were not met.
- R07 Plateau curve criteria were not met.
- R08 Professional judgment was used to qualify the data.

Radiological Calibration Verification

- S01 Efficiency verification criteria were not met.
- S02 Energy verification criteria were not met.
- S03 Resolution verification criteria were not met
- S04 Background verification criteria were not met.
- S05 Cross-talk verification criteria were not met.
- S06 Professional judgment was used to qualify the data.

Radionuclide Quantitation

- T01 Detection limits were not met.
- T02 Analytical uncertainties were not met and/or not reported.
- T03 Inappropriate aliquot sizes were used.
- T04 Professional judgment was used to qualify the data.
- T05 Analytical result is less than the associated MDA, but greater than the counting uncertainty.
- T06 Analytical result is less than both the associated counting uncertainty and MDA.
- T07 Negative analytical result where the absolute value exceeds 2x the associated MDA.

System Performance

- V01 High background levels or a shift in the energy calibration were observed.
- V02 Extraneous peaks were observed.
- V03 Loss of resolution was observed.
- V04 Peak-tailing or peak splitting that may result in inaccurate quantitation were observed.
- V05 Professional judgment was used to qualify the data.

DATA VALIDATION REPORT

Date:

November 17, 2003

To: Steve Passig	From: Carol Johnson
Laboratory: Severn Trent – St. Louis	SDG #: F3J140125

Attached you will find the results from the data validation technical review for the Westinghouse/Hematite samples and analyses that are associated with the above referenced laboratory and sample delivery group (SDG) number. These data points have been selected for data validation and the sample index on the following page specifically identifies the samples and analyses associated with this validation review.

The Westinghouse/Hematite validation technical review was performed in accordance with the *Contract Laboratory Program Data Validation Functional Guidelines for Evaluating Inorganic Analytical Data*, and the *Laboratory Data Validation Guidelines for Evaluating Radionuclide Analyses and Radiochemical Data Verification and Validation*. It was based on the information and documentation supplied by the associated laboratory. The analyses were evaluated against criteria established in the related analytical procedures and the Westinghouse/Hematite data quality requirements.

Attachment A to this report provides the Sample Data Summary Sheets for the samples associated with the above referenced request. These summary sheets identify the analytical values and the qualifiers for each sample and parameter. Attachment B outlines the validation qualifiers and reason codes used in the validation of the data.

Report Summary	
Total Number of Samples	11
Total Number of Data Points	24
Total Number of Rejected Data Points	0
Percent Completeness (approval to rejection ratio)	100.0%

Sample Index

Date:

November 17, 2003

Laboratory:

Severn Trent – St. Louis

SDG #:

F3J140125

WESTINGHOUSE Sample ID	Target Analyses
BHKD4-14	Total Uranium, Technetium-99, pH
BHKD6-01	Total Uranium, Technetium-99, pH
BHKD1-04	Total Uranium, pH
BHKD1-23	Total Uranium, pH
BHKD1-28	Total Uranium, pH
BHKD3-16	Total Uranium, pH
BHKD3-23	Total Uranium, pH
BHKD4-02	Total Uranium, pH
BHKD4-24	Total Uranium, pH
BHKD6-11	Total Uranium, pH
BHKD6-26	Total Uranium, pH

ANALYTICAL CATEGORY: Miscellaneous

- pH was determined by SW846 Method 9045A.
- 1. The following items (as applicable) have been addressed during the validation review:
 - sample custody, integrity & preservation
 - sample handling & preparation
 - holding times
 - instrument calibration & performance
 - dilution factors
 - detection limits
 - laboratory background & carry-over
 - overall appearance of the data
 - Quality Control:
 - calibration checks & blanks
 - laboratory blanks (method, TCLP)
 - laboratory control samples
 - matrix spike samples
 - matrix duplicates
 - field blanks (if available)
 - field duplicates (if available)
- 2. The above items were found to be acceptable, except as follows:
 - none
- 3. Additional comments:
 - none

ANALYTICAL CATEGORY: Radiochemical

- Total Uranium was determined by Laser Phosphorimetry Method ASTM 5174-91, Technetium was determined by Liquid scintillation counters (DOE TC-02-RC).
1. The following items (as applicable) have been addressed during the validation review:
 - sample custody, integrity & preservation
 - sample handling & preparation
 - holding times
 - instrument calibration & performance
 - dilution factors
 - detection limits
 - laboratory background & carry-over
 - overall appearance of the data
 - Quality Control:
 - calibration checks & background
 - preparation blanks
 - laboratory control samples
 - field blanks (if available)
 - field duplicates (if available)
 2. The above items were found to be acceptable, except as follows:

None
 3. Additional comments:

None

ATTACHMENT A

WESTINGHOUSE Sample Data Summary Sheets

ATTACHMENT B

KEY TO THE WESTINGHOUSE DATA VALIDATION QUALIFIERS

QUALIFIERS	
=	Indicates that the data met all QA/QC requirements, and that the parameter has been positively identified and the associated concentration value is accurate.
U	Indicates that the data met all QA/QC requirements, and that the parameter was analyzed for but was not detected above the reported sample quantitation limit.
J	Indicates that the parameter was positively identified; the associated numerical value is the approximate concentration of the parameter in the sample.
UJ	Indicates that the parameter was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
N	The analysis indicates the presence of a parameter for which there is presumptive evidence to make a "tentative identification."
R	Indicates that the sample results for the parameter are rejected or unusable due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the parameter cannot be verified.

Data Validation Reason Codes

Holding Times

- A01 Extraction holding times were exceeded.
- A02 Extraction holding times were grossly exceeded.
- A03 Analysis holding times were exceeded.
- A04 Analysis holding times were grossly exceeded.
- A05 Samples were not preserved properly.
- A06 Professional judgment was used to qualify the data.

GC/MS Tuning

- B01 Mass calibration was in error, even after applying expanded criteria.
- B02 Mass calibration was not performed every 12 hours.
- B03 Mass calibration did not meet ion abundance.
- B04 Professional judgment was used to qualify the data.

Initial/Continuing Calibration – Organics

- C01 Initial calibration RRF was <0.05.
- C02 Initial calibration RSD was >30%.
- C03 Initial calibration sequence was not followed as required.
- C04 Continuing calibration RRF was <0.05.
- C05 Continuing calibration %D was >25%.
- C06 Continuing calibration was not performed at the required frequency.
- C07 Resolution criteria were not met.
- C08 RPD criteria were not met.
- C09 RSD criteria were not met.
- C10 Retention time of compounds was outside windows.
- C11 Compounds were not adequately resolved.
- C12 Breakdown of endrin or DDT was >20%.
- C13 Combined breakdown of endrin/DDT was >30%.
- C14 Professional judgment was used to qualify the data.

Blanks

- F01 Sample data were qualified as a result of the method blank.
- F02 Sample data were qualified as a result of the field blank.
- F03 Sample data were qualified as a result of the equipment rinsate.
- F04 Sample data were qualified as a result of the trip blank.
- F05 Gross contamination exists.
- F06 Concentration of the contaminant was detected at a level below the CRQL.
- F07 Concentration of the contaminant was detected at a level less than the action limit, but greater than the CRQL.
- F08 Concentration of the contaminant was detected at a level that exceeds the action level.
- F09 No laboratory blanks were analyzed.
- F10 Blank had a negative value >2x's the IDL.
- F11 Blanks were not analyzed at required frequency.
- F12 Professional judgment was used to qualify the data.

Surrogate/Radiological Chemical Recovery

- G01 Surrogate/radiological chemical recovery was above the upper control limit.
- G02 Surrogate/radiological chemical recovery was below the lower control limit.
- G03 Surrogate recovery was <10%.
- G04 Surrogate/radiological chemical recovery was zero.
- G05 Surrogate/radiological chemical recovery was not present.
- G06 Professional judgment was used to qualify the data.
- G07 Radiological chemical recovery was <20%.
- G08 Radiological chemical recovery was >150%.

Matrix Spike/Matrix Spike Duplicate

- H01 MS/MSD recovery was above the upper control limit.
- H02 MS/MSD recovery was below the lower control limit.
- H03 MS/MSD recovery was <10%.
- H04 MS/MSD pairs exceed the RPD limit.
- H05 No action was taken on MS/MSD results.
- H06 Professional judgment was used to qualify the data.
- H07 Radiological MS/MSD recovery was <20%.
- H08 Radiological MS/MSD recovery was >160%.
- H09 Radiological MS/MSD samples were not analyzed at the required frequency.

Laboratory Duplicate

- J01 Duplicate RPD/normalized absolute difference (NAD) was outside the control limit.
- J02 Duplicate sample results were >5x the CRDL.
- J03 Duplicate sample results were <5x the CRDL.
- J04 Professional judgment was used to qualify the data.
- J05 Duplicate was not analyzed at the required frequency.

Target Compound Identification

- M01 Incorrect identifications were made.
- M02 Qualitative criteria were not met.
- M03 Cross contamination occurred.
- M04 Confirmatory analysis was not performed.
- M05 No results were provided.
- M06 Analysis occurred outside 12 hr GC/MS window.
- M07 Professional judgment was used to qualify the data.
- M08 The %D between the two pesticide/PCB column checks was >25%.

Laboratory Control Samples (LCSs)

- P01 LCS recovery was above upper control limit.
- P02 LCS recovery was below lower control limit.
- P03 LCS recovery was <50%.
- P04 No action was taken on the LCS data.
- P05 LCS was not analyzed at required frequency.
- P06 Radiological LCS recovery was <50% for aqueous samples; <40% for solid samples.
- P07 Radiological LCS recovery was >150% for aqueous samples; >160% for solid samples.
- P08 Professional judgment was used to qualify the data.

Field Duplicate

- Q01 No action was taken on the basis of field duplicate RPDs.
- Q02 Radiological field duplicate normalized absolute difference (NAD) was outside the control limit.
- Q03 Duplicate sample results were >5x the CRDL.
- Q04 Duplicate sample results were <5x the CRDL.

Radiological Calibration

- R01 Efficiency calibration criteria were not met.
- R02 Energy calibration criteria were not met.
- R03 Resolution calibration criteria were not met.
- R04 Background determination criteria were not met.
- R05 Quench curve criteria were not met.
- R06 Absorption curve criteria were not met.
- R07 Plateau curve criteria were not met.
- R08 Professional judgment was used to qualify the data.

Radiological Calibration Verification

- S01 Efficiency verification criteria were not met.
- S02 Energy verification criteria were not met.
- S03 Resolution verification criteria were not met.
- S04 Background verification criteria were not met.
- S05 Cross-talk verification criteria were not met.
- S06 Professional judgment was used to qualify the data.

Radionuclide Quantitation

- T01 Detection limits were not met.
- T02 Analytical uncertainties were not met and/or not reported.
- T03 Inappropriate aliquot sizes were used.
- T04 Professional judgment was used to qualify the data.
- T05 Analytical result is less than the associated MDA, but greater than the counting uncertainty.
- T06 Analytical result is less than both the associated counting uncertainty and MDA.
- T07 Negative analytical result where the absolute value exceeds 2x the associated MDA.

System Performance

- V01 High background levels or a shift in the energy calibration were observed.
- V02 Extraneous peaks were observed.
- V03 Loss of resolution was observed.
- V04 Peak-tailing or peak splitting that may result in inaccurate quantitation were observed.
- V05 Professional judgment was used to qualify the data.

DATA VALIDATION REPORT

Date:

November 17, 2003

To: Steve Passig	From: Carol Johnson
Laboratory: Severn Trent – St. Louis	SDG #: F3J140132

Attached you will find the results from the data validation technical review for the Westinghouse/Hematite samples and analyses that are associated with the above referenced laboratory and sample delivery group (SDG) number. These data points have been selected for data validation and the sample index on the following page specifically identifies the samples and analyses associated with this validation review.

The Westinghouse/Hematite validation technical review was performed in accordance with the *Contract Laboratory Program Data Validation Functional Guidelines for Evaluating Inorganic Analytical Data*, and the *Laboratory Data Validation Guidelines for Evaluating Radionuclide Analyses and Radiochemical Data Verification and Validation*. It was based on the information and documentation supplied by the associated laboratory. The analyses were evaluated against criteria established in the related analytical procedures and the Westinghouse/Hematite data quality requirements.

Attachment A to this report provides the Sample Data Summary Sheets for the samples associated with the above referenced request. These summary sheets identify the analytical values and the qualifiers for each sample and parameter. Attachment B outlines the validation qualifiers and reason codes used in the validation of the data.

Report Summary	
Total Number of Samples	11
Total Number of Data Points	24
Total Number of Rejected Data Points	0
Percent Completeness (approval to rejection ratio)	100.0%

Sample Index

Date:

November 17, 2003

Laboratory:

Severn Trent – St. Louis

SDG #:

F3J140132

WESTINGHOUSE Sample ID	Target Analyses
BHKD4-14	Total Uranium, Technetium-99, pH
BHKD6-01	Total Uranium, Technetium-99, pH
BHKD1-04	Total Uranium, pH
BHKD1-23	Total Uranium, pH
BHKD1-28	Total Uranium, pH
BHKD3-16	Total Uranium, pH
BHKD3-23	Total Uranium, pH
BHKD4-02	Total Uranium, pH
BHKD4-24	Total Uranium, pH
BHKD6-11	Total Uranium, pH
BHKD6-26	Total Uranium, pH

ANALYTICAL CATEGORY: Miscellaneous

- pH was determined by SW846 Method 9045A.

1. The following items (as applicable) have been addressed during the validation review:

- sample custody, integrity & preservation
- sample handling & preparation
- holding times
- instrument calibration & performance
- dilution factors
- detection limits
- laboratory background & carry-over
- overall appearance of the data
- Quality Control:
 - calibration checks & blanks
 - laboratory blanks (method, TCLP)
 - laboratory control samples
 - matrix spike samples
 - matrix duplicates
 - field blanks (if available)
 - field duplicates (if available)

2. The above items were found to be acceptable, except as follows:

- none

3. Additional comments:

- none

ANALYTICAL CATEGORY: Radiochemical

- Total Uranium was determined by Laser Phosphorimetry Method ASTM 5174-91 Technetium was determined by Liquid scintillation counters (DOE TC-02-RC)

1. The following items (as applicable) have been addressed during the validation review:

- sample custody, integrity & preservation
- sample handling & preparation
- holding times
- instrument calibration & performance
- dilution factors
- detection limits
- laboratory background & carry-over
- overall appearance of the data
- Quality Control:
 - calibration checks & background
 - preparation blanks
 - laboratory control samples
 - field blanks (if available)
 - field duplicates (if available)

2. The above items were found to be acceptable, except as follows:

None

3. Additional comments:

None

ATTACHMENT A

WESTINGHOUSE Sample Data Summary Sheets

ATTACHMENT B

KEY TO THE WESTINGHOUSE DATA VALIDATION QUALIFIERS

QUALIFIERS	
=	Indicates that the data met all QA/QC requirements, and that the parameter has been positively identified and the associated concentration value is accurate.
U	Indicates that the data met all QA/QC requirements, and that the parameter was analyzed for but was not detected above the reported sample quantitation limit.
J	Indicates that the parameter was positively identified; the associated numerical value is the approximate concentration of the parameter in the sample.
UJ	Indicates that the parameter was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
N	The analysis indicates the presence of a parameter for which there is presumptive evidence to make a "tentative identification."
R	Indicates that the sample results for the parameter are rejected or unusable due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the parameter cannot be verified.

Data Validation Reason Codes

Holding Times

- A01 Extraction holding times were exceeded.
- A02 Extraction holding times were grossly exceeded.
- A03 Analysis holding times were exceeded.
- A04 Analysis holding times were grossly exceeded.
- A05 Samples were not preserved properly.
- A06 Professional judgment was used to qualify the data.

GC/MS Tuning

- B01 Mass calibration was in error, even after applying expanded criteria.
- B02 Mass calibration was not performed every 12 hours.
- B03 Mass calibration did not meet ion abundance.
- B04 Professional judgment was used to qualify the data.

Initial/Continuing Calibration – Organics

- C01 Initial calibration RRF was <0.05.
- C02 Initial calibration RSD was >30%.
- C03 Initial calibration sequence was not followed as required.
- C04 Continuing calibration RRF was <0.05.
- C05 Continuing calibration %D was >25%.
- C06 Continuing calibration was not performed at the required frequency.
- C07 Resolution criteria were not met.
- C08 RPD criteria were not met.
- C09 RSD criteria were not met.
- C10 Retention time of compounds was outside windows.
- C11 Compounds were not adequately resolved.
- C12 Breakdown of endrin or DDT was >20%.
- C13 Combined breakdown of endrin/DDT was >30%.
- C14 Professional judgment was used to qualify the data.

Blanks

- F01 Sample data were qualified as a result of the method blank.
- F02 Sample data were qualified as a result of the field blank.
- F03 Sample data were qualified as a result of the equipment rinsate.
- F04 Sample data were qualified as a result of the trip blank.
- F05 Gross contamination exists.
- F06 Concentration of the contaminant was detected at a level below the CRQL.
- F07 Concentration of the contaminant was detected at a level less than the action limit, but greater than the CRQL.
- F08 Concentration of the contaminant was detected at a level that exceeds the action level.
- F09 No laboratory blanks were analyzed.
- F10 Blank had a negative value >2x's the IDL.
- F11 Blanks were not analyzed at required frequency.
- F12 Professional judgment was used to qualify the data.

Surrogate/Radiological Chemical Recovery

- G01 Surrogate/radiological chemical recovery was above the upper control limit.
- G02 Surrogate/radiological chemical recovery was below the lower control limit.
- G03 Surrogate recovery was <10%.
- G04 Surrogate/radiological chemical recovery was zero.
- G05 Surrogate/radiological chemical recovery was not present.
- G06 Professional judgment was used to qualify the data.
- G07 Radiological chemical recovery was <20%.
- G08 Radiological chemical recovery was >150%.

Matrix Spike/Matrix Spike Duplicate

- H01 MS/MSD recovery was above the upper control limit.
- H02 MS/MSD recovery was below the lower control limit.
- H03 MS/MSD recovery was <10%.
- H04 MS/MSD pairs exceed the RPD limit.
- H05 No action was taken on MS/MSD results.
- H06 Professional judgment was used to qualify the data.
- H07 Radiological MS/MSD recovery was <20%.
- H08 Radiological MS/MSD recovery was >160%.
- H09 Radiological MS/MSD samples were not analyzed at the required frequency.

Laboratory Duplicate

- J01 Duplicate RPD/normalized absolute difference (NAD) was outside the control limit.
- J02 Duplicate sample results were >5x the CRDL.
- J03 Duplicate sample results were <5x the CRDL.
- J04 Professional judgment was used to qualify the data.
- J05 Duplicate was not analyzed at the required frequency.

Target Compound Identification

- M01 Incorrect identifications were made.
- M02 Qualitative criteria were not met.
- M03 Cross contamination occurred.
- M04 Confirmatory analysis was not performed.
- M05 No results were provided.
- M06 Analysis occurred outside 12 hr GC/MS window.
- M07 Professional judgment was used to qualify the data.
- M08 The %D between the two pesticide/PCB column checks was >25%.

Laboratory Control Samples (LCSs)

- P01 LCS recovery was above upper control limit.
- P02 LCS recovery was below lower control limit.
- P03 LCS recovery was <50%.
- P04 No action was taken on the LCS data.
- P05 LCS was not analyzed at required frequency.
- P06 Radiological LCS recovery was <50% for aqueous samples; <40% for solid samples.
- P07 Radiological LCS recovery was >150% for aqueous samples; >160% for solid samples.
- P08 Professional judgment was used to qualify the data.

Field Duplicate

- Q01 No action was taken on the basis of field duplicate RPDs.
- Q02 Radiological field duplicate normalized absolute difference (NAD) was outside the control limit.
- Q03 Duplicate sample results were >5x the CRDL.
- Q04 Duplicate sample results were <5x the CRDL.

Radiological Calibration

- R01 Efficiency calibration criteria were not met.
- R02 Energy calibration criteria were not met.
- R03 Resolution calibration criteria were not met
- R04 Background determination criteria were not met.
- R05 Quench curve criteria were not met.
- R06 Absorption curve criteria were not met.
- R07 Plateau curve criteria were not met.
- R08 Professional judgment was used to qualify the data.

Radiological Calibration Verification

- S01 Efficiency verification criteria were not met.
- S02 Energy verification criteria were not met.
- S03 Resolution verification criteria were not met
- S04 Background verification criteria were not met.
- S05 Cross-talk verification criteria were not met.
- S06 Professional judgment was used to qualify the data.

Radionuclide Quantitation

- T01 Detection limits were not met.
- T02 Analytical uncertainties were not met and/or not reported.
- T03 Inappropriate aliquot sizes were used.
- T04 Professional judgment was used to qualify the data.
- T05 Analytical result is less than the associated MDA, but greater than the counting uncertainty.
- T06 Analytical result is less than both the associated counting uncertainty and MDA.
- T07 Negative analytical result where the absolute value exceeds 2x the associated MDA.

System Performance

- V01 High background levels or a shift in the energy calibration were observed.
- V02 Extraneous peaks were observed.
- V03 Loss of resolution was observed.
- V04 Peak-tailing or peak splitting that may result in inaccurate quantitation were observed.
- V05 Professional judgment was used to qualify the data.

DATA VALIDATION REPORT

Date:

November 17, 2003

To: Steve Passig	From: Carol Johnson
Laboratory: Severn Trent – St. Louis	SDG #: F3J140135

Attached you will find the results from the data validation technical review for the Westinghouse/Hematite samples and analyses that are associated with the above referenced laboratory and sample delivery group (SDG) number. These data points have been selected for data validation and the sample index on the following page specifically identifies the samples and analyses associated with this validation review.

The Westinghouse/Hematite validation technical review was performed in accordance with the *Contract Laboratory Program Data Validation Functional Guidelines for Evaluating Inorganic Analytical Data*, and the *Laboratory Data Validation Guidelines for Evaluating Radionuclide Analyses and Radiochemical Data Verification and Validation*. It was based on the information and documentation supplied by the associated laboratory. The analyses were evaluated against criteria established in the related analytical procedures and the Westinghouse/Hematite data quality requirements.

Attachment A to this report provides the Sample Data Summary Sheets for the samples associated with the above referenced request. These summary sheets identify the analytical values and the qualifiers for each sample and parameter. Attachment B outlines the validation qualifiers and reason codes used in the validation of the data.

Report Summary	
Total Number of Samples	11
Total Number of Data Points	24
Total Number of Rejected Data Points	0
Percent Completeness (approval to rejection ratio)	100.0%

Sample Index

Date:

November 17 2003

Laboratory:

Severn Trent - St. Louis

SDG #:

F3J140135

WESTINGHOUSE Sample ID	Target Analyses
BHKD4-14	Total Uranium, Technetium-99, pH
BHKD6-01	Total Uranium, Technetium-99, pH
BHKD1-04	Total Uranium, pH
BHKD1-23	Total Uranium, pH
BHKD1-28	Total Uranium, pH
BHKD3-16	Total Uranium, pH
BHKD3-23	Total Uranium, pH
BHKD4-02	Total Uranium, pH
BHKD4-24	Total Uranium, pH
BHKD6-11	Total Uranium, pH
BHKD6-26	Total Uranium, pH

ANALYTICAL CATEGORY: Miscellaneous

- pH was determined by SW846 Method 9045A.

1. The following items (as applicable) have been addressed during the validation review:

- sample custody, integrity & preservation
- sample handling & preparation
- holding times
- instrument calibration & performance
- dilution factors
- detection limits
- laboratory background & carry-over
- overall appearance of the data
- Quality Control:
 - calibration checks & blanks
 - laboratory blanks (method, TCLP)
 - laboratory control samples
 - matrix spike samples
 - matrix duplicates
 - field blanks (if available)
 - field duplicates (if available)

2. The above items were found to be acceptable, except as follows:

- none

3. Additional comments:

- none

ANALYTICAL CATEGORY: Radiochemical

- Total Uranium was determined by Laser Phosphorimetry Method ASTM 5174-91, Technetium was determined by Liquid scintillation counters (DOE TC-02-RC).
1. The following items (as applicable) have been addressed during the validation review:
 - sample custody, integrity & preservation
 - sample handling & preparation
 - holding times
 - instrument calibration & performance
 - dilution factors
 - detection limits
 - laboratory background & carry-over
 - overall appearance of the data
 - Quality Control:
 - calibration checks & background
 - preparation blanks
 - laboratory control samples
 - field blanks (if available)
 - field duplicates (if available)
 2. The above items were found to be acceptable, except as follows:

None
 3. Additional comments:

None

ATTACHMENT A

WESTINGHOUSE Sample Data Summary Sheets

ATTACHMENT B

KEY TO THE WESTINGHOUSE DATA VALIDATION QUALIFIERS

QUALIFIERS	
=	Indicates that the data met all QA/QC requirements, and that the parameter has been positively identified and the associated concentration value is accurate.
U	Indicates that the data met all QA/QC requirements, and that the parameter was analyzed for but was not detected above the reported sample quantitation limit.
J	Indicates that the parameter was positively identified; the associated numerical value is the approximate concentration of the parameter in the sample.
UJ	Indicates that the parameter was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
N	The analysis indicates the presence of a parameter for which there is presumptive evidence to make a "tentative identification."
R	Indicates that the sample results for the parameter are rejected or unusable due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the parameter cannot be verified.

Data Validation Reason Codes

Holding Times

- A01 Extraction holding times were exceeded.
- A02 Extraction holding times were grossly exceeded.
- A03 Analysis holding times were exceeded.
- A04 Analysis holding times were grossly exceeded.
- A05 Samples were not preserved properly.
- A06 Professional judgment was used to qualify the data.

GC/MS Tuning

- B01 Mass calibration was in error, even after applying expanded criteria.
- B02 Mass calibration was not performed every 12 hours.
- B03 Mass calibration did not meet ion abundance.
- B04 Professional judgment was used to qualify the data.

Initial/Continuing Calibration – Organics

- C01 Initial calibration RRF was <0.05 .
- C02 Initial calibration RSD was $>30\%$.
- C03 Initial calibration sequence was not followed as required.
- C04 Continuing calibration RRF was <0.05 .
- C05 Continuing calibration %D was $>25\%$.
- C06 Continuing calibration was not performed at the required frequency.
- C07 Resolution criteria were not met.
- C08 RPD criteria were not met.
- C09 RSD criteria were not met.
- C10 Retention time of compounds was outside windows.
- C11 Compounds were not adequately resolved.
- C12 Breakdown of endrin or DDT was $>20\%$.
- C13 Combined breakdown of endrin/DDT was $>30\%$.
- C14 Professional judgment was used to qualify the data.

Blanks

- F01 Sample data were qualified as a result of the method blank.
- F02 Sample data were qualified as a result of the field blank.
- F03 Sample data were qualified as a result of the equipment rinsate.
- F04 Sample data were qualified as a result of the trip blank.
- F05 Gross contamination exists.
- F06 Concentration of the contaminant was detected at a level below the CRQL.
- F07 Concentration of the contaminant was detected at a level less than the action limit, but greater than the CRQL.
- F08 Concentration of the contaminant was detected at a level that exceeds the action level.
- F09 No laboratory blanks were analyzed.
- F10 Blank had a negative value $>2x$'s the IDL.
- F11 Blanks were not analyzed at required frequency.
- F12 Professional judgment was used to qualify the data.

Surrogate/Radiological Chemical Recovery

- G01 Surrogate/radiological chemical recovery was above the upper control limit.
- G02 Surrogate/radiological chemical recovery was below the lower control limit.
- G03 Surrogate recovery was <10%.
- G04 Surrogate/radiological chemical recovery was zero.
- G05 Surrogate/radiological chemical recovery was not present.
- G06 Professional judgment was used to qualify the data.
- G07 Radiological chemical recovery was <20%.
- G08 Radiological chemical recovery was >150%.

Matrix Spike/Matrix Spike Duplicate

- H01 MS/MSD recovery was above the upper control limit.
- H02 MS/MSD recovery was below the lower control limit.
- H03 MS/MSD recovery was <10%.
- H04 MS/MSD pairs exceed the RPD limit.
- H05 No action was taken on MS/MSD results.
- H06 Professional judgment was used to qualify the data.
- H07 Radiological MS/MSD recovery was <20%.
- H08 Radiological MS/MSD recovery was >160%.
- H09 Radiological MS/MSD samples were not analyzed at the required frequency.

Laboratory Duplicate

- J01 Duplicate RPD/normalized absolute difference (NAD) was outside the control limit.
- J02 Duplicate sample results were >5x the CRDL.
- J03 Duplicate sample results were <5x the CRDL.
- J04 Professional judgment was used to qualify the data.
- J05 Duplicate was not analyzed at the required frequency.

Target Compound Identification

- M01 Incorrect identifications were made.
- M02 Qualitative criteria were not met.
- M03 Cross contamination occurred.
- M04 Confirmatory analysis was not performed.
- M05 No results were provided.
- M06 Analysis occurred outside 12 hr GC/MS window.
- M07 Professional judgment was used to qualify the data.
- M08 The %D between the two pesticide/PCB column checks was >25%.

Laboratory Control Samples (LCSs)

- P01 LCS recovery was above upper control limit.
- P02 LCS recovery was below lower control limit.
- P03 LCS recovery was <50%.
- P04 No action was taken on the LCS data.
- P05 LCS was not analyzed at required frequency.
- P06 Radiological LCS recovery was <50% for aqueous samples; <40% for solid samples.
- P07 Radiological LCS recovery was >150% for aqueous samples; >160% for solid samples.
- P08 Professional judgment was used to qualify the data.

Field Duplicate

- Q01 No action was taken on the basis of field duplicate RPDs.
- Q02 Radiological field duplicate normalized absolute difference (NAD) was outside the control limit.
- Q03 Duplicate sample results were >5x the CRDL.
- Q04 Duplicate sample results were <5x the CRDL.

Radiological Calibration

- R01 Efficiency calibration criteria were not met.
- R02 Energy calibration criteria were not met.
- R03 Resolution calibration criteria were not met
- R04 Background determination criteria were not met.
- R05 Quench curve criteria were not met.
- R06 Absorption curve criteria were not met.
- R07 Plateau curve criteria were not met.
- R08 Professional judgment was used to qualify the data.

Radiological Calibration Verification

- S01 Efficiency verification criteria were not met.
- S02 Energy verification criteria were not met.
- S03 Resolution verification criteria were not met
- S04 Background verification criteria were not met.
- S05 Cross-talk verification criteria were not met.
- S06 Professional judgment was used to qualify the data.

Radionuclide Quantitation

- T01 Detection limits were not met.
- T02 Analytical uncertainties were not met and/or not reported.
- T03 Inappropriate aliquot sizes were used.
- T04 Professional judgment was used to qualify the data.
- T05 Analytical result is less than the associated MDA, but greater than the counting uncertainty.
- T06 Analytical result is less than both the associated counting uncertainty and MDA.
- T07 Negative analytical result where the absolute value exceeds 2x the associated MDA.

System Performance

- V01 High background levels or a shift in the energy calibration were observed.
- V02 Extraneous peaks were observed.
- V03 Loss of resolution was observed.
- V04 Peak-tailing or peak splitting that may result in inaccurate quantitation were observed.
- V05 Professional judgment was used to qualify the data.

DATA VALIDATION REPORT

Date:

November 17, 2003

<i>To:</i> Steve Passig	<i>From:</i> Carol Johnson
<i>Laboratory:</i> Severn Trent – St. Louis	<i>SDG #:</i> F3J140135

Attached you will find the results from the data validation technical review for the Westinghouse/Hematite samples and analyses that are associated with the above referenced laboratory and sample delivery group (SDG) number. These data points have been selected for data validation and the sample index on the following page specifically identifies the samples and analyses associated with this validation review.

The Westinghouse/Hematite validation technical review was performed in accordance with the *Contract Laboratory Program Data Validation Functional Guidelines for Evaluating Inorganic Analytical Data*, and the *Laboratory Data Validation Guidelines for Evaluating Radionuclide Analyses and Radiochemical Data Verification and Validation*. It was based on the information and documentation supplied by the associated laboratory. The analyses were evaluated against criteria established in the related analytical procedures and the Westinghouse/Hematite data quality requirements.

Attachment A to this report provides the Sample Data Summary Sheets for the samples associated with the above referenced request. These summary sheets identify the analytical values and the qualifiers for each sample and parameter. Attachment B outlines the validation qualifiers and reason codes used in the validation of the data.

Report Summary	
Total Number of Samples	11
Total Number of Data Points	24
Total Number of Rejected Data Points	0
Percent Completeness (approval to rejection ratio)	100.0%

Sample Index

Date:

November 17 2003

Laboratory:

Severn Trent - St. Louis

SDG #:

F3J140135

WESTINGHOUSE Sample ID	Target Analyses
BHKD4-14	Total Uranium, Technetium-99, pH
BHKD6-01	Total Uranium, Technetium-99, pH
BHKD1-04	Total Uranium, pH
BHKD1-23	Total Uranium, pH
BHKD1-28	Total Uranium, pH
BHKD3-16	Total Uranium, pH
BHKD3-23	Total Uranium, pH
BHKD4-02	Total Uranium, pH
BHKD4-24	Total Uranium, pH
BHKD6-11	Total Uranium, pH
BHKD6-26	Total Uranium, pH

ANALYTICAL CATEGORY: Miscellaneous

- pH was determined by SW846 Method 9045A.

1. The following items (as applicable) have been addressed during the validation review:

- sample custody, integrity & preservation
- sample handling & preparation
- holding times
- instrument calibration & performance
- dilution factors
- detection limits
- laboratory background & carry-over
- overall appearance of the data
- Quality Control:
 - calibration checks & blanks
 - laboratory blanks (method, TCLP)
 - laboratory control samples
 - matrix spike samples
 - matrix duplicates
 - field blanks (if available)
 - field duplicates (if available)

2. The above items were found to be acceptable, except as follows:

- none

3. Additional comments:

- none

ANALYTICAL CATEGORY: Radiochemical

- Total Uranium was determined by Laser Phosphorimetry Method ASTM 5174-91, Technetium was determined by Liquid scintillation counters (DOE TC-02-RC).
1. The following items (as applicable) have been addressed during the validation review:
 - sample custody, integrity & preservation
 - sample handling & preparation
 - holding times
 - instrument calibration & performance
 - dilution factors
 - detection limits
 - laboratory background & carry-over
 - overall appearance of the data
 - Quality Control:
 - calibration checks & background
 - preparation blanks
 - laboratory control samples
 - field blanks (if available)
 - field duplicates (if available)
 2. The above items were found to be acceptable, except as follows:

None
 3. Additional comments:

None

ATTACHMENT A

WESTINGHOUSE Sample Data Summary Sheets

ATTACHMENT B

KEY TO THE WESTINGHOUSE DATA VALIDATION QUALIFIERS

QUALIFIERS	
=	Indicates that the data met all QA/QC requirements, and that the parameter has been positively identified and the associated concentration value is accurate.
U	Indicates that the data met all QA/QC requirements, and that the parameter was analyzed for but was not detected above the reported sample quantitation limit.
J	Indicates that the parameter was positively identified; the associated numerical value is the approximate concentration of the parameter in the sample.
UJ	Indicates that the parameter was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
N	The analysis indicates the presence of a parameter for which there is presumptive evidence to make a "tentative identification."
R	Indicates that the sample results for the parameter are rejected or unusable due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the parameter cannot be verified.

Data Validation Reason Codes

Holding Times

- A01 Extraction holding times were exceeded.
- A02 Extraction holding times were grossly exceeded.
- A03 Analysis holding times were exceeded.
- A04 Analysis holding times were grossly exceeded.
- A05 Samples were not preserved properly.
- A06 Professional judgment was used to qualify the data.

GC/MS Tuning

- B01 Mass calibration was in error, even after applying expanded criteria.
- B02 Mass calibration was not performed every 12 hours.
- B03 Mass calibration did not meet ion abundance.
- B04 Professional judgment was used to qualify the data.

Initial/Continuing Calibration – Organics

- C01 Initial calibration RRF was <0.05 .
- C02 Initial calibration RSD was $>30\%$.
- C03 Initial calibration sequence was not followed as required.
- C04 Continuing calibration RRF was <0.05 .
- C05 Continuing calibration %D was $>25\%$.
- C06 Continuing calibration was not performed at the required frequency.
- C07 Resolution criteria were not met.
- C08 RPD criteria were not met.
- C09 RSD criteria were not met.
- C10 Retention time of compounds was outside windows.
- C11 Compounds were not adequately resolved.
- C12 Breakdown of endrin or DDT was $>20\%$.
- C13 Combined breakdown of endrin/DDT was $>30\%$.
- C14 Professional judgment was used to qualify the data.

Blanks

- F01 Sample data were qualified as a result of the method blank.
- F02 Sample data were qualified as a result of the field blank.
- F03 Sample data were qualified as a result of the equipment rinsate.
- F04 Sample data were qualified as a result of the trip blank.
- F05 Gross contamination exists.
- F06 Concentration of the contaminant was detected at a level below the CRQL.
- F07 Concentration of the contaminant was detected at a level less than the action limit, but greater than the CRQL.
- F08 Concentration of the contaminant was detected at a level that exceeds the action level.
- F09 No laboratory blanks were analyzed.
- F10 Blank had a negative value $>2x$'s the IDL.
- F11 Blanks were not analyzed at required frequency.
- F12 Professional judgment was used to qualify the data.

Surrogate/Radiological Chemical Recovery

- G01 Surrogate/radiological chemical recovery was above the upper control limit.
- G02 Surrogate/radiological chemical recovery was below the lower control limit.
- G03 Surrogate recovery was <10%.
- G04 Surrogate/radiological chemical recovery was zero.
- G05 Surrogate/radiological chemical recovery was not present.
- G06 Professional judgment was used to qualify the data.
- G07 Radiological chemical recovery was <20%.
- G08 Radiological chemical recovery was >150%.

Matrix Spike/Matrix Spike Duplicate

- H01 MS/MSD recovery was above the upper control limit.
- H02 MS/MSD recovery was below the lower control limit.
- H03 MS/MSD recovery was <10%.
- H04 MS/MSD pairs exceed the RPD limit.
- H05 No action was taken on MS/MSD results.
- H06 Professional judgment was used to qualify the data.
- H07 Radiological MS/MSD recovery was <20%.
- H08 Radiological MS/MSD recovery was >160%.
- H09 Radiological MS/MSD samples were not analyzed at the required frequency.

Laboratory Duplicate

- J01 Duplicate RPD/normalized absolute difference (NAD) was outside the control limit.
- J02 Duplicate sample results were >5x the CRDL.
- J03 Duplicate sample results were <5x the CRDL.
- J04 Professional judgment was used to qualify the data.
- J05 Duplicate was not analyzed at the required frequency.

Target Compound Identification

- M01 Incorrect identifications were made.
- M02 Qualitative criteria were not met.
- M03 Cross contamination occurred.
- M04 Confirmatory analysis was not performed.
- M05 No results were provided.
- M06 Analysis occurred outside 12 hr GC/MS window.
- M07 Professional judgment was used to qualify the data.
- M08 The %D between the two pesticide/PCB column checks was >25%.

Laboratory Control Samples (LCSs)

- P01 LCS recovery was above upper control limit.
- P02 LCS recovery was below lower control limit.
- P03 LCS recovery was <50%.
- P04 No action was taken on the LCS data.
- P05 LCS was not analyzed at required frequency.
- P06 Radiological LCS recovery was <50% for aqueous samples; <40% for solid samples.
- P07 Radiological LCS recovery was >150% for aqueous samples; >160% for solid samples.
- P08 Professional judgment was used to qualify the data.

Field Duplicate

- Q01 No action was taken on the basis of field duplicate RPDs.
- Q02 Radiological field duplicate normalized absolute difference (NAD) was outside the control limit.
- Q03 Duplicate sample results were >5x the CRDL.
- Q04 Duplicate sample results were <5x the CRDL.

Radiological Calibration

- R01 Efficiency calibration criteria were not met.
- R02 Energy calibration criteria were not met.
- R03 Resolution calibration criteria were not met
- R04 Background determination criteria were not met.
- R05 Quench curve criteria were not met.
- R06 Absorption curve criteria were not met.
- R07 Plateau curve criteria were not met.
- R08 Professional judgment was used to qualify the data.

Radiological Calibration Verification

- S01 Efficiency verification criteria were not met.
- S02 Energy verification criteria were not met.
- S03 Resolution verification criteria were not met
- S04 Background verification criteria were not met.
- S05 Cross-talk verification criteria were not met.
- S06 Professional judgment was used to qualify the data.

Radionuclide Quantitation

- T01 Detection limits were not met.
- T02 Analytical uncertainties were not met and/or not reported.
- T03 Inappropriate aliquot sizes were used.
- T04 Professional judgment was used to qualify the data.
- T05 Analytical result is less than the associated MDA, but greater than the counting uncertainty.
- T06 Analytical result is less than both the associated counting uncertainty and MDA.
- T07 Negative analytical result where the absolute value exceeds 2x the associated MDA.

System Performance

- V01 High background levels or a shift in the energy calibration were observed.
- V02 Extraneous peaks were observed.
- V03 Loss of resolution was observed.
- V04 Peak-tailing or peak splitting that may result in inaccurate quantitation were observed.
- V05 Professional judgment was used to qualify the data.

DATA VALIDATION REPORT

Date:

November 17, 2003

To: Steve Passig	From: Carol Johnson
Laboratory: Severn Trent – St. Louis	SDG #: F3J140140

Attached you will find the results from the data validation technical review for the Westinghouse/Hematite samples and analyses that are associated with the above referenced laboratory and sample delivery group (SDG) number. These data points have been selected for data validation and the sample index on the following page specifically identifies the samples and analyses associated with this validation review.

The Westinghouse/Hematite validation technical review was performed in accordance with the *Contract Laboratory Program Data Validation Functional Guidelines for Evaluating Inorganic Analytical Data*, and the *Laboratory Data Validation Guidelines for Evaluating Radionuclide Analyses and Radiochemical Data Verification and Validation*. It was based on the information and documentation supplied by the associated laboratory. The analyses were evaluated against criteria established in the related analytical procedures and the Westinghouse/Hematite data quality requirements.

Attachment A to this report provides the Sample Data Summary Sheets for the samples associated with the above referenced request. These summary sheets identify the analytical values and the qualifiers for each sample and parameter. Attachment B outlines the validation qualifiers and reason codes used in the validation of the data.

Report Summary	
Total Number of Samples	11
Total Number of Data Points	24
Total Number of Rejected Data Points	0
Percent Completeness (approval to rejection ratio)	100.0%

Sample Index

Date:

November 17 2003

Laboratory:

Severn Trent - St. Louis

SDG #:

F3J140140

WESTINGHOUSE Sample ID	Target Analyses
BHKD4-14	Total Uranium, Technetium-99, pH
BHKD6-01	Total Uranium, Technetium-99, pH
BHKD1-04	Total Uranium, pH
BHKD1-23	Total Uranium, pH
BHKD1-28	Total Uranium, pH
BHKD3-16	Total Uranium, pH
BHKD3-23	Total Uranium, pH
BHKD4-02	Total Uranium, pH
BHKD4-24	Total Uranium, pH
BHKD6-11	Total Uranium, pH
BHKD6-26	Total Uranium, pH

ANALYTICAL CATEGORY: Miscellaneous

- pH was determined by SW846 Method 9045A.

1. The following items (as applicable) have been addressed during the validation review:

- sample custody, integrity & preservation
- sample handling & preparation
- holding times
- instrument calibration & performance
- dilution factors
- detection limits
- laboratory background & carry-over
- overall appearance of the data
- Quality Control:
 - calibration checks & blanks
 - laboratory blanks (method, TCLP)
 - laboratory control samples
 - matrix spike samples
 - matrix duplicates
 - field blanks (if available)
 - field duplicates (if available)

2. The above items were found to be acceptable, except as follows:

- none

3. Additional comments:

- none

ANALYTICAL CATEGORY: Radiochemical

- Total Uranium was determined by Laser Phosphorimetry Method ASTM 5174-91, Technetium was determined by Liquid scintillation counters (DOE TC-02-RC)

1. The following items (as applicable) have been addressed during the validation review:

- sample custody, integrity & preservation
- sample handling & preparation
- holding times
- instrument calibration & performance
- dilution factors
- detection limits
- laboratory background & carry-over
- overall appearance of the data
- Quality Control:
 - calibration checks & background
 - preparation blanks
 - laboratory control samples
 - field blanks (if available)
 - field duplicates (if available)

2. The above items were found to be acceptable, except as follows:

None

3. Additional comments:

None

ATTACHMENT A

WESTINGHOUSE Sample Data Summary Sheets

ATTACHMENT B

KEY TO THE WESTINGHOUSE DATA VALIDATION QUALIFIERS

QUALIFIERS	
=	Indicates that the data met all QA/QC requirements, and that the parameter has been positively identified and the associated concentration value is accurate.
U	Indicates that the data met all QA/QC requirements, and that the parameter was analyzed for but was not detected above the reported sample quantitation limit.
J	Indicates that the parameter was positively identified; the associated numerical value is the approximate concentration of the parameter in the sample.
UJ	Indicates that the parameter was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
N	The analysis indicates the presence of a parameter for which there is presumptive evidence to make a "tentative identification."
R	Indicates that the sample results for the parameter are rejected or unusable due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the parameter cannot be verified.

Data Validation Reason Codes

Holding Times

- A01 Extraction holding times were exceeded.
- A02 Extraction holding times were grossly exceeded.
- A03 Analysis holding times were exceeded.
- A04 Analysis holding times were grossly exceeded.
- A05 Samples were not preserved properly.
- A06 Professional judgment was used to qualify the data.

GC/MS Tuning

- B01 Mass calibration was in error, even after applying expanded criteria.
- B02 Mass calibration was not performed every 12 hours.
- B03 Mass calibration did not meet ion abundance.
- B04 Professional judgment was used to qualify the data.

Initial/Continuing Calibration – Organics

- C01 Initial calibration RRF was <0.05.
- C02 Initial calibration RSD was >30%.
- C03 Initial calibration sequence was not followed as required.
- C04 Continuing calibration RRF was <0.05.
- C05 Continuing calibration %D was >25%.
- C06 Continuing calibration was not performed at the required frequency.
- C07 Resolution criteria were not met.
- C08 RPD criteria were not met.
- C09 RSD criteria were not met.
- C10 Retention time of compounds was outside windows.
- C11 Compounds were not adequately resolved.
- C12 Breakdown of endrin or DDT was >20%.
- C13 Combined breakdown of endrin/DDT was >30%.
- C14 Professional judgment was used to qualify the data.

Blanks

- F01 Sample data were qualified as a result of the method blank.
- F02 Sample data were qualified as a result of the field blank.
- F03 Sample data were qualified as a result of the equipment rinsate.
- F04 Sample data were qualified as a result of the trip blank.
- F05 Gross contamination exists.
- F06 Concentration of the contaminant was detected at a level below the CRQL.
- F07 Concentration of the contaminant was detected at a level less than the action limit, but greater than the CRQL.
- F08 Concentration of the contaminant was detected at a level that exceeds the action level.
- F09 No laboratory blanks were analyzed.
- F10 Blank had a negative value >2x's the IDL.
- F11 Blanks were not analyzed at required frequency.
- F12 Professional judgment was used to qualify the data.

Surrogate/Radiological Chemical Recovery

- G01 Surrogate/radiological chemical recovery was above the upper control limit.
- G02 Surrogate/radiological chemical recovery was below the lower control limit.
- G03 Surrogate recovery was <10%.
- G04 Surrogate/radiological chemical recovery was zero.
- G05 Surrogate/radiological chemical recovery was not present.
- G06 Professional judgment was used to qualify the data.
- G07 Radiological chemical recovery was <20%.
- G08 Radiological chemical recovery was >150%.

Matrix Spike/Matrix Spike Duplicate

- H01 MS/MSD recovery was above the upper control limit.
- H02 MS/MSD recovery was below the lower control limit.
- H03 MS/MSD recovery was <10%.
- H04 MS/MSD pairs exceed the RPD limit.
- H05 No action was taken on MS/MSD results.
- H06 Professional judgment was used to qualify the data.
- H07 Radiological MS/MSD recovery was <20%.
- H08 Radiological MS/MSD recovery was >160%.
- H09 Radiological MS/MSD samples were not analyzed at the required frequency.

Laboratory Duplicate

- J01 Duplicate RPD/normalized absolute difference (NAD) was outside the control limit.
- J02 Duplicate sample results were >5x the CRDL.
- J03 Duplicate sample results were <5x the CRDL.
- J04 Professional judgment was used to qualify the data.
- J05 Duplicate was not analyzed at the required frequency.

Target Compound Identification

- M01 Incorrect identifications were made.
- M02 Qualitative criteria were not met.
- M03 Cross contamination occurred.
- M04 Confirmatory analysis was not performed.
- M05 No results were provided.
- M06 Analysis occurred outside 12 hr GC/MS window.
- M07 Professional judgment was used to qualify the data.
- M08 The %D between the two pesticide/PCB column checks was >25%.

Laboratory Control Samples (LCSs)

- P01 LCS recovery was above upper control limit.
- P02 LCS recovery was below lower control limit.
- P03 LCS recovery was <50%.
- P04 No action was taken on the LCS data.
- P05 LCS was not analyzed at required frequency.
- P06 Radiological LCS recovery was <50% for aqueous samples; <40% for solid samples.
- P07 Radiological LCS recovery was >150% for aqueous samples; >160% for solid samples.
- P08 Professional judgment was used to qualify the data.

Field Duplicate

- Q01 No action was taken on the basis of field duplicate RPDs.
- Q02 Radiological field duplicate normalized absolute difference (NAD) was outside the control limit.
- Q03 Duplicate sample results were >5x the CRDL.
- Q04 Duplicate sample results were <5x the CRDL.

Radiological Calibration

- R01 Efficiency calibration criteria were not met.
- R02 Energy calibration criteria were not met.
- R03 Resolution calibration criteria were not met.
- R04 Background determination criteria were not met.
- R05 Quench curve criteria were not met.
- R06 Absorption curve criteria were not met.
- R07 Plateau curve criteria were not met.
- R08 Professional judgment was used to qualify the data.

Radiological Calibration Verification

- S01 Efficiency verification criteria were not met.
- S02 Energy verification criteria were not met.
- S03 Resolution verification criteria were not met.
- S04 Background verification criteria were not met.
- S05 Cross-talk verification criteria were not met.
- S06 Professional judgment was used to qualify the data.

Radionuclide Quantitation

- T01 Detection limits were not met.
- T02 Analytical uncertainties were not met and/or not reported.
- T03 Inappropriate aliquot sizes were used.
- T04 Professional judgment was used to qualify the data.
- T05 Analytical result is less than the associated MDA, but greater than the counting uncertainty.
- T06 Analytical result is less than both the associated counting uncertainty and MDA.
- T07 Negative analytical result where the absolute value exceeds 2x the associated MDA.

System Performance

- V01 High background levels or a shift in the energy calibration were observed.
- V02 Extraneous peaks were observed.
- V03 Loss of resolution was observed.
- V04 Peak-tailing or peak splitting that may result in inaccurate quantitation were observed.
- V05 Professional judgment was used to qualify the data.

DATA VALIDATION REPORT

Date:

November 17, 2003

To: Steve Passig	From: Carol Johnson
Laboratory: Severn Trent – St. Louis	SDG #: F3K060101

Attached you will find the results from the data validation technical review for the Westinghouse/Hematite samples and analyses that are associated with the above referenced laboratory and sample delivery group (SDG) number. These data points have been selected for data validation and the sample index on the following page specifically identifies the samples and analyses associated with this validation review.

The Westinghouse/Hematite validation technical review was performed in accordance with the *Contract Laboratory Program Data Validation Functional Guidelines for Evaluating Inorganic Analytical Data*, and the *Laboratory Data Validation Guidelines for Evaluating Radionuclide Analyses and Radiochemical Data Verification and Validation*. It was based on the information and documentation supplied by the associated laboratory. The analyses were evaluated against criteria established in the related analytical procedures and the Westinghouse/Hematite data quality requirements.

Attachment A to this report provides the Sample Data Summary Sheets for the samples associated with the above referenced request. These summary sheets identify the analytical values and the qualifiers for each sample and parameter. Attachment B outlines the validation qualifiers and reason codes used in the validation of the data.

Report Summary	
Total Number of Samples	36
Total Number of Data Points	36
Total Number of Rejected Data Points	0
Percent Completeness (approval to rejection ratio)	100.0%

Sample Index

Date:

November 17, 2003

Laboratory:

Severn Trent – St. Louis

SDG #:

F3K060101

WESTINGHOUSE Sample ID	Target Analyses
BHKD1-04 DAY 3	Technetium-99
BHKD1-23 DAY 3	Technetium-99
BHKD1-28 DAY 3	Technetium-99
BHKD3-16 DAY 3	Technetium-99
BHKD3-23 DAY 3	Technetium-99
BHKD4-02 DAY 3	Technetium-99
BHKD4-24 DAY 3	Technetium-99
BHKD6-11 DAY 3	Technetium-99
BHKD6-26 DAY3	Technetium-99
BHKD1-04 DAY 7	Technetium-99
BHKD1-23 DAY 7	Technetium-99
BHKD1-28 DAY 7	Technetium-99
BHKD3-16 DAY 7	Technetium-99
BHKD3-23 DAY 7	Technetium-99
BHKD4-02 DAY 7	Technetium-99
BHKD4-24 DAY 7	Technetium-99
BHKD6-11 DAY 7	Technetium-99

WESTINGHOUSE Sample ID	Target Analyses
BHKD6-26 DAY 7	Technetium-99
BHKD1-04 DAY 10	Technetium-99
BHKD1-23 DAY 10	Technetium-99
BHKD1-28 DAY 10	Technetium-99
BHKD3-16 DAY 10	Technetium-99
BHKD3-23 DAY 10	Technetium-99
BHKD4-02 DAY 10	Technetium-99
BHKD4-24 DAY 10	Technetium-99
BHKD6-11 DAY 10	Technetium-99
BHKD6-26 DAY 10	Technetium-99
BHKD1-04 DAY 14	Technetium-99
BHKD6-26 DAY 14	Technetium-99
BHKD1-23 DAY 14	Technetium-99
BHKD1-28 DAY 14	Technetium-99
BHKD3-16 DAY 14	Technetium-99
BHKD3-23 DAY 14	Technetium-99
BHKD4-02 DAY 14	Technetium-99
BHKD4-24 DAY 14	Technetium-99
BHKD6-11 DAY 14	Technetium-99

ANALYTICAL CATEGORY: Radiochemical

- Technetium was determined by Liquid scintillation counters (DOE TC-02-RC)
1. The following items (as applicable) have been addressed during the validation review:
 - sample custody, integrity & preservation
 - sample handling & preparation
 - holding times
 - instrument calibration & performance
 - dilution factors
 - detection limits
 - laboratory background & carry-over
 - overall appearance of the data
 - Quality Control:
 - calibration checks & background
 - preparation blanks
 - laboratory control samples
 - field blanks (if available)
 - field duplicates (if available)
 2. The above items were found to be acceptable, except as follows:

None
 3. Additional comments:

None

ATTACHMENT A

WESTINGHOUSE Sample Data Summary Sheets

ATTACHMENT B

KEY TO THE WESTINGHOUSE DATA VALIDATION QUALIFIERS

QUALIFIERS	
=	Indicates that the data met all QA/QC requirements, and that the parameter has been positively identified and the associated concentration value is accurate.
U	Indicates that the data met all QA/QC requirements, and that the parameter was analyzed for but was not detected above the reported sample quantitation limit.
J	Indicates that the parameter was positively identified; the associated numerical value is the approximate concentration of the parameter in the sample.
UJ	Indicates that the parameter was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
N	The analysis indicates the presence of a parameter for which there is presumptive evidence to make a "tentative identification."
R	Indicates that the sample results for the parameter are rejected or unusable due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the parameter cannot be verified.

Data Validation Reason Codes

Holding Times

- A01 Extraction holding times were exceeded.
- A02 Extraction holding times were grossly exceeded.
- A03 Analysis holding times were exceeded.
- A04 Analysis holding times were grossly exceeded.
- A05 Samples were not preserved properly.
- A06 Professional judgment was used to qualify the data.

GC/MS Tuning

- B01 Mass calibration was in error, even after applying expanded criteria.
- B02 Mass calibration was not performed every 12 hours.
- B03 Mass calibration did not meet ion abundance.
- B04 Professional judgment was used to qualify the data.

Initial/Continuing Calibration – Organics

- C01 Initial calibration RRF was <0.05.
- C02 Initial calibration RSD was >30%.
- C03 Initial calibration sequence was not followed as required.
- C04 Continuing calibration RRF was <0.05.
- C05 Continuing calibration %D was >25%.
- C06 Continuing calibration was not performed at the required frequency.
- C07 Resolution criteria were not met.
- C08 RPD criteria were not met.
- C09 RSD criteria were not met.
- C10 Retention time of compounds was outside windows.
- C11 Compounds were not adequately resolved.
- C12 Breakdown of endrin or DDT was >20%.
- C13 Combined breakdown of endrin/DDT was >30%.
- C14 Professional judgment was used to qualify the data.

Blanks

- F01 Sample data were qualified as a result of the method blank.
- F02 Sample data were qualified as a result of the field blank.
- F03 Sample data were qualified as a result of the equipment rinsate.
- F04 Sample data were qualified as a result of the trip blank.
- F05 Gross contamination exists.
- F06 Concentration of the contaminant was detected at a level below the CRQL.
- F07 Concentration of the contaminant was detected at a level less than the action limit, but greater than the CRQL.
- F08 Concentration of the contaminant was detected at a level that exceeds the action level.
- F09 No laboratory blanks were analyzed.
- F10 Blank had a negative value >2x's the IDL.
- F11 Blanks were not analyzed at required frequency.
- F12 Professional judgment was used to qualify the data.

Surrogate/Radiological Chemical Recovery

- G01 Surrogate/radiological chemical recovery was above the upper control limit.
- G02 Surrogate/radiological chemical recovery was below the lower control limit.
- G03 Surrogate recovery was <10%.
- G04 Surrogate/radiological chemical recovery was zero.
- G05 Surrogate/radiological chemical recovery was not present.
- G06 Professional judgment was used to qualify the data.
- G07 Radiological chemical recovery was <20%.
- G08 Radiological chemical recovery was >150%.

Matrix Spike/Matrix Spike Duplicate

- H01 MS/MSD recovery was above the upper control limit.
- H02 MS/MSD recovery was below the lower control limit.
- H03 MS/MSD recovery was <10%.
- H04 MS/MSD pairs exceed the RPD limit.
- H05 No action was taken on MS/MSD results.
- H06 Professional judgment was used to qualify the data.
- H07 Radiological MS/MSD recovery was <20%.
- H08 Radiological MS/MSD recovery was >160%.
- H09 Radiological MS/MSD samples were not analyzed at the required frequency.

Laboratory Duplicate

- J01 Duplicate RPD/normalized absolute difference (NAD) was outside the control limit.
- J02 Duplicate sample results were >5x the CRDL.
- J03 Duplicate sample results were <5x the CRDL.
- J04 Professional judgment was used to qualify the data.
- J05 Duplicate was not analyzed at the required frequency.

Target Compound Identification

- M01 Incorrect identifications were made.
- M02 Qualitative criteria were not met.
- M03 Cross contamination occurred.
- M04 Confirmatory analysis was not performed.
- M05 No results were provided.
- M06 Analysis occurred outside 12 hr GC/MS window.
- M07 Professional judgment was used to qualify the data.
- M08 The %D between the two pesticide/PCB column checks was >25%.

Laboratory Control Samples (LCSs)

- P01 LCS recovery was above upper control limit.
- P02 LCS recovery was below lower control limit.
- P03 LCS recovery was <50%.
- P04 No action was taken on the LCS data.
- P05 LCS was not analyzed at required frequency.
- P06 Radiological LCS recovery was <50% for aqueous samples; <40% for solid samples.
- P07 Radiological LCS recovery was >150% for aqueous samples; >160% for solid samples.
- P08 Professional judgment was used to qualify the data.

Field Duplicate

- Q01 No action was taken on the basis of field duplicate RPDs.
- Q02 Radiological field duplicate normalized absolute difference (NAD) was outside the control limit.
- Q03 Duplicate sample results were >5x the CRDL.
- Q04 Duplicate sample results were <5x the CRDL.

Radiological Calibration

- R01 Efficiency calibration criteria were not met.
- R02 Energy calibration criteria were not met.
- R03 Resolution calibration criteria were not met
- R04 Background determination criteria were not met.
- R05 Quench curve criteria were not met.
- R06 Absorption curve criteria were not met.
- R07 Plateau curve criteria were not met.
- R08 Professional judgment was used to qualify the data.

Radiological Calibration Verification

- S01 Efficiency verification criteria were not met.
- S02 Energy verification criteria were not met.
- S03 Resolution verification criteria were not met
- S04 Background verification criteria were not met.
- S05 Cross-talk verification criteria were not met.
- S06 Professional judgment was used to qualify the data.

Radionuclide Quantitation

- T01 Detection limits were not met.
- T02 Analytical uncertainties were not met and/or not reported.
- T03 Inappropriate aliquot sizes were used.
- T04 Professional judgment was used to qualify the data.
- T05 Analytical result is less than the associated MDA, but greater than the counting uncertainty.
- T06 Analytical result is less than both the associated counting uncertainty and MDA.
- T07 Negative analytical result where the absolute value exceeds 2x the associated MDA.

System Performance

- V01 High background levels or a shift in the energy calibration were observed.
- V02 Extraneous peaks were observed.
- V03 Loss of resolution was observed.
- V04 Peak-tailing or peak splitting that may result in inaccurate quantitation were observed.
- V05 Professional judgment was used to qualify the data.

DATA VALIDATION REPORT

Date:

November 29, 2003

To:

Steve Passig

From:

Carol Johnson

Laboratory:

Severn Trent – St. Louis

SDG #:

F3K180313

Attached you will find the results from the data validation technical review for the Westinghouse/Hematite samples and analyses that are associated with the above referenced laboratory and sample delivery group (SDG) number. These data points have been selected for data validation and the sample index on the following page specifically identifies the samples and analyses associated with this validation review.

The Westinghouse/Hematite validation technical review was performed in accordance with the *Contract Laboratory Program Data Validation Functional Guidelines for Evaluating Inorganic Analytical Data*, and the *Laboratory Data Validation Guidelines for Evaluating Radionuclide Analyses and Radiochemical Data Verification and Validation*. It was based on the information and documentation supplied by the associated laboratory. The analyses were evaluated against criteria established in the related analytical procedures and the Westinghouse/Hematite data quality requirements.

Attachment A to this report provides the Sample Data Summary Sheets for the samples associated with the above referenced request. These summary sheets identify the analytical values and the qualifiers for each sample and parameter. Attachment B outlines the validation qualifiers and reason codes used in the validation of the data.

Report Summary	
Total Number of Samples	11
Total Number of Data Points	44
Total Number of Rejected Data Points	0
Percent Completeness (Approval to rejection ratio)	100.0%

Sample Index

Date:

November 29, 2003

Laboratory:

Severn Trent – St. Louis

SDG #:

F3K180313

WESTINGHOUSE Sample ID	Target Analyses
BHKD4-15	Isotopic Uranium, Technetium-99
BHKD6-01	Isotopic Uranium, Technetium-99
BHKD1-04	Isotopic Uranium, Technetium-99
BHKD1-23	Isotopic Uranium, Technetium-99
BHKD2-28	Isotopic Uranium, Technetium-99
BHKD3-16	Isotopic Uranium, Technetium-99
BHKD3-23	Isotopic Uranium, Technetium-99
BHKD4-02	Isotopic Uranium, Technetium-99
BHKD4-24	Isotopic Uranium, Technetium-99
BHKD6-11	Isotopic Uranium, Technetium-99
BHKD6-26	Isotopic Uranium, Technetium-99

ANALYTICAL CATEGORY: Radiochemical

- Isotopic uranium was determined by alpha spectroscopy (NAS/DOE 3050/RP), and technetium was determined by Liquid scintillation counters (DOE TC-02-RC), and Laser Phosphorimetry Method ASTM 5174-91 determined Total Uranium.

1. The following items (as applicable) have been addressed during the validation review:

- | | |
|--|-----------------------------------|
| ○ sample custody, integrity & preservation | Quality Control: |
| ○ sample handling & preparation | ◦ calibration checks & background |
| ○ holding times | ◦ preparation blanks |
| ○ instrument calibration & performance | ◦ laboratory control samples |
| ○ dilution factors | ◦ field blanks (if available) |
| ○ detection limits | field duplicates (if available) |
| ○ laboratory background & carry-over | |
| ○ overall appearance of the data | |

2. Additional comments:

- Total Uranium analysis was performed for spiking purposes only.

ATTACHMENT A

WESTINGHOUSE Sample Data Summary Sheets

ATTACHMENT B

KEY TO THE WESTINGHOUSE DATA VALIDATION QUALIFIERS

QUALIFIERS	
=	Indicates that the data met all QA/QC requirements, and that the parameter has been positively identified and the associated concentration value is accurate.
U	Indicates that the data met all QA/QC requirements, and that the parameter was analyzed for but was not detected above the reported sample quantitation limit.
J	Indicates that the parameter was positively identified; the associated numerical value is the approximate concentration of the parameter in the sample.
UJ	Indicates that the parameter was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
N	The analysis indicates the presence of a parameter for which there is presumptive evidence to make a "tentative identification."
R	Indicates that the sample results for the parameter are rejected or unusable due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the parameter cannot be verified.

Data Validation Reason Codes

Holding Times

- A01 Extraction holding times were exceeded.
- A02 Extraction holding times were grossly exceeded.
- A03 Analysis holding times were exceeded.
- A04 Analysis holding times were grossly exceeded.
- A05 Samples were not preserved properly.
- A06 Professional judgment was used to qualify the data.

GC/MS Tuning

- B01 Mass calibration was in error, even after applying expanded criteria.
- B02 Mass calibration was not performed every 12 hours.
- B03 Mass calibration did not meet ion abundance.
- B04 Professional judgment was used to qualify the data.

Initial/Continuing Calibration – Organics

- C01 Initial calibration RRF was <0.05 .
- C02 Initial calibration RSD was $>30\%$.
- C03 Initial calibration sequence was not followed as required.
- C04 Continuing calibration RRF was <0.05 .
- C05 Continuing calibration %D was $>25\%$.
- C06 Continuing calibration was not performed at the required frequency.
- C07 Resolution criteria were not met.
- C08 RPD criteria were not met.
- C09 RSD criteria were not met.
- C10 Retention time of compounds was outside windows.
- C11 Compounds were not adequately resolved.
- C12 Breakdown of endrin or DDT was $>20\%$.
- C13 Combined breakdown of endrin/DDT was $>30\%$.
- C14 Professional judgment was used to qualify the data.

Blanks

- F01 Sample data were qualified as a result of the method blank.
- F02 Sample data were qualified as a result of the field blank.
- F03 Sample data were qualified as a result of the equipment rinsate.
- F04 Sample data were qualified as a result of the trip blank.
- F05 Gross contamination exists.
- F06 Concentration of the contaminant was detected at a level below the CRQL.
- F07 Concentration of the contaminant was detected at a level less than the action limit, but greater than the CRQL.
- F08 Concentration of the contaminant was detected at a level that exceeds the action level.
- F09 No laboratory blanks were analyzed.
- F10 Blank had a negative value $>2x$'s the IDL.
- F11 Blanks were not analyzed at required frequency.
- F12 Professional judgment was used to qualify the data.

Surrogate/Radiological Chemical Recovery

- G01 Surrogate/radiological chemical recovery was above the upper control limit.
- G02 Surrogate/radiological chemical recovery was below the lower control limit.
- G03 Surrogate recovery was <10%.
- G04 Surrogate/radiological chemical recovery was zero.
- G05 Surrogate/radiological chemical recovery was not present.
- G06 Professional judgment was used to qualify the data.
- G07 Radiological chemical recovery was <20%.
- G08 Radiological chemical recovery was >150%.

Matrix Spike/Matrix Spike Duplicate

- H01 MS/MSD recovery was above the upper control limit.
- H02 MS/MSD recovery was below the lower control limit.
- H03 MS/MSD recovery was <10%.
- H04 MS/MSD pairs exceed the RPD limit.
- H05 No action was taken on MS/MSD results.
- H06 Professional judgment was used to qualify the data.
- H07 Radiological MS/MSD recovery was <20%.
- H08 Radiological MS/MSD recovery was >160%.
- H09 Radiological MS/MSD samples were not analyzed at the required frequency.

Laboratory Duplicate

- J01 Duplicate RPD/normalized absolute difference (NAD) was outside the control limit.
- J02 Duplicate sample results were >5x the CRDL.
- J03 Duplicate sample results were <5x the CRDL.
- J04 Professional judgment was used to qualify the data.
- J05 Duplicate was not analyzed at the required frequency.

Target Compound Identification

- M01 Incorrect identifications were made.
- M02 Qualitative criteria were not met.
- M03 Cross contamination occurred.
- M04 Confirmatory analysis was not performed.
- M05 No results were provided.
- M06 Analysis occurred outside 12 hr GC/MS window.
- M07 Professional judgment was used to qualify the data.
- M08 The %D between the two pesticide/PCB column checks was >25%.

Laboratory Control Samples (LCSs)

- P01 LCS recovery was above upper control limit.
- P02 LCS recovery was below lower control limit.
- P03 LCS recovery was <50%.
- P04 No action was taken on the LCS data.
- P05 LCS was not analyzed at required frequency.
- P06 Radiological LCS recovery was <50% for aqueous samples; <40% for solid samples.
- P07 Radiological LCS recovery was >150% for aqueous samples; >160% for solid samples.
- P08 Professional judgment was used to qualify the data.

Field Duplicate

- Q01 No action was taken on the basis of field duplicate RPDs.
- Q02 Radiological field duplicate normalized absolute difference (NAD) was outside the control limit.
- Q03 Duplicate sample results were >5x the CRDL.
- Q04 Duplicate sample results were <5x the CRDL.

Radiological Calibration

- R01 Efficiency calibration criteria were not met.
- R02 Energy calibration criteria were not met.
- R03 Resolution calibration criteria were not met
- R04 Background determination criteria were not met.
- R05 Quench curve criteria were not met.
- R06 Absorption curve criteria were not met.
- R07 Plateau curve criteria were not met.
- R08 Professional judgment was used to qualify the data.

Radiological Calibration Verification

- S01 Efficiency verification criteria were not met.
- S02 Energy verification criteria were not met.
- S03 Resolution verification criteria were not met
- S04 Background verification criteria were not met.
- S05 Cross-talk verification criteria were not met.
- S06 Professional judgment was used to qualify the data.

Radionuclide Quantitation

- T01 Detection limits were not met.
- T02 Analytical uncertainties were not met and/or not reported.
- T03 Inappropriate aliquot sizes were used.
- T04 Professional judgment was used to qualify the data.
- T05 Analytical result is less than the associated MDA, but greater than the counting uncertainty.
- T06 Analytical result is less than both the associated counting uncertainty and MDA.
- T07 Negative analytical result where the absolute value exceeds 2x the associated MDA.

System Performance

- V01 High background levels or a shift in the energy calibration were observed.
- V02 Extraneous peaks were observed.
- V03 Loss of resolution was observed.
- V04 Peak-tailing or peak splitting that may result in inaccurate quantitation were observed.
- V05 Professional judgment was used to qualify the data.

DATA VALIDATION REPORT

Date:

December 8, 2003

To: Steve Passig	From: Jerry Everett
Laboratory: Severn Trent – St. Louis	SDG #: F3G310383

Attached you will find the results from the data validation technical review for the Westinghouse/Hematite samples and analyses that are associated with the above referenced laboratory and sample delivery group (SDG) number. These data points have been selected for data validation and the sample index on the following page specifically identifies the samples and analyses associated with this validation review.

The FUSRAP validation technical review was performed in accordance with the *Contract Laboratory Program Data Validation Functional Guidelines for Evaluating Inorganic Analytical Data*, and the *Laboratory Data Validation Guidelines for Evaluating Radionuclide Analyses and Radiochemical Data Verification and Validation*. It was based on the information and documentation supplied by the associated laboratory. The analyses were evaluated against criteria established in the related analytical procedures and the Westinghouse/Hematite data quality requirements.

Attachment A to this report provides the Sample Data Summary Sheets for the samples associated with the above referenced request. These summary sheets identify the analytical values and the qualifiers for each sample and parameter. Attachment B outlines the validation qualifiers and reason codes used in the validation of the data.

Report Summary	
Total Number of Samples	9
Total Number of Data Points	90
Total Number of Rejected Data Points	0
Percent Completeness (approval to rejection ratio)	100.0%

Sample Index

	<i>Date:</i> December 8, 2003
<i>Laboratory:</i> Severn Trent – St. Louis	<i>SDG #:</i> F3G310383

WESTINGHOUSE Sample ID	Target Analyses
BHKD1-04	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD1-23	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD1-28	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD2-04	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD2-13	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD2-23	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD3-08	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD3-16	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD3-23	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH

ANALYTICAL CATEGORY: Metals

- Iron and manganese were analyzed by Inductively Coupled Plasma (ICP).

1. The following items (as applicable) have been addressed during the validation review:

- sample custody, integrity & preservation
- sample handling & preparation
- holding times
- instrument calibration & performance
- dilution factors
- detection limits
- laboratory background & carry-over
- overall appearance of the data
- Quality Control:
 - calibration checks & blanks
 - laboratory blanks (method, TCLP)
 - laboratory control samples
 - matrix spike samples
 - matrix duplicates
 - field blanks (if available)
 - field duplicates (if available)
 - CRDL standards
 - interference check standards
 - analytical bench spikes
 - serial dilutions

2. The above items were found to be acceptable, except as follows:

- None.

3. Additional comments:

- Contamination with iron and manganese were seen in the calibration blanks. Calibration blanks are run to verify that carry over does not occur and that no contamination is being introduced during the run. Iron and manganese data associated with the bracketed samples were greater than five times the contamination level. Therefore, qualification of the iron and manganese data was not necessary.
- The matrix spike recovery for iron was high. The spiked sample analysis is designed to provide information about the effect of each sample matrix on the sample preparation procedures and the measurement methodology. When the sample concentration is greater than 4X the spike concentration spike recoveries are not evaluated. Therefore qualification of the data is not necessary.
- The matrix spike recovery for manganese was low. The spiked sample analysis is designed to provide information about the effect of each sample matrix on the sample preparation procedures and the measurement methodology. When the sample concentration is greater than 4X the spike concentration, spike recoveries are not evaluated. Therefore qualification of the data is not necessary.

ANALYTICAL CATEGORY: Miscellaneous

- Total Organic Carbon and Total Carbon were determined by SW846 Method 9060; pH was determined by SW846 Method 9045A; and percent moisture was determined by MCAWW 160.3.

1. The following items (as applicable) have been addressed during the validation review:

- sample custody, integrity & preservation
- sample handling & preparation
- holding times
- instrument calibration & performance
- dilution factors
- detection limits
- laboratory background & carry-over
- overall appearance of the data
- Quality Control:
 - calibration checks & blanks
 - laboratory blanks (method, TCLP)
 - laboratory control samples
 - matrix spike samples
 - matrix duplicates
 - field blanks (if available)
 - field duplicates (if available)

2. The above items were found to be acceptable, except as follows:

- None.

3. Additional comments:

- The matrix spike recoveries for total carbon and total organic carbon were high. The spiked sample analysis is designed to provide information about the effect of each sample matrix on the sample preparation procedures and the measurement methodology. When the sample concentration is greater than 4X the spike concentration spike recoveries are not evaluated. Therefore qualification of the date is not necessary.

ANALYTICAL CATEGORY: Radiochemical

- Isotopic uranium was determined by alpha spectroscopy (NAS/DOE 3050/RP), and technetium was determined by Liquid scintillation counters (DOE TC-02-RC).

1. The following items (as applicable) have been addressed during the validation review:

- sample custody, integrity & preservation
- sample handling & preparation
- holding times
- instrument calibration & performance
- dilution factors
- detection limits
- laboratory background & carry-over
- overall appearance of the data
- Quality Control:
 - calibration checks & background
 - preparation blanks
 - laboratory control samples
 - field blanks (if available)
 - field duplicates (if available)

2. The above items were found to be acceptable, except as follows:

- Instrument Counting Error

Several samples have reported results that are less than the MDA and the uncertainty is greater than the result. The non-detect results for these samples were qualified *UU*.

Several samples have reported results that are greater than the MDA and the sample uncertainty is 50% to 100% of the sample result. The reported values for these samples were qualified with a *J*.

3. Additional comments:

- Contamination with technetium-99 was seen in the method blank. Method blanks are run to verify that contamination is being introduced during the run. Technetium-99 data associated with the method blank were greater than the contamination level. Therefore, qualification of the data was not necessary.

ATTACHMENT A

WESTINGHOUSE Sample Data Summary Sheets

ATTACHMENT B

KEY TO THE WESTINGHOUSE DATA VALIDATION QUALIFIERS

QUALIFIERS	
=	Indicates that the data met all QA/QC requirements, and that the parameter has been positively identified and the associated concentration value is accurate.
U	Indicates that the data met all QA/QC requirements, and that the parameter was analyzed for but was not detected above the reported sample quantitation limit.
J	Indicates that the parameter was positively identified; the associated numerical value is the approximate concentration of the parameter in the sample.
UJ	Indicates that the parameter was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
N	The analysis indicates the presence of a parameter for which there is presumptive evidence to make a "tentative identification."
R	Indicates that the sample results for the parameter are rejected or unusable due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the parameter cannot be verified.

Data Validation Reason Codes

Holding Times

- A01 Extraction holding times were exceeded.
- A02 Extraction holding times were grossly exceeded.
- A03 Analysis holding times were exceeded.
- A04 Analysis holding times were grossly exceeded.
- A05 Samples were not preserved properly.
- A06 Professional judgment was used to qualify the data.

GC/MS Tuning

- B01 Mass calibration was in error, even after applying expanded criteria.
- B02 Mass calibration was not performed every 12 hours.
- B03 Mass calibration did not meet ion abundance.
- B04 Professional judgment was used to qualify the data.

Initial/Continuing Calibration – Organics

- C01 Initial calibration RRF was <0.05.
- C02 Initial calibration RSD was >30%.
- C03 Initial calibration sequence was not followed as required.
- C04 Continuing calibration RRF was <0.05.
- C05 Continuing calibration %D was >25%.
- C06 Continuing calibration was not performed at the required frequency.
- C07 Resolution criteria were not met.
- C08 RPD criteria were not met.
- C09 RSD criteria were not met.
- C10 Retention time of compounds was outside windows.
- C11 Compounds were not adequately resolved.
- C12 Breakdown of endrin or DDT was >20%.
- C13 Combined breakdown of endrin/DDT was >30%.
- C14 Professional judgment was used to qualify the data.

Blanks

- F01 Sample data were qualified as a result of the method blank.
- F02 Sample data were qualified as a result of the field blank.
- F03 Sample data were qualified as a result of the equipment rinsate.
- F04 Sample data were qualified as a result of the trip blank.
- F05 Gross contamination exists.
- F06 Concentration of the contaminant was detected at a level below the CRQL.
- F07 Concentration of the contaminant was detected at a level less than the action limit, but greater than the CRQL.
- F08 Concentration of the contaminant was detected at a level that exceeds the action level.
- F09 No laboratory blanks were analyzed.
- F10 Blank had a negative value >2x's the IDL.
- F11 Blanks were not analyzed at required frequency.
- F12 Professional judgment was used to qualify the data.

Surrogate/Radiological Chemical Recovery

- G01 Surrogate/radiological chemical recovery was above the upper control limit.
- G02 Surrogate/radiological chemical recovery was below the lower control limit.
- G03 Surrogate recovery was <10%.
- G04 Surrogate/radiological chemical recovery was zero.
- G05 Surrogate/radiological chemical recovery was not present.
- G06 Professional judgment was used to qualify the data.
- G07 Radiological chemical recovery was <20%.
- G08 Radiological chemical recovery was >150%.

Matrix Spike/Matrix Spike Duplicate

- H01 MS/MSD recovery was above the upper control limit.
- H02 MS/MSD recovery was below the lower control limit.
- H03 MS/MSD recovery was <10%.
- H04 MS/MSD pairs exceed the RPD limit.
- H05 No action was taken on MS/MSD results.
- H06 Professional judgment was used to qualify the data.
- H07 Radiological MS/MSD recovery was <20%.
- H08 Radiological MS/MSD recovery was >160%.
- H09 Radiological MS/MSD samples were not analyzed at the required frequency.

Laboratory Duplicate

- J01 Duplicate RPD/normalized absolute difference (NAD) was outside the control limit.
- J02 Duplicate sample results were >5x the CRDL.
- J03 Duplicate sample results were <5x the CRDL.
- J04 Professional judgment was used to qualify the data.
- J05 Duplicate was not analyzed at the required frequency.

Target Compound Identification

- M01 Incorrect identifications were made.
- M02 Qualitative criteria were not met.
- M03 Cross contamination occurred.
- M04 Confirmatory analysis was not performed.
- M05 No results were provided.
- M06 Analysis occurred outside 12 hr GC/MS window.
- M07 Professional judgment was used to qualify the data.
- M08 The %D between the two pesticide/PCB column checks was >25%.

Laboratory Control Samples (LCSs)

- P01 LCS recovery was above upper control limit.
- P02 LCS recovery was below lower control limit.
- P03 LCS recovery was <50%.
- P04 No action was taken on the LCS data.
- P05 LCS was not analyzed at required frequency.
- P06 Radiological LCS recovery was <50% for aqueous samples; <40% for solid samples.
- P07 Radiological LCS recovery was >150% for aqueous samples; >160% for solid samples.
- P08 Professional judgment was used to qualify the data.

Field Duplicate

- Q01 No action was taken on the basis of field duplicate RPDs.
- Q02 Radiological field duplicate normalized absolute difference (NAD) was outside the control limit.
- Q03 Duplicate sample results were >5x the CRDL.
- Q04 Duplicate sample results were <5x the CRDL.

Radiological Calibration

- R01 Efficiency calibration criteria were not met.
- R02 Energy calibration criteria were not met.
- R03 Resolution calibration criteria were not met
- R04 Background determination criteria were not met.
- R05 Quench curve criteria were not met.
- R06 Absorption curve criteria were not met.
- R07 Plateau curve criteria were not met.
- R08 Professional judgment was used to qualify the data.

Radiological Calibration Verification

- S01 Efficiency verification criteria were not met.
- S02 Energy verification criteria were not met.
- S03 Resolution verification criteria were not met
- S04 Background verification criteria were not met.
- S05 Cross-talk verification criteria were not met.
- S06 Professional judgment was used to qualify the data.

Radionuclide Quantitation

- T01 Detection limits were not met.
- T02 Analytical uncertainties were not met and/or not reported.
- T03 Inappropriate aliquot sizes were used.
- T04 Professional judgment was used to qualify the data.
- T05 Analytical result is less than the associated MDA, but greater than the counting uncertainty.
- T06 Analytical result is less than both the associated counting uncertainty and MDA.
- T07 Negative analytical result where the absolute value exceeds 2x the associated MDA.

System Performance

- V01 High background levels or a shift in the energy calibration were observed.
- V02 Extraneous peaks were observed.
- V03 Loss of resolution was observed.
- V04 Peak-tailing or peak splitting that may result in inaccurate quantitation were observed.
- V05 Professional judgment was used to qualify the data.

DATA VALIDATION REPORT

		Date: December 8, 2003
To: Steve Passig	From: Jerry Everett	
Laboratory: Severn Trent – St. Louis	SDG #: F3H010120	

Attached you will find the results from the data validation technical review for the Westinghouse/Hematite samples and analyses that are associated with the above referenced laboratory and sample delivery group (SDG) number. These data points have been selected for data validation and the sample index on the following page specifically identifies the samples and analyses associated with this validation review.

The FUSRAP validation technical review was performed in accordance with the *Contract Laboratory Program Data Validation Functional Guidelines for Evaluating Inorganic Analytical Data*, and the *Laboratory Data Validation Guidelines for Evaluating Radionuclide Analyses and Radiochemical Data Verification and Validation*. It was based on the information and documentation supplied by the associated laboratory. The analyses were evaluated against criteria established in the related analytical procedures and the Westinghouse/Hematite data quality requirements.

Attachment A to this report provides the Sample Data Summary Sheets for the samples associated with the above referenced request. These summary sheets identify the analytical values and the qualifiers for each sample and parameter. Attachment B outlines the validation qualifiers and reason codes used in the validation of the data.

Report Summary	
Total Number of Samples	14
Total Number of Data Points	108
Total Number of Rejected Data Points	0
Percent Completeness (approval to rejection ratio)	100.0%

Sample Index

Date:

December 8, 2003

Laboratory:

Severn Trent – St. Louis

SDG #:

F3H010120

WESTINGHOUSE Sample ID	Target Analyses
BHKD4-02	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD4-14	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD4-24	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD5-01	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD5-19	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD5-27	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD6-01	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
BHKD6-11	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, Ph
BHKD6-26	Iron, Manganese, Total Carbon, TOC, Isotopic Uranium, Technetium-99, percent moisture, pH
OB-1-KD	Isotopic Uranium, Technetium-99
OB-1-ANION	Chloride, Nitrate, Sulfate
OB-1-CATION	Calcium, Potassium, Magnesium, Sodium
WS-14-ANION	Chloride, Nitrate, Sulfate
WS-14-CATION	Calcium, Potassium, Magnesium, Sodium

ANALYTICAL CATEGORY: Anions

- Chloride, Nitrate, and Sulfate were determined by SW846 Method 9056A.
 - 1. The following items (as applicable) have been addressed during the validation review:
 - sample custody, integrity & preservation
 - sample handling & preparation
 - holding times
 - instrument calibration & performance
 - dilution factors
 - detection limits
 - laboratory background & carry-over
 - appearance & interpretation of chromatography[†]
 - retention times[†]
 - overall appearance of the data
 - Quality Control:
 - calibration checks & blanks
 - laboratory blanks (method, TCLP)
 - laboratory control samples
 - matrix spike samples
 - matrix duplicates
 - field blanks (if available)
 - field duplicates (if available)
- [†] - for ion chromatography only.
2. The above items were found to be acceptable, except as follows:
 - None
3. Additional comments:
 - Contamination with chloride was seen in the calibration blanks. Calibration blanks are run to verify that carry over does not occur and that no contamination is being introduced during the run. Chloride data associated with the bracketed samples were greater than five times the contamination level. Therefore, qualification of the chloride data were not necessary.

ANALYTICAL CATEGORY: Metals

- Metals were analyzed by Inductively Coupled Plasma (ICP).

1. The following items (as applicable) have been addressed during the validation review:

- sample custody, integrity & preservation
- sample handling & preparation
- holding times
- instrument calibration & performance
- dilution factors
- detection limits
- laboratory background & carry-over
- overall appearance of the data
- Quality Control:
 - calibration checks & blanks
 - laboratory blanks (method, TCLP)
 - laboratory control samples
 - matrix spike samples
 - matrix duplicates
 - field blanks (if available)
 - field duplicates (if available)
 - CRDL standards
 - interference check standards
 - analytical bench spikes
 - serial dilutions

2. The above items were found to be acceptable, except as follows:

- Blank Contamination

The continuing calibration blank was contaminated with potassium at a concentration of 1600 ug/l. This is evidence of possible laboratory contamination. The positive potassium result in sample OB-1-CATION was less than five times the contamination level. The reported sample concentration was qualified with a *U*.

3. Additional comments:

- Contamination with iron and manganese were seen in the calibration blanks. Calibration blanks are run to verify that carry over does not occur and that no contamination is being introduced during the run. Iron and manganese data associated with the bracketed samples were greater than five times the contamination level. Therefore, qualification of iron and manganese were not necessary.
- Detection limits in samples OB-1-CATION and WS-14-CATION have been changed.

ANALYTICAL CATEGORY: Miscellaneous

- Total Organic Carbon and Total Carbon were determined by SW846 Method 9060; pH was determined by SW846 Method 9045A; and percent moisture was determined by MCAWW 160.3.

1. The following items (as applicable) have been addressed during the validation review:

- sample custody, integrity & preservation
- sample handling & preparation
- holding times
- instrument calibration & performance
- dilution factors
- detection limits
- laboratory background & carry-over
- overall appearance of the data
- Quality Control:
 - calibration checks & blanks
 - laboratory blanks (method, TCLP)
 - laboratory control samples
 - matrix spike samples
 - matrix duplicates
 - field blanks (if available)
 - field duplicates (if available)

2. The above items were found to be acceptable, except as follows:

- None.

3. Additional comments:

- None.

ANALYTICAL CATEGORY: Radiochemical

- Isotopic uranium was determined by alpha spectroscopy (NAS/DOE 3050/RP), and technetium was determined by Liquid scintillation counters (DOE TC-02-RC).

1. The following items (as applicable) have been addressed during the validation review:

- sample custody, integrity & preservation
- sample handling & preparation
- holding times
- instrument calibration & performance
- dilution factors
- detection limits
- laboratory background & carry-over
- overall appearance of the data
- Quality Control:
 - calibration checks & background
 - preparation blanks
 - laboratory control samples
 - field blanks (if available)
 - field duplicates (if available)

2. The above items were found to be acceptable, except as follows:

- Instrument Counting Error

Several samples have reported results that are less than the MDA and the uncertainty is greater than the result. The non-detect results for these samples were qualified *UU*.

Several samples have reported results that are greater than the MDA and the sample uncertainty is 50% to 100% of the sample result. The reported values for these samples were qualified with a *J*.

- Blank Contamination

Uranium-234 was present in the associated method blank at 0.1 ± 0.11 pCi/g. This may indicate that contamination could have been introduced during the laboratory preparation. The normalized absolute difference between the sample OB-1-KD and the method blank was less than 2.58 and was qualified as estimated, *J*.

3. Additional comments:

- MDC values for Isotopic uranium in sample BHKD6-01 have been changed.

ATTACHMENT A

WESTINGHOUSE Sample Data Summary Sheets

ATTACHMENT B

KEY TO THE WESTINGHOUSE DATA VALIDATION QUALIFIERS

QUALIFIERS	
=	Indicates that the data met all QA/QC requirements, and that the parameter has been positively identified and the associated concentration value is accurate.
U	Indicates that the data met all QA/QC requirements, and that the parameter was analyzed for but was not detected above the reported sample quantitation limit.
J	Indicates that the parameter was positively identified; the associated numerical value is the approximate concentration of the parameter in the sample.
UJ	Indicates that the parameter was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
N	The analysis indicates the presence of a parameter for which there is presumptive evidence to make a "tentative identification."
R	Indicates that the sample results for the parameter are rejected or unusable due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the parameter cannot be verified.

Data Validation Reason Codes

Holding Times

- A01 Extraction holding times were exceeded.
- A02 Extraction holding times were grossly exceeded.
- A03 Analysis holding times were exceeded.
- A04 Analysis holding times were grossly exceeded.
- A05 Samples were not preserved properly.
- A06 Professional judgment was used to qualify the data.

GC/MS Tuning

- B01 Mass calibration was in error, even after applying expanded criteria.
- B02 Mass calibration was not performed every 12 hours.
- B03 Mass calibration did not meet ion abundance.
- B04 Professional judgment was used to qualify the data.

Initial/Continuing Calibration – Organics

- C01 Initial calibration RRF was <0.05.
- C02 Initial calibration RSD was >30%.
- C03 Initial calibration sequence was not followed as required.
- C04 Continuing calibration RRF was <0.05.
- C05 Continuing calibration %D was >25%.
- C06 Continuing calibration was not performed at the required frequency.
- C07 Resolution criteria were not met.
- C08 RPD criteria were not met.
- C09 RSD criteria were not met.
- C10 Retention time of compounds was outside windows.
- C11 Compounds were not adequately resolved.
- C12 Breakdown of endrin or DDT was >20%.
- C13 Combined breakdown of endrin/DDT was >30%.
- C14 Professional judgment was used to qualify the data.

Blanks

- F01 Sample data were qualified as a result of the method blank.
- F02 Sample data were qualified as a result of the field blank.
- F03 Sample data were qualified as a result of the equipment rinsate.
- F04 Sample data were qualified as a result of the trip blank.
- F05 Gross contamination exists.
- F06 Concentration of the contaminant was detected at a level below the CRQL.
- F07 Concentration of the contaminant was detected at a level less than the action limit, but greater than the CRQL.
- F08 Concentration of the contaminant was detected at a level that exceeds the action level.
- F09 No laboratory blanks were analyzed.
- F10 Blank had a negative value >2x's the IDL.
- F11 Blanks were not analyzed at required frequency.
- F12 Professional judgment was used to qualify the data.

Surrogate/Radiological Chemical Recovery

- G01 Surrogate/radiological chemical recovery was above the upper control limit.
- G02 Surrogate/radiological chemical recovery was below the lower control limit.
- G03 Surrogate recovery was <10%.
- G04 Surrogate/radiological chemical recovery was zero.
- G05 Surrogate/radiological chemical recovery was not present.
- G06 Professional judgment was used to qualify the data.
- G07 Radiological chemical recovery was <20%.
- G08 Radiological chemical recovery was >150%.

Matrix Spike/Matrix Spike Duplicate

- H01 MS/MSD recovery was above the upper control limit.
- H02 MS/MSD recovery was below the lower control limit.
- H03 MS/MSD recovery was <10%.
- H04 MS/MSD pairs exceed the RPD limit.
- H05 No action was taken on MS/MSD results.
- H06 Professional judgment was used to qualify the data.
- H07 Radiological MS/MSD recovery was <20%.
- H08 Radiological MS/MSD recovery was >160%.
- H09 Radiological MS/MSD samples were not analyzed at the required frequency.

Laboratory Duplicate

- J01 Duplicate RPD/normalized absolute difference (NAD) was outside the control limit.
- J02 Duplicate sample results were >5x the CRDL.
- J03 Duplicate sample results were <5x the CRDL.
- J04 Professional judgment was used to qualify the data.
- J05 Duplicate was not analyzed at the required frequency.

Target Compound Identification

- M01 Incorrect identifications were made.
- M02 Qualitative criteria were not met.
- M03 Cross contamination occurred.
- M04 Confirmatory analysis was not performed.
- M05 No results were provided.
- M06 Analysis occurred outside 12 hr GC/MS window.
- M07 Professional judgment was used to qualify the data.
- M08 The %D between the two pesticide/PCB column checks was >25%.

Laboratory Control Samples (LCSs)

- P01 LCS recovery was above upper control limit.
- P02 LCS recovery was below lower control limit.
- P03 LCS recovery was <50%.
- P04 No action was taken on the LCS data.
- P05 LCS was not analyzed at required frequency.
- P06 Radiological LCS recovery was <50% for aqueous samples; <40% for solid samples.
- P07 Radiological LCS recovery was >150% for aqueous samples; >160% for solid samples.
- P08 Professional judgment was used to qualify the data.

Field Duplicate

- Q01 No action was taken on the basis of field duplicate RPDs.
- Q02 Radiological field duplicate normalized absolute difference (NAD) was outside the control limit.
- Q03 Duplicate sample results were >5x the CRDL.
- Q04 Duplicate sample results were <5x the CRDL.

Radiological Calibration

- R01 Efficiency calibration criteria were not met.
- R02 Energy calibration criteria were not met.
- R03 Resolution calibration criteria were not met
- R04 Background determination criteria were not met.
- R05 Quench curve criteria were not met.
- R06 Absorption curve criteria were not met.
- R07 Plateau curve criteria were not met.
- R08 Professional judgment was used to qualify the data.

Radiological Calibration Verification

- S01 Efficiency verification criteria were not met.
- S02 Energy verification criteria were not met.
- S03 Resolution verification criteria were not met
- S04 Background verification criteria were not met.
- S05 Cross-talk verification criteria were not met.
- S06 Professional judgment was used to qualify the data.

Radionuclide Quantitation

- T01 Detection limits were not met.
- T02 Analytical uncertainties were not met and/or not reported.
- T03 Inappropriate aliquot sizes were used.
- T04 Professional judgment was used to qualify the data.
- T05 Analytical result is less than the associated MDA, but greater than the counting uncertainty.
- T06 Analytical result is less than both the associated counting uncertainty and MDA.
- T07 Negative analytical result where the absolute value exceeds 2x the associated MDA.

System Performance

- V01 High background levels or a shift in the energy calibration were observed.
- V02 Extraneous peaks were observed.
- V03 Loss of resolution was observed.
- V04 Peak-tailing or peak splitting that may result in inaccurate quantitation were observed.
- V05 Professional judgment was used to qualify the data.

APPENDIX B

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**Appendix B
Boring Logs**



SUBSURFACE LOG

Project Name <u>Hematite Transport Factors</u>	Location <u>Evaporation Pond</u>
Client <u>Westinghouse Electric Company</u>	Boring No. <u>BHKD6</u> Total Depth <u>30.0'</u>
City, State <u>Hematite, Missouri</u>	Surface Elevation _____
Project Type <u>Environmental</u>	Date Started <u>7/30/03</u> Completed <u>7/30/03</u>
Supervisor <u>Todd Calhoun</u> Driller <u>Brian Fingers</u>	Depth to Water <u>Dry</u> Date/Time <u>7/30/03</u>
Logged By <u>Todd Calhoun</u>	Depth to Water _____ Date/Time _____

Lithology		Description	Overburden	Sample # Depth	Penetration ft./ Recovery ft.	Field Screening Results	USCS Classification	Remarks
Elevation	Depth (ft.)					Beta/ Gamma (cpm)		
	0.0	Ground Surface						
	1.0	SILTY CLAY, w/ DGA, brown/brown gray, dry, sli-plastic, med, gravel loose		1 0.0-4.0	4.0 2.7	0.0-1.0 410 β 10000 γ	CL	Analytical Sample No. BHKD6-01, BHKD6-01-ARCH, BHKD6-01-PSA collected 1.0 - 8.0 @ 1503 hrs Chain of Custody No. 105109
	1.2					1.0-2.0 250 β 11600 γ	CL	
	2.0	SILTY CLAY, brown, plastic, damp, stiff, w/ manganese nodules, 10% limonite mottling		2 4.0-8.0	4.0 0.7	2.0-3.0 210 β 11600 γ		
	3.0					3.0-4.0 180 β 10400 γ		
	4.0					4.0-5.0 260 β 10600 γ		
	5.0					5.0-6.0 266 β 12000 γ		
	6.0					6.0-7.0 220 β 12000 γ		
	7.0					7.0-8.0 200 β 11800 γ		
	8.0							



SUBSURFACE LOG

Project Name Hematite Transport Factors Location Evaporation Pond
 Client Westinghouse Electric Company Boring No. BHKD6 Logged By T. Calhoun

Lithology		Description	Overburden	Sample # Depth	Penetration ft./ Recovery ft.	Field Screening Results	USCS Classification	Remarks
Elevation	Depth (ft.)							
	9.0	SILTY CLAY, brown, plastic, damp, stiff, w/ manganese nodules, 10% limonite mottling		3 8.0-12.0	4.0 4.0	8.0-9.0 202 β 13400 γ	CH	
	10.0					9.0-10.0 220 β 12000 γ		
	11.0					10.0-11.0 266 β 12000 γ		
	11.2					11.0-12.0 222 β 11200 γ		
	12.0	SILTY CLAY, brown, sli-plastic to plastic, damp to moist, med stiff to stiff, w/ manganese nodules, 15% limonite mottling		4 12.0-16.0	4.0 4.0	12.0-13.0 266 β 12400 γ	CL	Analytical Sample No. BHKD5-11, BHKD5-11-ARCH, BHKD5-11-PSA collected 11.0 - 16.0 @ 1510 hrs Chain of Custody No. 105109
	13.0					13.0-14.0 204 β 11400 γ		
	14.0					14.0-15.0 226 β 10600 γ		
	15.0					15.0-16.0 170 β 10800 γ		
	16.0					16.0-17.0 206 β 10600 γ		
	17.0			5 16.0-20.0	4.0 3.0			



SUBSURFACE LOG

Project Name Hematite Transport Factors

Location Evaporation Pond

Client Westinghouse Electric Company

Boring No. BHKD6 Logged By T. Calhoun

Lithology		Description	Overburden	Sample # Depth	Penetration ft./ Recovery ft.	Field Screening Results	USCS Classification	Remarks
Elevation	Depth (ft.)							
	18.0	SILTY CLAY (continued)				17.0-18.0 236 β 13400 γ		
	19.0					18.0-19.0 256 β 11400 γ		
	20.0					19.0-20.0 196 β 12000 γ		
	21.0			6 20.0-24.0	4.0 0.0	20.0-24.0 — β — γ		Gravel from above zone wedged into shoe. No sample recovered
	22.0							
	23.0							
	24.0							
	25.0			7 24.0-28.0	4.0 3.1	24.0-25.0 190 β 11400 γ		
	26.0					25.0-26.0 226 β 10800 γ		



SUBSURFACE LOG

Project Name Hematite Transport Factors Location Evaporation Pond
 Client Westinghouse Electric Company Boring No. BHKD6 Logged By T. Calhoun

Lithology		Description	Overburden	Sample #/ Depth	Penetration ft./ Recovery ft.	Field Screening Results	USCS Classification	Remarks
Elevation	Depth (ft.)							
	26.4	SILTY CLAY, brownish gray, plastic, moist, medium to med stiff, w 20% limonite mottling				26.0-27.0 246 β 11600 γ	CL	Analytical Sample No. BHKD6-26, BHKD6-26- ARCH, BHKD6-26- PSA collected 26.0 - 30.0 @ 1518 hrs Chain of Custody No. 105109
	27.0							
	27.5							
	28.0	SILTY CLAY, gray, silty-plastic, moist, medium				27.0-28.0 176 β 11000 γ	CL	
	29.0 29.2		8 28.0-30.0	2.0 2.0	28.0-29.0 246 β 11400 γ			
	30.0	CLAYEY SAND W/ GRAVEL, gray, wet, compact to dense				29.0-30.0 198 β 12600 γ	SC	
		Bottom of Hole 30.0' 7/30/03						



SUBSURFACE LOG

Project Name <u>Hematite Transport Factors</u>	Location <u>Duel's Mountain</u>
Client <u>Westinghouse Electric Company</u>	Boring No. <u>BHKD1</u> Total Depth <u>33.0'</u>
City, State <u>Hematite, Missouri</u>	Surface Elevation _____
Project Type <u>Environmental</u>	Date Started <u>7/28/03</u> Completed <u>7/28/03</u>
Supervisor <u>Todd Calhoun</u> Driller <u>Mike Umfleet</u>	Depth to Water <u>Dry</u> Date/Time <u>7/28/03</u>
Logged By <u>Todd Calhoun</u>	Depth to Water _____ Date/Time _____

Lithology		Description	Overburden	Sample #/ Depth	Penetration ft./ Recovery ft.	Field Screening Results	USCS Classification	Remarks
Elevation	Depth (ft.)							
	0.0	Ground Surface						
	0.3	SILTY CLAY, brown, slight plastic, damp, stiff		1 0.0-4.0	4.0 1.3	0.0-4.0 214 β	CL	
	0.5	GRAVEL (DGA), gray, dry				10200 γ	GW	
	1.0	SILTY CLAY, brown, plastic, damp, stiff, w/ 10% gray mottling, manganese nodules					CH	
	2.0							
	3.0							
	4.0			2 4.0-8.0	4.0 4.0	4.0-5.0 248 β 9800 γ		Analytical Sample No. BHKD1-04, BHKD1-04- ARCH collected 4.0 - 8.6 @ 1530 hrs Chain of Custody No. 105108
	5.0					5.0-6.0 238 β 10000 γ		
	6.0					6.0-7.0 234 β 10000 γ		
	7.0					7.0-8.0 228 β 10000 γ		
	8.0							



SUBSURFACE LOG

Project Name Hematite Transport Factors Location Duel's Mountain
 Client Westinghouse Electric Company Boring No. BHKD1 Logged By T. Calhoun

Lithology		Description	Overburden	Sample #/ Depth	Penetration ft./ Recovery ft.	Field Screening Results	USCS Classification	Remarks		
Elevation	Depth (ft.)									
	8.6	CLAYEY GRAVEL, brown, damp, compact SILTY CLAY, brown, plastic, moist, medium stiff, w/ chert nodules Wet sandy lens at 10.7 ft		3 8.0-12.0	4.0 4.0	8.0-9.0 230 β 10000 γ	GC CH			
	8.8									
	10.0						9.0-10.0 222 β 8400 γ			
	11.0						10.0-11.0 198 β 9000 γ			
	12.0					11.0-12.0 206 β 9200 γ				
	13.0	SILTY CLAY, brown, plastic, damp to moist, soft to medium		4 12.0-16.0	4.0 2.8	12.0-13.0 242 β 8600 γ	CH			
	14.0								13.0-14.0 230 β 9200 γ	
	14.8								14.0-15.0 172 β 9400 γ	
	15.0	SILTY CLAY, brownish gray, plastic, moist medium, w/ chert and manganese nodules, 3% brown/gray mottling				15.0-16.0 192 β 10200 γ	CH			
	16.0									
	17.0	SILTY CLAY, brown, plastic, moist, medium, w/ chert and manganese nodules		5 16.0-20.0	4.0 4.0	16.0-17.0 254 β 9200 γ	CL			



SUBSURFACE LOG

Project Name Hematite Transport Factors Location Duel's Mountain
 Client Westinghouse Electric Company Boring No. BHKD1 Logged By T. Calhoun

Lithology		Description	Overburden	Sample #/ Depth	Penetration ft./ Recovery ft.	Field Screening Results	USCS Classification	Remarks
Elevation	Depth (ft.)							
	18.0	SILTY CLAY, brownish gray, plastic, moist, medium, w/ chert and manganese nodules				17.0-18.0 236 β 9400 γ	CL	
	19.0					18.0-19.0 216 β 10400 γ		
	19.3					19.0-20.0 176 β 10000 γ		
	20.0	SILTY CLAY, brown, plastic, moist, soft		6 20.0-24.0	4.0 4.0	20.0-21.0 258 β 10600 γ	CL	Analytical Sample No. BHKD1-23, BHKD1-23- ARCH collected 23.0 - 28.0 @ 1535 hrs Chain of Custody No. 105108
	21.0					21.0-22.0 170 β 10400 γ		
	22.0					22.0-23.0 186 β 9800 γ		
	23.0					23.0-24.0 206 β 9800 γ		
	24.0					24.0-25.0 190 β 9800 γ		
	24.6			7 24.0-28.0	4.0 4.0	24.0-25.0 190 β 9800 γ		
	25.0	SILTY CLAY, brownish gray, plastic, moist, medium to medium stiff, w/ occasional dolomite fragments, 5% mottling				25.0-26.0 172 β 9800 γ	CL	
	26.0							



SUBSURFACE LOG

Project Name Hematite Transport Factors Location Duel's Mountain
 Client Westinghouse Electric Company Boring No. BHKD1 Logged By T. Calhoun

Lithology		Description	Overburden	Sample #/ Depth	Penetration ft./ Recovery ft.	Field Screening Results	USCS Classification	Remarks
Elevation	Depth (ft.)							
	27.0					26.0-27.0 188 β 9000 γ		
	28.0					27.0-28.0 210 β 10000 γ		
	29.0			8 28.0-32.0	4.0 4.0	28.0-29.0 244 β 8200 γ		Analytical Sample No. BHKD1-28, BHKD1-28- ARCH collected 28.0 - 33.0 @ 1540 hrs Chain of Custody No. 105108
	30.0					29.0-30.0 172 β 9400 γ		
	31.0					30.0-31.0 178 β 9400 γ		
	32.0					31.0-32.0 154 β 10000 γ		
	33.0			9 32.0-33.0	1.0 1.0	32.0-33.0 228 β 10000 γ	CH	
		Bottom of Hole 33.0' 7/28/03						



SUBSURFACE LOG

Project Name <u>Hematite Transport Factors</u>	Location <u>Burial Pits</u>
Client <u>Westinghouse Electric Company</u>	Boring No. <u>BHKD2</u> Total Depth <u>34.0'</u>
City, State <u>Hematite, Missouri</u>	Surface Elevation _____
Project Type <u>Environmental</u>	Date Started <u>7/29/03</u> Completed <u>7/29/03</u>
Supervisor <u>Todd Calhoun</u> Driller <u>Mike Umfleet</u>	Depth to Water <u>22.0'</u> Date/Time <u>7/29/03 0900</u>
Logged By <u>Todd Calhoun</u>	Depth to Water _____ Date/Time _____

Lithology		Description	Overburden	Sample #/ Depth	Penetration ft./ Recovery ft.	Field Screening Results	USCS Classification	Remarks
Elevation	Depth (ft.)					Beta/ Gamma (cpm)		
	0.0	Ground Surface						
	1.0	SILTY CLAY, brown, sil-plastic to pl., damp, stiff, w/ manganese nodules and 5% gray mottling		1 0.0-4.0	4.0 2.2	0.0-1.0 1538 β 40000 γ	CL	
	2.0		Plastic fragments recovered, ~1.2 ft, Scanned very hot					
	3.0					2.0-4.0 2232 β 26000 γ		
	4.0							
	5.0			2 4.0-8.0	4.0 4.0	4.0-5.0 2162 β 58000 γ		Analytical Sample No. BHKD2-04, BHKD2-04-ARCH collected 4.0 - 10.0 @ 0906 hrs Chain of Custody No. 105108
	6.0					5.0-6.0 3402 β 50000 γ		
	7.0					6.0-7.0 644 β 32000 γ		
	8.0					7.0-8.0 406 β 24000 γ		



SUBSURFACE LOG

Project Name Hematite Transport Factors Location Burial Pits
 Client Westinghouse Electric Company Boring No. BHKD2 Logged By T. Calhoun

Lithology		Description	Overburden	Sample # Depth	Penetration ft/ Recovery ft.	Field Screening Results	USCS Classification	Remarks
Elevation	Depth (ft.)							
	9.0	SILTY CLAY, brown, plastic, damp, medium to stiff, w/ 5% gray mottling and manganese nodules		3 8.0-12.0	4.0 3.3	8.0-9.0 1208 β 48000 γ	CH	
	10.0					9.0-10.0 3782 β 90000 γ		
	10.8					10.0-11.0 490 β 60000 γ		
	12.0					11.0-12.0 410 β 26000 γ		
	13.0	SILTY CLAY, brown, plastic, moist, medium to medium stiff, w/ 15% gray mottling		4 12.0-16.0	4.0 4.0	12.0-13.0 616 β 58000 γ	CL	Analytical Sample No. BHKD2-13, BHKD2-13- ARCH collected 13.0 - 17.0 @ 0914 hrs Chain of Custody No. 105108
	14.0					13.0-14.0 1768 β 80000 γ		
	15.0					14.0-15.0 1390 β 26000 γ		
	16.0					15.0-16.0 380 β 26000 γ		
	17.0				5 16.0-20.0	4.0 2.7		



SUBSURFACE LOG

Project Name Hematite Transport Factors Location Burial Pits
 Client Westinghouse Electric Company Boring No. BHKD2 Logged By T. Calhoun

Lithology		Description	Overburden	Sample #/ Depth	Penetration ft./ Recovery ft.	Field Screening Results	USCS Classification	Remarks	
Elevation	Depth (ft.)								
	18.0	Wet ~ 22.6				17.0-18.0 808 β 34000 γ	CL	Analytical Sample No. BHKD2-23, BHKD2-23- ARCH collected 23.0 - 34.0 @ 0920 hrs Chain of Custody No. 105108	
	19.0					18.0-19.0 466 β 26000 γ			
	20.0					19.0-20.0 282 β 24000 γ			
	21.0		6 20.0-24.0	4.0 3.0	20.0-21.0 496 β 28000 γ				
	22.0				21.0-22.0 452 β 30000 γ				
	23.0				22.0-23.0 356 β 26000 γ				
	23.5				23.0-24.0 426 β 24000 γ				
	24.0		SILTY CLAY, brownish gray, silty-plastic to plastic, moist to wet, stiff, w/ 15% brown mottling, w/ chert fragments		7 24.0-28.0	4.0 2.7			24.0-25.0 228 β 58000 γ
	25.0								25.0-26.0 2290 β 58000 γ
	26.0								



SUBSURFACE LOG

Project Name Hematite Transport Factors Location Burial Pits
 Client Westinghouse Electric Company Boring No. BHKD2 Logged By T. Calhoun

Lithology		Description	Overburden	Sample # Depth	Penetration ft./ Recovery ft.	Field Screening Results	USCS Classification	Remarks
Elevation	Depth (ft.)							
	27.0	Limonite staining 31.1' - 31.4'				26.0-27.0 496 β 30000 γ		
	28.0					27.0-28.0 512 β 24000 γ		
	29.0			8 28.0-32.0	4.0 4.0	28.0-29.0 818 β 34000 γ		
	30.0					29.0-30.0 882 β 24000 γ		
	31.0					30.0-31.0 566 β 30000 γ		
	32.0					31.0-32.0 356 β 34000 γ		
	33.0	SILTY CLAY, gray, plastic, moist, medium stiff Sandy lense 32.8' - 33.0'		9 32.0-34.0	2.0 2.0	32.0-33.0 404 β 26000 γ	CH	
	33.6					33.0-34.0 312 β 24000 γ		
	34.0	CLAYEY SILTY SANDY GRAVEL, gray, wet, dense					GC-GM	
		Bottom of Hole 34.0' 7/29/03						



SUBSURFACE LOG

Project Name	<u>Hematite Transport Factors</u>	Location	<u>Red Barn – Cistern Burn Pit Area</u>	
Client	<u>Westinghouse Electric Company</u>	Boring No.	<u>BHKD3</u>	Total Depth <u>27.0'</u>
City, State	<u>Hematite, Missouri</u>	Surface Elevation	_____	
Project Type	<u>Environmental</u>	Date Started	<u>7/29/03</u>	Completed <u>7/29/03</u>
Supervisor	<u>Todd Calhoun</u>	Driller	<u>Mike Umfleet</u>	Depth to Water <u>21.0'</u> Date/Time <u>7/29/03 1120</u>
Logged By	<u>Todd Calhoun</u>	Depth to Water	_____ Date/Time _____	

Lithology		Description	Overburden	Sample #/ Depth	Penetration ft./ Recovery ft.	Field Screening Results	USCS Classification	Remarks
Elevation	Depth (ft.)					Beta/ Gamma (cpm)		
	0.0	Ground Surface						
	0.5	SILTY CLAY, brown, sli-plastic, dry, medium, w/ scattered rock fragments		1 0.0-4.0	4.0 3.0	0.0-1.0 10694 β 46000 γ	CL	Encountered gravels 0.5-0.8. Advanced sampler to depth with 140# automatic hammer. 23000 cpm recorded for gravels.
	0.8	GRAVELS, brown/gray, dry, compact, up to ½ "					GP	
	2.0	SILTY CLAY, brown, plastic, damp, medium to stiff, w/ 15% limonite/gray mottling, w/ manganese nodules				1.0-2.0 394 β 12000 γ	CL	
	3.0					2.0-3.0 358 β 10000 γ		
	4.0					3.0-4.0 324 β 12000 γ		
	5.0			2 4.0-8.0	4.0 0.9	4.0-8.0 562 β 16000 γ		
	6.0							
	7.0							
	8.0							



SUBSURFACE LOG

Project Name Hematite Transport Factors Location Red Barn – Cistern Burn Pit Area
 Client Westinghouse Electric Company Boring No. BHKD3 Logged By T. Calhoun

Lithology		Description	Overburden	Sample #/ Depth	Penetration ft./ Recovery ft.	Field Screening Results	USCS Classification	Remarks
Elevation	Depth (ft.)							
	9.0	Moist ~ 9.0'		3 8.0-12.0	4.0 4.0	8.0-9.0 5008 β 26000 γ		Analytical Sample No. BHKD3-08, BHKD3-08- ARCH collected 8.0 - 13.0 @ 1127 hrs Chain of Custody No. 105108
	10.0					9.0-10.0 14682 β 48000 γ		
	11.0					10.0-11.0 1362 β 12000 γ		
	12.0					11.0-12.0 1394 β 14000 γ		
	13.0 13.3				4 12.0-16.0	4.0 4.0		
	14.0	SILTY CLAY, brown, plastic, moist, medium, w/ chert and manganese nodules, limonite staining				13.0-14.0 304 β 14000 γ		
	15.0					14.0-15.0 210 β 12000 γ		
	16.0					15.0-16.0 340 β 14000 γ		
	17.0	SILTY CLAY, brown, plastic, moist, stiff, w/ chert and manganese nodules, 5% limonite staining		5 16.0-20.0	4.0 4.0	16.0-17.0 264 β 14000 γ	CL	Analytical Sample No. BHKD3-16, BHKD3-16- ARCH



SUBSURFACE LOG

Project Name Hematite Transport Factors

Location Red Barn - Cistern Burn Pit Area

Client Westinghouse Electric Company

Boring No. BHKD3 Logged By T. Calhoun

Lithology		Description	Overburden	Sample # Depth	Penetration ft./ Recovery ft.	Field Screening Results	USCS Classification	Remarks		
Elevation	Depth (ft.)									
	18.0	Wet ~ 21.8'				17.0-18.0 208 β 16000 γ	CL	collected 16.0 - 20.0 @ 1134 hrs Chain of Custody No. 105108		
	19.0					18.0-19.0 212 β 18000 γ				
	20.0					19.0-20.0 190 β 12000 γ				
	21.0			6 20.0-24.0	4.0 4.0	20.0-21.0 234 β 15400 γ				
	22.0					21.0-22.0 222 β 16000 γ				
	23.0					22.0-23.0 206 β 14600 γ				
	23.5					23.0-24.0 210 β 1100 γ				
	24.0		SILTY CLAY, brownish gray, plastic, wet, medium, w/ 10% brown mottling, w/ dolomite fragments			24.0-25.0 236 β — γ			CL	Analytical Sample No. BHKD3-23, BHKD3-23- ARCH collected 23.0 - 27.0 @ 1142 hrs Chain of Custody No. 105108 No gamma Readings 24.0-27.0
	25.0			7 24.0-27.0	3.0 3.0	25.0-26.0 184 β — γ				
	26.0									



SUBSURFACE LOG

Project Name Hematite Transport Factors

Location Red Barn - Cistern Burn Pit Area

Client Westinghouse Electric Company

Boring No. BHKD3 Logged By T. Calhoun

Lithology		Description	Overburden	Sample # Depth	Penetration ft./ Recovery ft.	Field Screening Results	USCS Classification	Remarks
Elevation	Depth (ft.)							
	27.0					26.0-27.0 276 β - Y		
		Bottom of Hole 27.0' 7/29/03						



SUBSURFACE LOG

Project Name Hematite Transport Factors Location Restricted Area # 1
 Client Westinghouse Electric Company Boring No. BHKD4 Total Depth 30.0'
 City, State Hematite, Missouri Surface Elevation _____
 Project Type Environmental Date Started 7/30/03 Completed 7/30/03
 Supervisor Todd Calhoun Driller Brian Fingers Depth to Water 28.0' Date/Time 7/30/03 0925
 Logged By Todd Calhoun Depth to Water _____ Date/Time _____

Lithology		Description	Overburden	Sample #/ Depth	Penetration ft./ Recovery ft.	Field Screening Results	USCS Classification	Remarks
Elevation	Depth (ft.)					Beta/ Gamma (cpm)		
	0.0	Ground Surface						
	0.7	GRAVELS (DGA), brown/gray, dry		1 0.0-4.0	4.0 3.0	0.0-1.0 354 β 6000 γ	GW	Analytical Sample No. BHKD4-02, BHKD4-02- ARCH collected 2.0 - 14.0 @ 0936 hrs Chain of Custody No. 105109
	1.0	SILTY CLAY, brown, plastic, damp, medium, w/ manganese and chert nodules				1.0-2.0 240 β 16000 γ	CL	
	2.0					2.0-3.0 284 β 18000 γ		
	3.0					3.0-4.0 224 β 18000 γ		
	4.0					4.0-8.0 294 β 16000 γ		
	5.0			2 4.0-8.0	4.0 0.8			
	6.0							
	7.0							
	8.0							



SUBSURFACE LOG

Project Name Hematite Transport Factors Location Restricted Area # 1
 Client Westinghouse Electric Company Boring No. BHKD4 Logged By T. Calhoun

Lithology		Description	Overburden	Sample #/ Depth	Penetration ft./ Recovery ft.	Field Screening Results	USCS Classification	Remarks
Elevation	Depth (ft.)							
	18.0	SILTY CLAY, grayish brown, moist, stiff, plastic w/ manganese nodules, 15% limonite staining				17.0-18.0 232 β 15600 γ	CL	Analytical Sample No. BHKD4-24, BHKD4-24- ARCH collected 24.0 - 30.0 @ 0945 hrs Chain of Custody No. 105109
	19.0					18.0-19.0 256 β 15600 γ		
	20.0					19.0-20.0 268 β 17200 γ		
	21.0			6 20.0-24.0	4.0 4.0	20.0-21.0 254 β 15000 γ		
	22.0					21.0-22.0 258 β 15200 γ		
	23.0					22.0-23.0 212 β 16400 γ		
	23.5					23.0-24.0 244 β 16400 γ		
	24.0					24.0-25.0 260 β 16000 γ		
	25.0			7 24.0-28.0	4.0 3.0	25.0-26.0 226 β 13000 γ		
	26.0							



SUBSURFACE LOG

Project Name Hematite Transport Factors Location Restricted Area # 1
 Client Westinghouse Electric Company Boring No. BHKD4 Logged By T. Calhoun

Lithology		Description	Overburden	Sample #/ Depth	Penetration ft./ Recovery ft.	Field Screening Results	USCS Classification	Remarks
Elevation	Depth (ft.)							
	27.0	Wet ~ 28.0'				26.0-27.0 214 β 14000 γ	SW	
	28.0					27.0-28.0 240 β 16200 γ		
	29.0		8 28.0-30.0	2.0 1.0	28.0-30.0 218 β 14400 γ			
	29.6							
	30.0	SAND W/ GRAVEL, gray, wet, dense, gravels up to ¼"						
		Bottom of Hole 30.0' 7/30/03						



SUBSURFACE LOG

Project Name Hematite Transport Factors Location Restricted Area # 2
 Client Westinghouse Electric Company Boring No. BHKD5 Logged By T. Calhoun

Lithology		Description	Overburden	Sample # Depth	Penetration ft./ Recovery ft.	Field Screening Results	USCS Classification	Remarks
Elevation	Depth (ft.)							
	9.0			3 8.0-12.0	4.0 2.5	8.0-9.0 1092 β 20000 γ		
	10.0					9.0-10.0 362 β 14000 γ		
	11.0					10.0-11.0 308 β 15000 γ		
	12.0					11.0-12.0 298 β 15400 γ		
	13.0	SILTY CLAY, brown, damp to moist, medium plastic, w/ manganese nodules, 10% limonite mottling		4 12.0-16.0	4.0 3.0	12.0-13.0 690 β 17600 γ	CH	
	14.0					13.0-14.0 316 β 15400 γ		
	15.0					14.0-15.0 274 β 15600 γ		
	16.0					15.0-16.0 238 β 15800 γ		
	17.0			5 16.0-20.0	4.0 3.1	16.0-17.0 958 β 18400 γ		



SUBSURFACE LOG

Project Name Hematite Transport Factors Location Restricted Area # 2
 Client Westinghouse Electric Company Boring No. BHKD5 Logged By T. Calhoun

Lithology		Description	Overburden	Sample #/ Depth	Penetration ft./ Recovery ft.	Field Screening Results	USCS Classification	Remarks
Elevation	Depth (ft.)							
	18.0					17.0-18.0 282 β 16400 γ		
	19.0					18.0-19.0 326 β 15200 γ		
	20.0	SILTY CLAY, brown, moist to wet, plastic medium, w/ manganese nodules, 15% limonite mottling		6 20.0-24.0	4.0 3.7	19.0-20.0 348 β 14600 γ	CL	Analytical Sample No. BHKD5-19, BHKD5-19- ARCH, BHKD5-19- PSA collected 19.0 - 24.0 @ 1123 hrs Chain of Custody No. 105109
	21.0	Wet ~ 21.0'				20.0-21.0 340 β 16600 γ		
	22.0					21.0-22.0 278 β 16000 γ		
	22.6					22.0-23.0 250 β 15600 γ		
	23.0	SILTY CLAY, brownish gray, moist to wet, plastic medium stiff, w/ 20% limonite mottling				23.0-24.0 226 β 14600 γ	CL	
	24.0			7 24.0-28.0	4.0 3.1	24.0-25.0 284 β 15600 γ		
	25.0					25.0-26.0 258 β 15200 γ		
	26.0							



SUBSURFACE LOG

Project Name Hematite Transport Factors

Location Restricted Area # 2

Client Westinghouse Electric Company

Boring No. BHKD5 Logged By T. Calhoun

Lithology		Description	Overburden	Sample # Depth	Penetration ft./ Recovery ft.	Field Screening Results	USCS Classification	Remarks
Elevation	Depth (ft.)							
	27.0					26.0-27.0 264 β 14600 γ		Analytical Sample No. BHKD5-27, BHKD5-27- ARCH, BHKD5-27- PSA collected 27.0 - 31.0 @ 1127 hrs Chain of Custody No. 105109
	28.0					27.0-28.0 244 β 15600 γ		
	29.0			8 28.0-31.0	3.0 3.0	28.0-29.0 242 β 14000 γ		
	29.8					29.0-30.0 244 β 14000 γ		
	30.0	SILTY CLAY, gray, plastic, wet, medium				30.0-31.0 246 β 14000 γ	CL	
	30.5							
	31.0	CLAYEY SAND W/ GRAVEL, gray, wet, compact to dense					SC	
		Bottom of Hole 31.0' 7/30/03						

APPENDIX C

)

)

)

Appendix C
Particle Size Distribution Results



Geotechnical Laboratory
PO Box 4339
1570 Bear Creek Road
Oak Ridge TN 37830
865/482-6497

CERTIFICATE OF ANALYSIS

Bill Tierney
Severn Trent Laboratories
13715 Rider Trail North
Earth City, MO 63045

September 11, 2003

This is the Certificate of Analysis for the following samples:

Project ID:	STL – St. Louis
Project Number:	801576.01010000
COC/RFA No.:	114361
Date Received by Lab:	September 3, 2003
Number of Samples:	Six (6)
Sample Type:	Soil

I. Introduction/Case Narrative

Six soil samples were received by the Shaw Geotechnical Laboratory on September 11, 2003. The samples were submitted for determination of particle-size distribution.

Please see Appendix A, Sample Number Cross Reference List; Appendix B, Analysis Results; and Appendix C, Chain-of-Custody and Request-for-Analysis Records.

Reviewed and Approved:

Ralph Cole
Laboratory Manager, Geotechnical Services

II. Analytical Results/Methodology

REFERENCES: United States Army Corps of Engineers (USACE), Engineer Manual 1110-2-1906, *Laboratory Soils Testing*, appendix II, 1970; United States Environmental Protection Agency, SW846, *Test Methods for Examining Solid Waste, Physical/Chemical Methods*, 3rd ed., Nov 1986 (EPA SW-846). Annual Book of ASTM Standards, Section 4, Construction, Volume 04.08, *Soil and Rock (I)*, and Volume 04.09, *Soil and Rock (II)*, 2003.

Particle-Size Analysis of Soils.....ASTM D 422
Laboratory Determination of Water (Moisture) Content of Soil and Rock.....ASTM D 2216

III. Quality Control

Quality control checks such as duplicates and spikes (QC samples), are not normally applicable to geotechnical testing. This is due largely to the inability of obtaining samples with known characteristics, the heterogenous nature of the samples, and quality control procedures built-in to the analytical method.

QC measures to ensure accuracy and precision of test results include the following:

- 100% verification of all numerical results - raw data entries, transcriptions and calculations entered by lab technicians are checked, recalculated and verified. Most data calculations are performed by computer programs.
- Data validation through test reasonableness - summaries of all test results for individual reports are reviewed to determine the overall reasonableness of data and to determine the presence of any data that may be considered outliers.
- Quality control procedures are built into most standardized geotechnical procedures. For example, liquid limit and plastic limit analyses call for re-analyses and specify acceptance criteria.
- Routine instrument calibration - instruments, gauges and equipment used in testing are calibrated on a routine basis. All instrument calibration follows ASTM or manufacturer guidelines.
- Maintenance of all past calibration records - calibration records and certification documents of all instruments, gauges and equipment are updated routinely and maintained in the Quality Control Coordinators Quality/Operations files.
- Certified and trained personnel - all technicians are certified by the National Institute for Certification of Engineering Technicians (NICET) in geotechnical soil testing, and are

Page 3 of 17
September 11, 2003
Bill Tierney
Severn Trent Laboratories
STL – St. Louis
Project No. 801576.01010000

**Shaw Geotechnical
Laboratory
Oak Ridge TN
865/482-6497**

trained in the application of standard laboratory procedures for geotechnical analyses as well as the quality assurance measures implemented by Shaw.

IV. Data Qualification

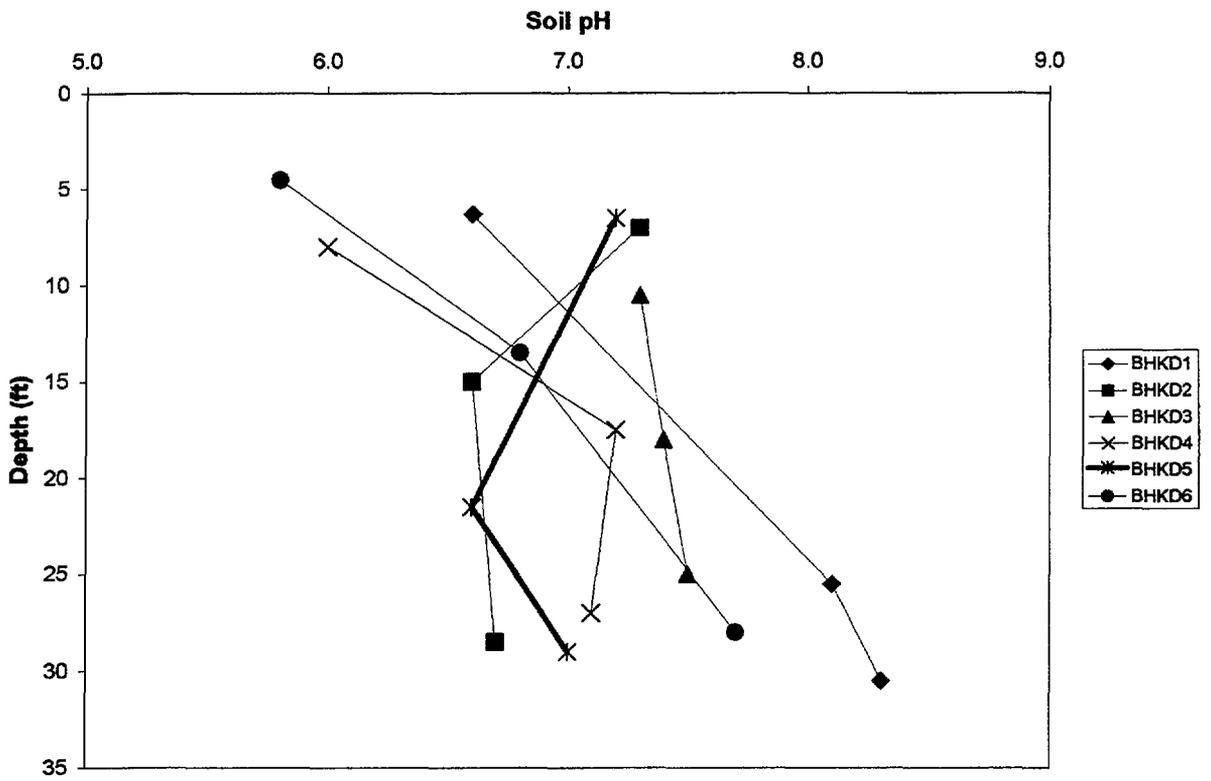
None.

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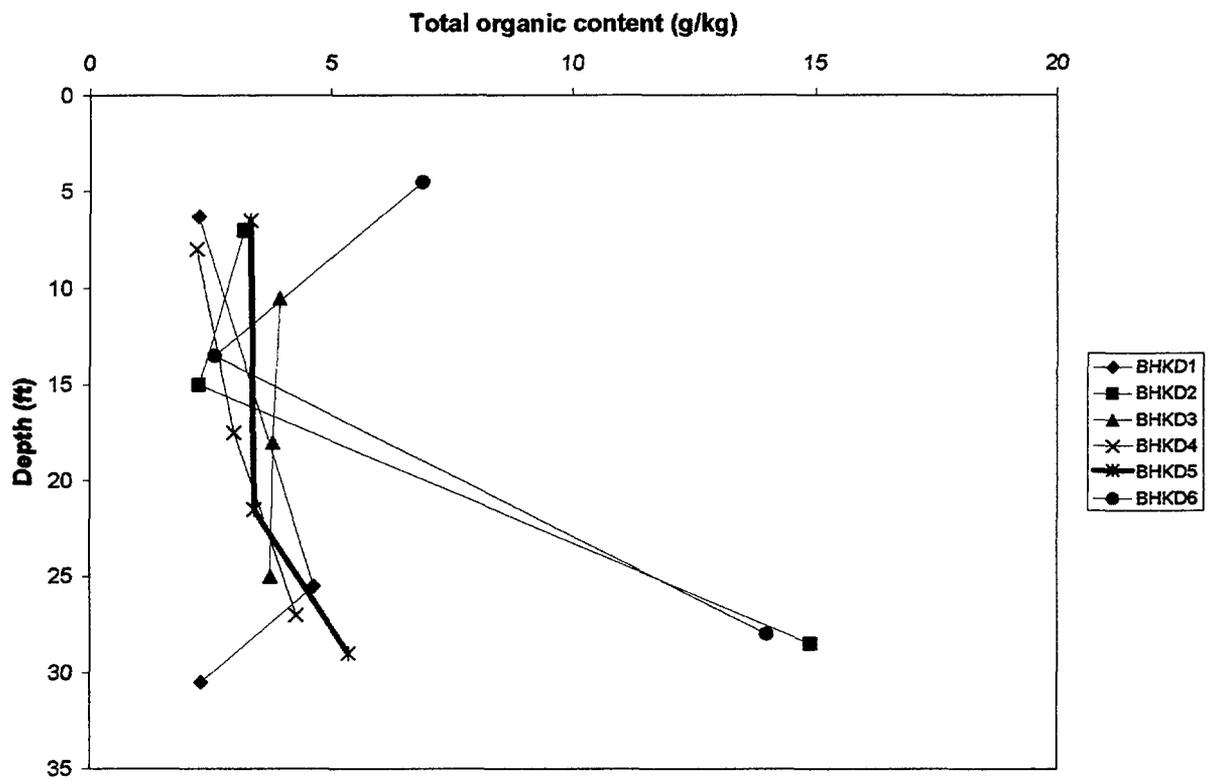
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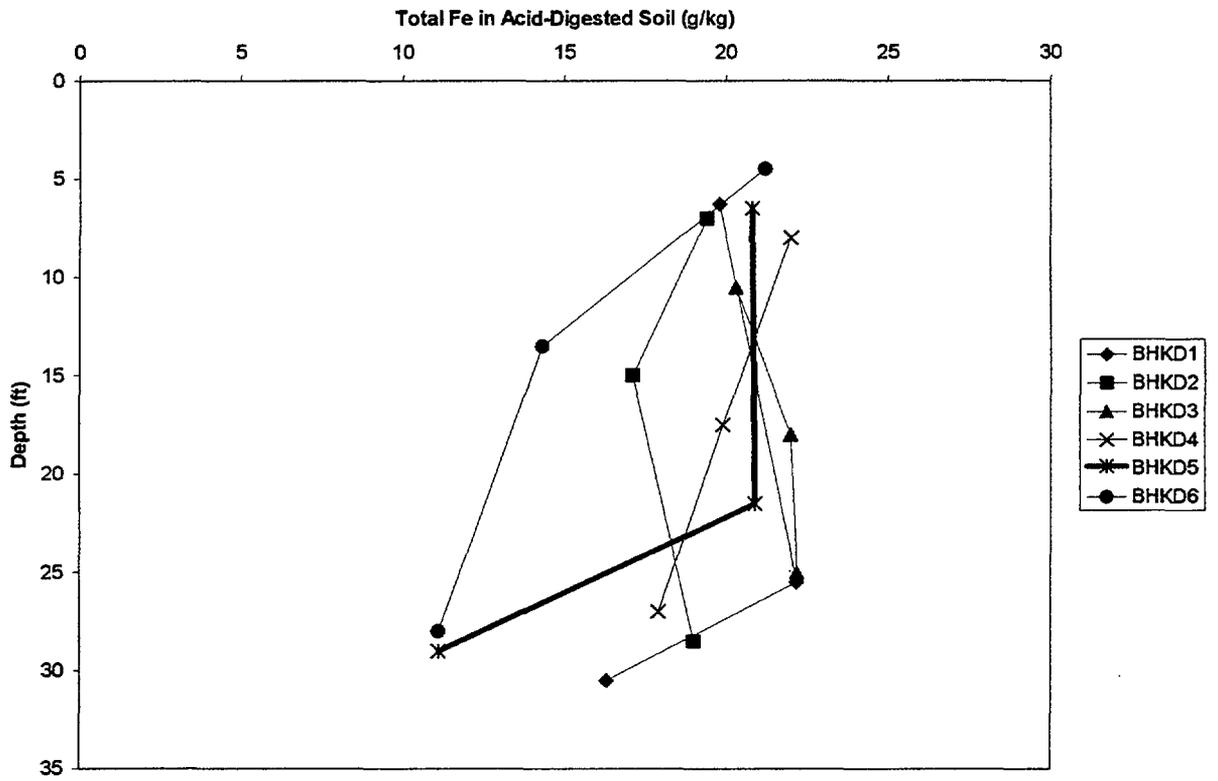
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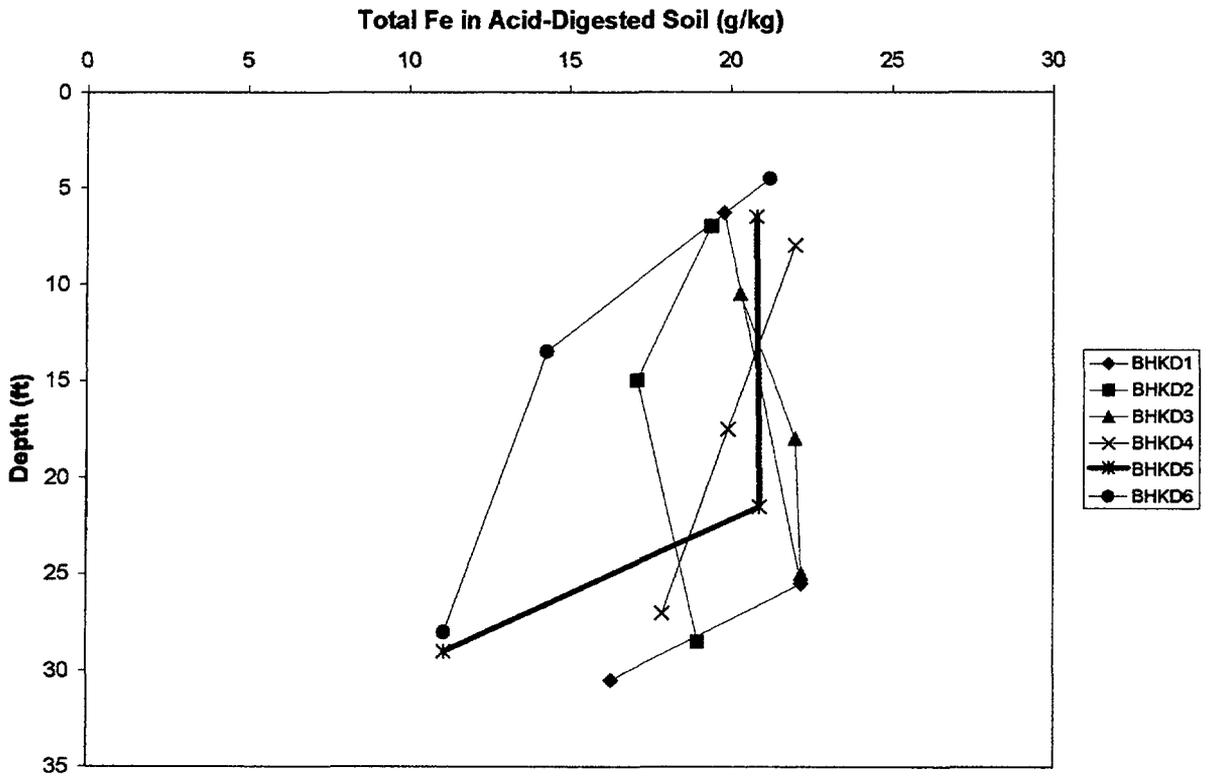
Appendix D
Soil Properties vs. Depth



Soil pH vs depth in samples collected from the Hematite site for Kd measurements







**Westinghouse****Hematite Former Fuel Cycle Facility Decommissioning**

TITLE: Historical Site Assessment**USERS:** Decommissioning Staff**REVISION:** 0

Owner:

Karen Ann Craig

Date:

5/20/03

Reviewer:

Phillip J. Malich

Date:

5/20/03

Director:

Thomas H. Dent

Date:

5/20/03

(effective date)

Official Record Electronically Approved in EDMS 2000

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**1.0 GLOSSARY OF TERMS, ACRONYMS AND ABBREVIATIONS**

ABB – Asea Brown Boveri

ACOE – Army Corps of Engineers

ADU – Ammonium Diurate

AEC – Atomic Energy Commission

ASTM – American Society for Testing and Materials

CaF₂ – Calcium Fluoride

CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act

CE – Combustion Engineering

CSSG – Clay, Silty, Sandy Gravel

DA – Disassociated Ammonia

DSCC – Deeper, Silty Clay/Clay

EPA – Environmental Protection Agency

HEU – Highly Enriched Uranium

HF – Hydrofluoric Acid

Historical Site Assessment (HSA) – a detailed investigation to collect existing information, primarily historical, on a site and its surroundings.

Impacted Area – any area that is not classified as non-impacted. Areas with a possibility of containing residual radioactivity in excess of natural background or fallout levels.

FFCF – Former Fuel Cycle Facility

MDNR – Missouri Department of Natural Resources

MTR – Materials Test Reactors

N₂ – Nitrogen Gas

NH₃ – Anhydrous Ammonia



Non-Impacted Area – areas where there is no reasonable possibility (extremely low probability) of residual contamination.

NRC – United States Nuclear Regulatory Commission

NSSSC – Near Surface Silt, Silty-Clay

PCE - Perchloroethylene

RI/FS – Remedial Investigation/Feasibility Study

SNM – Special Nuclear Material

TCE – Trichloroethylene

UF₄ – Uranium Tetrafluoride

UF₆ – Uranium Hexafluoride

UO₂ – Uranium Oxide

UO₂F₂ – Uranyl Fluoride

U₃O₈ – Uranium Oxide

UNC – United Nuclear Corporation

2.0 EXECUTIVE SUMMARY

Throughout its history, Hematite's primary function has been to manufacture uranium metal and uranium compounds from natural and enriched uranium for use as nuclear fuel. From its inception in 1956 through 1974 the facility was used primarily in support of Government contracts that required production of highly enriched uranium products. From 1974 through the plant closure in 2001 the focus changed from Government contracts to commercial fuel production plant. Over the lifetime of the facility there have been six owners. Mallinckrodt, United Nuclear and Gulf United Nuclear owned the plant for the government focused phase of operations. Combustion Engineering, ABB and Westinghouse owned the plant during the commercial phase of operations.

3.0 PURPOSE OF HISTORICAL SITE ASSESSMENT



This Historical Site Assessment (HAS) compiles the existing information about the Hematite Former Fuel Cycle Facility (FFCF) to describe the sites complete history from the start of site activities to the present time. The primary objectives of this assessment are to:

- Identify potential or likely sources of contamination
- Determine if the site poses a threat to human health and the environment
- Differentiate impacted from non-impacted areas
- Provide input into scoping and characterization survey design
- Provide an assessment of the likelihood of contaminant migration

4.0 PROPERTY IDENTIFICATION

4.1 Physical Characteristics

4.1.1 Name

The site is the Hematite Former Fuel Cycle Facility and is now owned by Westinghouse Electric Co.

4.1.2 Location

The Hematite Facility is located at:

3300 State Road P
Festus, MO 63028

4.1.3 Topography

The Pleistocene terrace deposit has a surface topography that slopes gently to the southeast eventually blending with the alluvial floodplain deposits of the Joachim Creek, a tributary of the Mississippi River.

4.2 Environmental Setting

In 1997 general and Site specific information was gathered to create an understanding of the geology and hydrogeology of the area. Major aquifers in the area as well as their uses were identified. The bedrock structure and stratigraphic relations have been determined. The unconsolidated sediments, their depositional environment, lithology and stratigraphic relations have been determined. In 1998, a more thorough understanding of the hydrogeology and geology at the Site was obtained as part of continuing investigations.



This section provides a brief summary of the geology, hydrogeology, hydrology and provides some information regarding public water supply. There is a basic understanding of the hydrogeology at the Site based on previous investigations: Leggette, Brashears & Graham, Inc., 1998, (Ref. 1), Gateway Environmental Associates, Inc., 1997, (Ref. 2); a few points are presented below. In the hydrology sub-section, a gross summary of precipitation and stream characteristics is provided.

The Water Supply sub-section introduces the facts that nearby water users are supplied by ground-water sources (wells) and no nearby public drinking water sources are known to be from surface water sources. According to Westinghouse, Jefferson County Health officials during a community relations interview, indicated they believe that some shallow wells (10-20 feet) in Hematite may be producing from a sandy layer, which in their opinion may be influenced by surface water.

4.2.1 Geology

The Site is on the north, northeast flank of the Precambrian age St. Francis Mountains uplift, which created the Ozark Dome. Cambrian, Ordovician, Silurian, Devonian and Mississippian age sedimentary formations of various depositional environments are draped on the flanks of the Ozark Dome. The Site is situated over these sedimentary formations. Based upon the "Missouri Geologic Map, 1979" (Ref. 3) and the "Bedrock Geologic Map of the Festus 7.5 Minute Quadrangle, Jefferson County, Missouri" (Ref. 4) the uppermost bedrock beneath the Site is the lower Ordovician Canadian series, Jefferson City Dolomite.

The Jefferson City Dolomite is described in Martin et al. (Ref. 5) as mostly light-brown to medium-brown, medium to finely crystalline dolomite and argillaceous dolomite. Chert, which is not abundant, is typically oolitic, banded, mottled or sandy. Lithologic succession within the formation is complex and varies among locations. The Jefferson City Dolomite, typically is 125 to 325 feet thick, is bounded by the overlying Cotter Formation also mostly a dolomite, and beneath by the Roubidoux Formation that is dominantly a sandy dolomite with lesser beds of dolomitic sandstone and dolomite.

The indurated sedimentary rocks in this area dip gently and uniformly to the north, northeast. There are no mapped or suspected faults within several miles of the Site.

4.2.1.1 Site Specific Bedrock Stratigraphy

In 1956, Mallinckrodt Chemical Company installed an industrial water supply well for the Plant, which was logged by a State of Missouri geologist. The "Missouri Geological Survey and Water Resources Log No. 14993, 1956," (Ref. 6) documents the bedrock stratigraphy encountered by the well. Unconsolidated

sediments are present to 35 feet below ground surface (bgs). The Jefferson City Dolomite extended from 35 to 125 feet bgs, the Roubidoux Formation from 125 to 255 feet bgs, the Gasconade Formation from 255 to 470 feet bgs, the Gunter Sandstone Member of the Gasconade Formation from 455 to 470 feet bgs and the Eminence Dolomite, from 470 to the total depth of the well, which is 600 feet bgs.

4.2.1.2 Unconsolidated Sediments (Pleistocene and Quaternary)

The Site is positioned in the valley of the Joachim Creek, which has incised into the surrounding Cotter and Jefferson City Formations. During late Pleistocene glacial regression, terrace units were deposited in the Joachim Creek valley. These units are chiefly derived from loess and colluvium. Later during the Holocene, alluvium was deposited in the Joachim Creek valley.

The Reference 4 describes the Holocene alluvium as clay, silt, sand and gravel chiefly derived from local loess and colluvium. Colluvium is described as a mixture of residuum, from fines to cobbles, and loess that is moving down slope as a result of slope wash and gravity. Colluvium accumulates at the base of valley slopes and in large valleys washes onto the floodplain, blending with the alluvium. Terraces typically contain lenticular beds of sand and gravel interbedded with silt and clay.

Several subsurface investigations within the terrace deposit at and near the Plant have produced geotechnical and geologic information, which allows a general stratigraphic interpretation to be made.

The more comprehensive geologic investigation performed in 1998 and 1999 greatly refined the knowledge of the unconsolidated subsurface. The study supported the concept of a sand/gravel unit present in the subsurface above the uppermost bedrock unit. Soil collected during the drilling process was analyzed for physical properties (i.e., permeability, coefficient distribution, etc.) and/or chemical laboratory parameters. Generally, the geologic information collected during this investigation corroborated geologic data obtained during previous studies. Specifically, five unique hydrostratigraphic units are located beneath the Plant portion of the Site:

- a near surface silt, silty-clay (NSSSC);
- a fat clay;
- a deeper, silty clay/clay (DSCC);
- a clayey, silty, sandy-gravel (CSSG) sometimes later in this document is referred to as the sandy-gravel unit; and
- The Jefferson City Dolomite.
- Roubidoux Formation

4.2.2 Hydrogeology

Reference 1 characterized the near-surface hydrostratigraphic units at the Site. In that investigation, two ground-water monitoring wells were generally installed at each location to serve the purposes of discrete geologic unit mapping and sampling and to provide vertical hydraulic gradient information.

As part of the hydrogeologic studies, single-well hydraulic conductivity tests were performed to characterize the horizontal hydraulic conductivity of distinct geologic horizons. From these tests, the average hydraulic conductivities of the unconsolidated materials above bedrock were found to be 3×10^{-5} cm/sec and 8×10^{-4} cm/sec for the NSSSC and DSCC units, respectively. Single-well testing of the Jefferson City Dolomite showed a hydraulic conductivity of 8×10^{-4} cm/sec. Fracturing and other features causing secondary porosity and permeability in the rock affect the hydrogeologic characteristics of the Jefferson City Dolomite and other bedrock formations. The primary permeability of the bedrock (i.e., through the solid rock matrix) is measured to be low, thus, slow ground-water velocity would be predicted. However, ground water flowing discretely through fractures, partings, or other secondary permeability features may do so at a much higher velocity. The size, density, and orientation of these fractures and partings determine the effective hydraulic conductivity of the bedrock.

Potentiometric surface (ground-water elevation) maps were constructed for the NSSSC, DSCC, and Jefferson City units to determine ground-water flow direction and hydraulic gradient. In the NSSSC unit, ground water flows to the northeast and southeast. In the DSCC and Jefferson City units, ground water flows to the southeast. Recent work shows the Roubidoux Fm.'s piezometric surface as also indicating southeast flow direction. The orientation of the fractures and other secondary permeability features influence ground-water flow directions and gradients in the Jefferson City and other bedrock formations.

In 2002, responding to the need for more hydrogeologic data prompted by the discovery of trichloroethylene (TCE) contaminated private domestic wells, additional drilling and characterization was accomplished, adding to the hydrogeologic body of knowledge. That information is summarized in the Site Remedial Investigation/Feasibility Study (RI/FS) Work Plan (Ref. 7).

4.2.3 Hydrology

The "Missouri Water Atlas, 1986" (Ref. 8) was referenced to determine local stream characteristics. The Atlas shows that Joachim Creek, located along the southeast Site boundary, is a permanent flowing stream. There are several other surface water features present on the Site, including a spring, intermittent perennial and ephemeral streams, a lake and ponds.

- The Site Spring flows an estimated 1 to 10 gallons per minute (gpm) most of the year. The spring is likely a result of fracture flow in the Jefferson City-Cotter Formation, which receives its source water in the hills northwest of the Site.
- The Site Pond is a small concrete dam impoundment southwest of the Plant. It receives flow from the Site Spring and storm water runoff from the Plant area.
- The Site Creek is the effluent from below the dam of the Site Pond that receives discharge from the sanitary and storm water system. It flows through a culvert beneath the railroad track and joins the effluent from the Lake Virginia drainage basin.
- Lake Virginia/Site Creek combined tributary flows east to the Joachim Creek.
- The Northeast Site Creek flows southeast to the east of the Burial Pits and then east to its confluence with the effluent of East Lake tributary, then to the Joachim Creek.
- East Lake east of the Site is an earth impoundment lake used as a water supply for cattle. It is reported to never have been used in conjunction with Plant operations.
- North Lake Tributary is the effluent drainage from North Lake and North Tributary. This tributary crosses the terrace, west of East Lake.
- North Tributary is an intermittent stream west of North Lake.

Quantitative data regarding flow quantity, duration, peak discharge, etc. is not available for all of these features. However some observations can be made.

- The Site Spring flows virtually continually.
- The ponds and lake on the Site hold water year round. (Flow is measured at the dam of Site Pond and reported quarterly to the Missouri Department of Natural Resources (MDNR) Water Pollution Control Program.)
- The streams flow intermittently.
- The Joachim Creek is perennial.

4.2.4 Water Supply

Water for the Plant is supplied by a well located north of Building 253 within the fenced manufacturing area. Up to 36,000 gallons were withdrawn from this well daily. Well water is stored in an elevated 200,000-gallon tank and distributed as needed within the plant, primarily for process water.

According to "Water Resources Report 30, 1974" (Ref. 9) domestic and industrial water wells in the vicinity produce water from the Powell - Gasconade aquifer group which includes the Jefferson City Dolomite, the upper most bedrock unit at the Site. Wells in the area, may intersect the Jefferson City Dolomite if it is

present, but presumably do not derive significant quantities of water from it due to its poor storativity.

There are no public water supply intakes on Joachim Creek. According to an Environmental Protection Agency (EPA) field investigation report (1990) "Preliminary Assessment, Hematite Radioactive Site, Hematite, Jefferson County, Missouri, 1990" (Ref. 10) most of the residents of Hematite receive their drinking water from Rural Water District #5. The report also states that surface water is not used for drinking within at least a four-mile radius of the Site.

4.2.5 Meteorology

The "Missouri Water Atlas, 1986" (Ref. 8) was referenced to determine local precipitation. The area receives an average of 38 inches of precipitation per year, with 12 inches of average annual runoff. The maximum 10-day event expected precipitation is 9 inches in a given 25-year event.

5.0 HISTORICAL SITE ASSESSMENT METHODOLOGY

5.1 Boundaries of Site

The property consists of approximately 228 acres, of which eight have most recently been used for operations. The facility is located on Missouri State Road P, between the hills to the northwest and a terrace/floodplain of Joachim Creek.

5.2 Documents Reviewed

Specific actions regarding the historical review include:

- Review of the burial area records,
- Review of plant survey data and environmental monitoring data,
- Review of plant files regarding regulatory action and license history,
- Review of plant files regarding spills and leaks,
- Review of pre-construction survey records, and
- Review of historical plant photos taken during construction activities.

In addition to this internal records review, fire insurance maps, environmental regulatory database and aerial photographs were reviewed. Below is a summary of the various sources of public record historical information reviewed in addition to the pertinent information from the review.

5.2.1 Sanborn Maps

Sanborn Fire Insurance Maps are comprised of fire risk information for various years from the late 1880s to present. The maps when available illustrate historic Site features, usage, and potential hazards. An attempt was made to acquire the Sanborn Fire Insurance Maps for the facility however according to Environmental Data Resources, owner of the Sanborn Map Company, Sanborn Fire Insurance maps were not published for this area.

5.2.2 Regulatory Database Search

Federal and State environmental history records relating to the Site and surrounding properties were reviewed. These records provide information on whether environmentally regulated or hazardous materials may have been improperly handled, stored or disposed at or near the Site.

The Federal and State record review was accomplished through a computer database (EDR, Inc.) search of facilities that appear on lists generated by federal, state and local governments. The review also considered sites surrounding the Site to a distance specified in American Society for Testing and Measurements (ASTM) Standard E 1527-00 (Ref. 11). The database identified no facilities within the specified query area.

5.2.3 Aerial Photography Review

Readily obtainable, high to medium altitude, black and white aerial photographs provided by Westinghouse, the United States Geological Survey and obtained from private sources were reviewed. These include the following years: 1937, 1954, 1956, 1959, 1960, 1962, 1966, 1971, 1973, 1974, 1975, 1978, 1980, 1986, 1990, 1991, 1993 and 1996 (Ref. 12). The available photographs were for a specific day in each of the above-referenced years. The purpose of the review was to discern visible evidence of potential environmental conditions on the Site, or contiguous areas.

In 1937 the Site contained the two existing barns in the northwest portion of the site. At least one residence and related outbuildings were located immediately southwest of the Site Pond, fronting the eastbound lane of State Highway P. Areas north and south of the railway easement, south of State Highway P, were cultivated. The Northeast Site Creek located immediately northeast from the current plant appears to have been straightened. Some trees lined the intermittent tributaries of Joachim Creek, and were dense along those tributaries south of the rail line. A fenceline and unimproved road were noted trending south-southeast from the highway, immediately southeast of current East Lake and northeast of North Lake tributary.

In 1954 one or two small structures were observed immediately south of the north-most barn. A fence was apparent around the south portion of the north-

most barn. A south-southeast trending unimproved road located immediately northeast from the existing plant, originating from State Highway P, crossed the rail line and terminated near Joachim Creek. Agricultural activities were noted in the vicinity of the current Plant and immediately south of the rail line. A potential fence line was observed south, and parallel to, the rail line. The southeast-trending unimproved road near the East Lake extended southeast of the rail line terminating near Joachim Creek.

In 1956, grading activities associated with construction of the plant facilities were observed. Disturbed or graded areas were observed northeast of the new plant structure, between the unimproved road and the Northeast Site Creek. Two plant structures were apparent in the 1959 photograph. The unimproved road located northeast from the Plant is no longer discernible in 1959, although a fenceline may have been installed in its place. Scrub vegetation is noted northeast of the Northeast Site Creek. This portion of the Site between the Northeast Site Creek and the Residence (south of Highway P) did not exhibit row crops for the remaining photographs reviewed. A footpath or potential surface drainage channel was noted trending southwest from the plant, toward the Site Pond. Grading or disturbed areas were observed on both sides of the Site Pond. Construction of Lake Virginia was noted north from the Site.

In 1960, the parcel south of the rail line contained scrub vegetation and did not exhibit row crops for the remaining photographs reviewed. A darkened circular area, potentially a small body of standing water, is located east of the Site Pond, southwest of the Site structure. In 1962, three disturbed areas or areas of distressed vegetation were noted immediately northeast of the fence line (former unimproved road), southwest of the Northeast Site Creek.

In 1966, sedimentation or a disturbed area was observed in the north portion of the Site Pond. The Site Pond appeared dry. A disturbed area, larger than that identified in the 1962 photograph, was noted immediately northeast of the fence line located between the Site structure and the Northeast Site Creek. A structure or trailer was noted in the center of the disturbed area. Excavated or disturbed areas consistent with the current locations of the evaporation ponds were noted immediately south of the plant. The East Lake had been constructed and was apparent northeast. In 1971, the four or five structures noted southwest of the barns were no longer visible. An unimproved, northeast-trending path or trail was observed southeast of the rail line. Water was discernible within the evaporation ponds.

In 1973, a disturbed area was noted immediately southwest of the Site Creek, east of the Highway. Disturbed areas were also noted immediately south of the rail line, and near existing monitoring well WS-16. Circular tracks, indicative of cattle feed areas, were evident immediately east of the East Lake. No significant changes or features were observed in 1974. In 1975, distressed vegetation was



noted immediately northeast from the plant, southwest of Northeast Site Creek. A small disturbed area was observed south of the Plant, immediately north of Joachim Creek. Construction of Missouri State Highway A was apparent east of the Site.

The 1978, 1980 and 1986 aerial photographs were taken from high altitudes limiting detailed assessment; however, changes or significant features were not observed. In 1990 and 1991, disturbed areas were noted northeast of the Site Plant, southwest of North Site Creek, and southwest of the barns. These areas may be associated with limestone gravel that was reportedly placed in similar locations. An unimproved access road from Highway P to the area northeast of the Plant was discernible. The 1991 photograph shows road and other construction associated with the water storage tank located in the north portion of the Site, north of Highway P. In 1993, the Site and immediate vicinity appear essentially as viewed today. No change was noted in 1996 from the 1993 photo.

5.3 Personal Interviews

Subsequent to the Westinghouse acquisition of the Hematite facility, numerous interviews have been conducted with former employees regarding the historical operations. Information, gathered during these interviews in addition to on-site document reviews of Site conditions, was used to describe the Site's complete history from the start of activities to the present time.

6.0 HISTORY AND CURRENT USES

6.1 History

Throughout its history, Hematite's primary function has been to manufacture uranium metal and uranium compounds from natural and enriched uranium for use as nuclear fuel. Specifically Hematite was primarily used to convert government-owned and leased uranium hexafluoride (UF₆) gas of various U-235 enrichments to uranium oxide, uranium carbide, uranium dioxide pellets and uranium metal. These products were manufactured for use by the federal government and government contractors and by commercial and research reactors approved by the Atomic Energy Commission (AEC). Research and development was also conducted at the Plant, as were uranium scrap recovery processes.

In 1955 Mallinckrodt Chemical Works purchased the parcel of farmland on which the plant sits. The Plant became operational in July of 1956 producing uranium for use in the navy nuclear fuel program. Mallinckrodt Chemical Works operated the facility until approximately May of 1961 at which time ownership was transferred to the United Nuclear Corporation (UNC). UNC provided uranium products to the federal government.

In 1970, UNC and Gulf Nuclear Corporation entered into a joint venture forming, Gulf United Nuclear Fuels Corporation (Gulf) which owned and operated the facility until the spring of 1973 when UNC closed the plant and began decommissioning. Combustion Engineering Inc. (CE) purchased the Property in May of 1974. In 1989 Asea Brown Boveri (ABB) acquired the stock of CE and began operating the facility as ABB Combustion Engineering. In April of 2000, Westinghouse purchased the nuclear operations of ABB which include the Hematite facility.

During the period prior to CE's purchase of the Facility in 1974, government projects dominated the operations on Site. During this time period the government owned all the national uranium supply and leased it to facilities as needed. In order to obtain uranium, even for government projects, a facility had to submit a request for allocation to the AEC describing the amount and enrichment of uranium needed. A review of the requests for allocation from 1959 through 1966 (the only such documents located to date) indicates that approximately 7,576 kg of uranium was requested for government-related projects and 1,887 kg of uranium was requested for commercial projects.

Much of the work on behalf of the government at the Site was classified, and therefore specific details regarding the exact nature of the processes are not known. Generally, the government work began under Mallinckrodt's supervision and then dominated Hematite production during the ownership and operation of UNC. Examples of government projects during this time include:

- production of uranium metal for nuclear submarines and a D1G destroyer reactor;
- the supply of specialized uranium oxides for the Army Package Power Reactor;
- the supply of high enriched oxides for a General Atomics' gas-cooled reactor in Fort St. Vrain, Colorado;
- the production of highly enriched metal for materials test reactors (MTR) utilized by the Navy;
- the supply of uranium-beryllium pellets for use in the "SL-1" reactor;
- the production of high enrichment uranium zirconia pellets for the Shippingsport naval reactor under contract to Bettis Laboratory;
- and the production of highly enriched oxides to General Atomics for use in the NERVA nuclear rocket projects.

Hematite also contracted directly with Oak Ridge AEC office and other government contractors for the recovery of uranium from scrap materials. Scrap recovery projects at Hematite included the recovery of uranium from scrap generated by a variety of Navy projects and CUNO filter scrap generated by the Aircraft Nuclear Propulsion program.

Although the physical design of the Plant was modified over the years, certain areas of the Plant were dedicated to particular production processes as well as certain types of work (i.e., low enrichment processes versus high enrichment processes). For example, Building 240 was historically dedicated to the chemical conversion of uranium into



compounds, solutions, and metal. Building 240 was further divided into areas for high enriched and low enriched uranium processes: the "Red Room" (area 240-2) containing high enriched conversion processes and the "Green Room" (area 240-3) containing low enriched conversion processes and high enriched scrap processing. The Red Room was specifically used for the reduction of UF_6 to uranium tetrafluoride (UF_4), the conversion of UF_4 to uranium metal, high enriched uranium scrap recovery, and other chemical conversion processes using high or fully enriched uranium.

Building 255 of the Plant was used for the fabrication of uranium compounds into physical shapes. Again, this building was segregated into areas of high enrichment and low enrichment, with area 255-2 containing the low enrichment pellet plant and area 255-3 containing the "Item Plant." The Item Plant work was classified and products coming out of the Plant were referred to only as "items," and thus, the area received its name as the Item Plant. The Item Plant was dedicated solely to classified government-related work and specifically Navy fuel production work. The Item Plant was specifically designed to process uranium dioxide into a Navy fuel product. Other activities within the Plant included the blending of uranium oxide (UO_2) with other chemical compounds.

Other areas of the Hematite Facility were used for storage, and again were separated primarily by degree of enriched material or product stored. High enrichment storage areas included Buildings 235, 250, and 252. Also, high enriched scrap was held in an outdoor, fenced 75' x 120' area to the south of the Plant.

6.1.1 Burial Pits

Beginning no later than 1965, and perhaps as early as 1958 or 1959, and continuing at least until November of 1970, on-site burial was used as a means of disposal of contaminated materials and wastes at Hematite. From 1965 until 1971 up to 40 large unlined pits were dug east of the Plant buildings. These pits were used to dispose of materials and waste generated by the Plant processes. This on-site burial was a formally authorized activity, conducted pursuant to a policy and memoranda describing the size and spacing of the pits, the thickness of the cover, and the quantity of radioactive material that could be buried in each pit. Copies of two United Nuclear Corporation Memoranda regarding burial of residues and contaminated material are attached in Appendix A.

UNC and Gulf maintained detailed logs of burials for the period of July of 1965 through November of 1970. A copy of excerpts of the Hematite burial logs is attached hereto as Appendix B. Each entry contains a date, a verbal description of the waste buried, the weight of the uranium measured for that waste and a cumulative total of the uranium buried in that particular pit. Some entries also list percent enrichment for the uranium.

The logs show a wide variety of wastes being buried in the pits. Although the number of entries is too great to include, some examples of entries include: Tile

(Red Room floor); Contam. 5 gal. Endshake oil; B.D. Chloroform; 97% Acid H₂; R.S. oil; UO₂ THO₂ Paper Towels; Unknown Oil; R.S. Acid Insoluble; Mixed Acid Residues; MB Rafinate Sample bottles; Bottle unknown organics; Pickling Solution; 1 Drum of TCE #930 unknown enr; vac. Oil; KOH Insolubles; press oil; pentachloride from vaporizer; Used Magnorite; Perclene; TCE u. metal wash; chloroethene – can cleanup; TCE Rags; Oily rags from Item floor; NbCl₅ vap. Cleanout; Item 51 Poison equipt.; and TCE-Oil-Rags.

No records of burials exist prior to July of 1965. However, an untitled memorandum has been located indicating that burial pits may have been used as early as 1958 or 1959, and that as many as three or four pits were used each year prior to 1965 (Appendix C). Accordingly, it is estimated that an additional 20-25 pits may exist for which there are no records. There is no information to indicate the nature of the material buried in these other pits.

On-site burial of radioactive material was terminated in November of 1970 as a result of an AEC citation issued for failure to adhere to revised AEC regulations concerning the quantity of material which could be buried on-site. It appears though that Gulf did not cover the final pit until 1974 when it sold the property.

There has been no substantial investigation or analysis of the extent of the contamination of the pits and the surrounding area. Rather, the pits remain in substantially the same condition as when Gulf ended on-site burial activity in November of 1970.

6.1.2 Filtrate Disposal Evaporation Ponds

The Hematite Plant has two former filtrate disposal evaporation ponds that were also used for on-site disposal of low-level contaminants and both high enrichment and low enrichment uranium materials. The two ponds consisted of a primary pond and a larger secondary/overflow pond. When constructed, the ponds were excavated to a depth of 3 feet, 4 inches and the soil removed was used to construct a 1 ½ foot high berm around each pond. The ponds were then lined with a 6 inch bed of 3 inch diameter rock, followed by a 4 inch bed of ½ inch diameter rock. The original size of the primary pond was 30 feet by 40 feet and the secondary pond was 30 feet by 85 feet. Twelve feet separated the two ponds.

The Evaporation Ponds were primarily used for the disposal of low level liquid wastes containing insoluble uranium bearing precipitates and other solids. The precipitates and solids were allowed to settle and the water evaporated naturally. As additional liquids were added to the primary pond, the overflow flowed through a pipe into the secondary pond. The ponds were originally built to receive filtrates from the low enriched ammonium diuranate (ADU) conversion facility, but were later used for the disposal of both high and low enrichment recovery waste liquid. The logs from the burial pits also contain a number of

entries reflecting disposal of various materials in the Ponds. Examples of such entries include: Filtered Perclene; Liquid from Sump; TCE from Metal Wash; Filtered Reactor Cleanout; Filtered KOH Solution; Acid Water Cleanup; HCl Solution; TCE Cleanup; Oil from Vac. Pump; Mop Water; TCE and Oil; TCE (u. Metal Wash); Acetic Acid & H₂O; H₂O and Perclene; Filtrate; Nitric Acid Wash Water; and Pickling Hood Cleanup. Entries documenting this disposal are located in the logs in Appendix B.

Immediately after CE purchased the Plant in 1974, use of the Ponds was curtailed so as to allow only disposal of spent potassium hydroxide scrubber solution from the uranium dry recycle process and liquids from startup testing of the wet recovery process. Use of the ponds was discontinued altogether in September 1978. Following the discontinued use of the ponds, 700 ft³ of sludge was pumped out of the primary pond on October 1979. The sludge was dried and shipped to licensed burial during 1982, 1983 and early 1984.

Formal decommissioning and decontamination efforts were undertaken in 1984, as specified and ordered by the U.S. Nuclear Regulatory Commission (NRC) in a March 8, 1984 letter (Ref. 13). In response, CE submitted a decommissioning plan to the NRC by letter dated May 31, 1984 (Ref. 14) (Appendix D). The NRC approved the plan by letter dated October 3, 1984 (Ref. 15). As a result of the 1984 decontamination approximately 2,800 ft³ of sludge, rock and dirt was removed from the primary pond in August 1985. Detailed sampling of the primary pond was performed during the period of August through October 1986. Additional sampling, following the remediation effort, determined the average contamination of the soil in the ponds was below the 250-pCi/g decontamination limit set by the NRC. However, contamination levels in excess of the average limit remained.

In a status report dated May 20, 1988 (Ref. 16) to NRC, CE provided further information concerning the remediation of the ponds. CE reported that core samples from the sides and bottom of the primary pond were taken and analyzed. The samples revealed an average contamination of approximately 60 pCi/g, with one sample as high as 674 pCi/g. Approximately 1,200 cubic feet of soil and rock was also removed from the secondary pond during 1987, and detailed surface soil samples were taken. The average contamination from these 150 samples was 173 pCi/g, and the highest reported level was 745 pCi/g.

During the period of 1991-1992 CE commissioned a contractor to plan and execute a soil and water study of residual contamination in the ponds. The results of this study were not consistent with the previous analyses. Rather, in this testing, the near surface soil samples from both ponds showed higher total uranium activity and further remediation of this area appears likely.

6.1.3 Red Room, Item Plant and Related Areas

Because these areas were used for high enrichment fuel production processes from at least the 1950's to the early 1970's they are highly likely to contain nuclear contamination above currently applicable limits. In fact, these areas were identified as contaminated or "hot" areas during the transition of ownership of the Plant from Gulf to CE in 1974. At that time, partial decontamination was undertaken. Specifically, equipment was removed, duct work and exhaust fans were removed, the floors were scarified and both rooms were vacuumed, steam cleaned and painted. In the Red Room, three inches of concrete was added to the floor and the roof was removed and supposedly buried on-site. However, these decontamination efforts, although acceptable at the time are probably not in compliance with current regulations for free release. Moreover, additional contamination has been identified in the areas under the Red Room floor and immediately outside the Red Room.

6.1.4 High Enrichment Storage Areas

Three buildings, as well as an outside area at the Plant, have been identified as potentially contaminated storage areas. Specifically, Building 250 (159 ft. by 20 ft., housing up to 600 storage units) in the center of the Plant was used for high enriched filter storage and high enriched UF₆ cylinder storage. Building 252 (41 ft. by 50 ft), to the south, contained up to twelve sets of storage racks, five shelves high, used to store high enriched finished products and waste. Building 235 (20 ft. by 37 ft.) was also used to store high enriched product and waste in a similar fashion. The outside storage area (75 ft. by 120 ft.) was used as a high enriched scrap holding area.

6.1.5 Spent Limestone

The Hematite plant used crushed limestone rock chips in dry scrubbers to facilitate the removal of hydrogen fluoride from off gas streams associated with the UF₆ to UO₂ conversion process. The limestone chips are partially converted to calcium fluoride in the scrubbers and the waste limestone chips are referred to as "spent limestone." After removal from the scrubbers, the spent limestone was tested to determine the level of radiological activity.

Prior to 1979, all spent limestone with radiological activity below 100 dpm/100 cm² was quarantined in a pile located in the southeast corner of the current fenced in area of the plant. Since 1979, all spent limestone with radiological activity below 100 dpm/100 cm² has been used, with NRC approval, as onsite landfill, while spent limestone with activity greater than 100 dpm/100 cm² has been quarantined in piles in the southeast corner. All spent limestone with greater than 1,000 dpm/100 cm² activity has been sent to a licensed burial facility. Sampling and testing of the material has been performed periodically, revealing uranium

contamination concentrations in the piles and the soils adjacent to and/or beneath the piles.

6.1.6 Building 101 Tile Barn

The Tile Barn formerly functioned as the emergency operations center. The building has been used to store both clean and radiologically contaminated equipment.

6.1.7 Building 110 Office Building

No work with radioactive or chemical compounds was reportedly undertaken in this building.

6.1.8 Building 115 Generator – Fire Pump building

A diesel-powered emergency generator was located in this building. No work with radioactive materials was performed in this building. A 600 gpm diesel fire water pump currently remains in the building.

6.1.9 Building 120 Wood Barn

The wood barn has been used to store both clean and contaminated equipment. The floor is dirt and may have residual contamination in low concentrations.

6.1.10 Building 230 Rod Loading

Finished pellets (standard, erbium and gadolinium) were loaded into fuel rods and assemblies for shipment offsite from Building 230. This building was built circa 1992.

6.1.11 Building 231 Warehouse

Building 231 was used to store shipping containers. Some shipping container refurbishment was performed in this area. A small potential for UO₂ contamination exists.

6.1.12 Building 235 West Vault

The West Vault was most recently used to store depleted and natural uranium. It was historically used to store high-enriched uranium. The interior of the building was painted in 1994 and contamination may be present under the paint.

6.1.13 Building 240 Recycle Recovery (Red Room, Green Room, Blue Room)

This building contains laboratory and maintenance areas, a recycle recovery area, a waste incinerator area and the former Health Physics laboratory. Support-operations were conducted for conversion, pelletizing and fuel assembly including material recycle, scrap recovery, cylinder heel recovery, quality control and analytical laboratory, maintenance, waste consolidation and disposal preparation. This building was integral to the historic operations of the facility. Past operations included the conversion of HEU using a wet conversion process and wet recovery of scrap. The effluent streams were piped to the retention ponds for settling and evaporation. The pipe system is likely to contain HEU. Numerous spills and leaks likely occurred in these areas and parts of the slab were repoured in 1974 over some existing contaminated flooring. Additionally, sub slab contamination was found during the 1989 construction of Building 253.

Building 240-1 currently houses the Health Physics and production laboratories, lunchroom and laundry for radiologically contaminated PPE. It historically housed the lunchroom, offices, locker rooms and laundry.

Building 240-2 (Red Room) was used for recycle and recovery operations. It historically included high enriched powder and metal operations, including recycle and recovery.

Building 240-3 (Green Room) is currently used for the incinerator and associated support operations. It historically included low-enriched powder operations, including ADU and oxidation/reduction furnaces.

Building 240-4 (Blue Room) currently houses the maintenance shop. It also housed the production laboratory until 1993 when it was moved to 240-1. It formerly housed low-enriched powder operations.

6.1.14 Well House

The Well House is the block building attached to the potable water tank by the double doors into the laundry room. Currently, chlorinating of potable water occurs in the building using sodium hypochlorite (bleach), and the tank marked "potable water" is used to ensure appropriate contact time. This building and the attached tank are connected to the 200,000-gallon gravity tank on the hill across State Road P, whose elevation creates a 50-psig static head throughout the system. A pressure switch in the well house automatically activates the well pump when static pressure drops below 50-psig.

Formerly, the existing chlorine contact tank was used as a pressure tank to create the static head by adding nitrogen as necessary. That operation ended when the gravity tank was built in 1991. The Well House formerly contained a mop water boil-down tank immediately east of the chlorinating tank with a storm drain under



the tank for overflow. The boil-down tank was eliminated around 1993 and the storm drain was capped with concrete.

6.1.15 Building 252 South Vault

The South Vault was used for storage of low and high enriched nuclear material. It was most recently used for storage of chemicals and low level radioactive wastes.

6.1.16 Building 253 Office

This building contains offices, various Site utilities, storage of uranium, processing areas and decontamination facilities. Within building 253 is an inner building 250 that was formerly a stand alone structure used for storage and housed the boiler, cooling tower pumps, and recycle hopper make-up.

6.1.17 Building 254 Pellet Plant

In the pelletizing buildings granules of UO_2 or uranium oxide (U_3O_8) were fed into a mill (micronizer) that produced fine powder for pressing. A starch and die lubricant were added and blended into a batch and subsequently pressed into pellets. The "Green" fuel pellets were processed through a dewaxing furnace to remove the additives and then passed through a sintering furnace where they were made into a ceramic. These furnaces were electrically heated and used disassociated ammonia to provide a reducing atmosphere.

6.1.18 Building 255 Erbia Plant

Most recent use of this building was for the special product line making erbium pellets. It was the main pellet plant from 1974 through the opening of Building 254 in 1989. This process area included agglomeration, which used cranko and freon, instead of the slugging presses, to increase particle size between the micronization/blending and pellet pressing. Additionally, Building 255-3, the current erbium recycling area, was historically called the Item Plant in which high-enriched shot to be used as reactor fuel was sized and coated.

6.1.19 Building 256

Building 256-1 was used for Pellet Drying. Pellet trays were loaded into pans, dried in an electric oven using disassociated ammonia (DA) as a cover gas and either stored or transferred to Building 230. This structure was originally used as warehouse space.

Building 256-2 was the main site warehouse for shipping pellets and powder and for receiving site supplies.



6.1.20 Building 260 Oxide and Oxide Loading Dock

The Oxide Building was built in approximately 1968 and is a four-story Butler type building. This building was used for the conversion of uranium compounds into uranium oxide granules.

6.2 Current Land Usage

Westinghouse has started environmental remediation and decommissioning activities at the Plant. This includes investigation into the groundwater contamination issues and preparing the Plant for the start of decommissioning.

In addition to the building descriptions provided previously, Building 230 is now being used as office space to house the Decommissioning Team. The Tile Barn functions as the emergency operations center and is being used to store both clean and radiologically contaminated equipment. The wood barn is also currently being used to store both clean and contaminated equipment. Building 240 currently contains laboratory and maintenance areas, a recycle recovery area, a waste incineration area and the Health Physics laboratory.

In addition, Westinghouse also leases part of its property to residents and farmers. This property is located outside of the main Plant boundaries.

6.3 Adjacent Land Usage

Adjacent to the Westinghouse property is residential homes, woods and farmland.

7.0 FINDINGS

7.1 Potential Contaminants

The primary known contaminants of concern are uranium and technetium. Due to the unknowns associated with government activities, thorium, Americium and Neptunium should be considered isotopes of concern until proven otherwise.

TCE was used in the Navy process and later as thinner for a binding agent in pellet manufacturing. Perchloroethylene (PCE) was used at the facility in a historic uranium processing operation. Both of these contaminants have been found as contaminants in the soil and groundwater and are being dealt with through the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process.

7.2 Potential Contaminated Areas



7.2.1 Impacted Areas

The process buildings and surrounding land are to be considered impacted area. The actual extent of the land area shall be determined but is presently assumed within the central 7-acres of the site. Class 1, 2 and 3 impacted areas will be determined based on future characterization efforts.

The ground water in the overburden has historical contamination of Tc-99. Characterization efforts will be developed to further determine the extent of the water contamination in the overburden. The aquifers have shown no detectable levels of contamination.

7.2.2 Non-Impacted Areas

The area land outside the burial pits shows no documented evidence of activities that could possibly have contaminated these areas. As such, they are expected to be classified as non-impacted but will be tentatively included in site characterization for further investigation..

7.3 Related Environmental Concerns

7.3.1 Jurisdictional Wetlands and Surface Water Issues

Jurisdictional wetlands and surface water issues would need to be considered in operations and actions related to executing the decommissioning effort. Wetlands are believed to be present on the Site and the surrounding properties. This natural resource is under the jurisdiction of the federal government, jointly administered by the United States (U.S.) Army Corps of Engineers (ACOE) and the U.S. EPA. At the state level, jurisdiction is administered by participating state agencies including the MDNR and the Missouri Department of Conservation Wetlands Management Program.

7.3.2 Surface Water Issues

Five intermittent tributaries (North Lake Tributary, East Lake Tributary, Northeast Site Creek, Site Creek, and Lake Virginia/Site Creek Tributary) and one perennial stream (Joachim Creek) flow across or run adjacent to the Site. Two ponds/lakes, including East Lake and Site Creek Pond are also on the property. These water resources, just as wetlands, are under the jurisdiction of the federal government and the State of Missouri.

7.3.3 Threatened and Endangered Species

An evaluation of the potential effects of the Plant's decommissioning may have on threatened and endangered species is an important aspect of the project.

Threatened and endangered species are protected under federal and state statute and threatened and endangered species are often key indicators to the overall health of an ecosystem.

8.0 CONCLUSIONS

Based on the HSA the potential sources of contamination are the burial pits, the lagoons, and soil contamination remaining after years of operation. TCE from the site is migrating off site and does pose a threat to human health and the environment. The approximately eight (8) acres surrounding the site are considered impacted with the remaining property classified as non-impacted.

There are numerous unknowns associated with the burial pits. This HSA provides a detail description of the site history and has provided valuable insight for the decommissioning planning; however, the detailed information on the pits for safe and effective remediation planning is not available. Further site characterization is needed to determine the content and extent of contamination associated with the burial pits.

9.0 REFERENCES

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11. ASTM Standard E 1527-00, *"Standard Practice for Environmental Site Assessments:Phase I Environmental Site Assessment Process,"* 2000.
12. Photographs for years 1937, 1954, 1956, 1959, 1960, 1962, 1966, 1971, 1973, 1974, 1975, 1978, 1980, 1986, 1990, 1991, 1993 and 1996.
13. Letter from NRC to CE, March 8, 1984.
14. Response letter from CE to NRC, May 31, 1984.
15. Letter from NRC to CE, October 3, 1984.
16. CE Status Report, May 20, 1988.

10.0 APPENDICES

Appendix A: Memoranda for Burial

Appendix B: Burial Log Excerpts

Appendix C: Memorandum

Appendix D: 1984 Evaporation Ponds Decommissioning Plan

Appendix A**Memoranda for Burial**

OFFICE MEMO



TO E. F. SANDERS AT HEMATITE DATE JULY 19, 1965

FROM L. J. SWALLOW AT HEMATITE COPY TO D. F. CRONIN
D. G. DARR
R. M. HAMMOND
J. A. RODE
J. P. ROSSER
F. G. STENGEL

SUBJECT BURIAL OF RESIDUES AND CONTAMINATED MATERIAL

THE FOLLOWING IS A SUMMARY OF THE CRITERIA WE AGREED TO FOR THE BURIAL OF LOW LEVEL WASTES AND CONTAMINATED EQUIPMENT.

1. AEC REGULATIONS

MAXIMUM QUANTITY PER BURIAL PIT: 50 MICROCURIES

ENRICHMENT	GRAMS U
>50 - 100%	790
>25 - <50	2000
>20 - <25	5000
>15 - <20	6000
>10 - <15	8000
> 6 - <10	12000
5	22000
4	26000
3	32000
2	40000
1	59000
NATURAL AND DEPLETED THORIUM	150000
	450000

IF MORE THAN ONE ENRICHMENT IS INVOLVED IN THE BURIAL THEN THE QUANTITY OF URANIUM OF EACH ENRICHMENT BURIED MUST BE LIMITED SUCH THAT:

$$\frac{X_1}{Ax_1} + \frac{X_2}{Ax_2} + \dots + \frac{X_N}{Ax_N} = 1.00$$

WHERE: X₁, X₂, X_N IS THE QUANTITY OF U (IN GRAMS) OF EACH ENRICHMENT TO BE BURIED. Ax₁, Ax₂, Ax_N IS THE ALLOWABLE QUANTITY TO BURY OF THE CORRESPONDING ENRICHMENT.

BURIAL DEPTH: ALL MATERIAL BURIED IS A MINIMUM OF 4 FEET BELOW GRADE.

BURIAL FREQUENCY: NOT MORE THAN 12 PER CALENDAR YEAR.

B

RESIDUES AND
MATERIAL

SEPARATION OF BURIAL PITS: A MINIMUM OF SIX FEET BETWEEN PITS.

RECORDS: EACH ITEM SHALL BE TAGGED SHOWING ENRICHMENT, TOTAL U
CONTENT.

A WRITTEN RECORD SHALL BE MAINTAINED BY THE RESPONSIBLE
SUPERVISOR OF EACH BURIAL. THIS RECORD WILL LIST THE
INDIVIDUAL ITEMS BURIED, TOTAL CONTENT AND DATE OF BURIAL.

NOTE: THERE IS NO REGULATION ON THE SIZE OF THE PIT.

II. UNC REGULATIONS

A. CONTAINERS: PROCESS RESIDUES (SUCH AS ACID INSOLUBLES), MSA FILTERS,
CONTAMINATED TRASH, ETC., WILL BE PACKAGED IN SUITABLE
CONTAINERS TO PREVENT THE SPREAD OF RADIOACTIVE CONTAM-
INATION DURING THE BURIAL PROCESS.

VISIBLE CONTAMINATION: VISIBLE CONTAMINATION ON EXTERNAL SURFACES
OF ALL CONTAINERS OR EQUIPMENT SHALL BE
REMOVED.

DETERMINING U CONTENT: THE URANIUM CONTENT OF EACH ITEM BURIED SHALL
BE DETERMINED BY EITHER SAMPLE AND CHEMICAL
ANALYSIS, GAMMA COUNTING OR ENGINEERING
ESTIMATE.

III. SOP FOR PARTICULAR TYPES OF MATERIAL

A. GENERAL TRASH FROM PLANT AREA

THIS INCLUDES PAPER, RAGS, EMPTY BOTTLES, ETC.

PACKAGE IN POLY BAGS AND GAMMA COUNT.

LESS THAN OR EQUAL 4 GM 93% ENRICHED U (OR EQUIVALENT) PER BAG: BURY
GREATER THAN 4 GRAMS 93% U PER BAG:

1. IF CONCENTRATED -- LOCATE AND REMOVE.
2. IF DISPERSED: BURY.

B. PROCESS EQUIPMENT

1. REMOVE VISIBLE EXTERNAL CONTAMINATION.
2. REMOVE INTERNAL ACCUMULATIONS AS PRACTICAL.

S AND
TERRIAL

3. MAKE "ENGINEERING ESTIMATE" OF TOTAL U OR GAMMA COUNT.

4. DISPOSE OF THROUGH AEC LICENSED COMMERCIAL BURIAL FACILITIES OR SCRAP DEALERS.

C. NON-PROCESS EQUIPMENT FROM PLANT AREAS (PIPING, FURNACE COILS, INSULATION FROM NON-PROCESS PIPING, ETC.)

1. REMOVE VISIBLE CONTAMINATION AND BURY. ASSUME NO U VALUE.

D. GLASS FROM CHEM LAB

1. RINSE AND COLLECT IN 55 GALLON DRUM. KEEP SEPARATE FROM OTHER TRASH.

BURY ASSUMING NO U VALUE.

E. ACID INSOLUBLES, MSA FILTERS, OTHER SOLID PROCESS RESIDUES

1. DETERMINE U CONTENT AND BURY WITHIN AEC LIMITS LISTED IN SECTION I ABOVE OR FORWARD TO LICENSED COMMERCIAL BURIAL FACILITIES.

F. OTHER

ITEMS NOT SPECIFICALLY FITTING THE ABOVE LISTED CATEGORIES WILL BE DISPOSITIONED AS THEY OCCUR BY THE HEALTH PHYSICS DEPARTMENT.


LJSWALLOW/JB

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EFFECTIVE 10/17/69

ISSUED 10/17/69

SUPERSEDES 7/19/65

SUBJECT: Burial of Residues and Contaminated Material

The following is a summary of the criteria for burial of low level wastes and contaminated equipment.

I. Burial Pit Requirements

A. Maximum quantity per burial pit: (50 millicuries)

Enrichment			Grams U
>50	-	100%	790
>25	-	<50	2000
>20	-	<25	5000
>15	-	<20	6000
>10	-	<15	8000
>6	-	<10	12000
5			22000
4			26000
3			32000
2			40000
1			59000
Natural and Depleted			150000
Thorium			450000

If more than one enrichment is involved in the burial then the quantity of uranium of each enrichment buried must be limited such that:

$$\frac{X_1}{Ax_1} + \frac{X_2}{Ax_2} + \dots + \frac{X_n}{Ax_n} = 1.00$$

Where: X_1, X_2, X_n is the quantity of U (in grams) of each enrichment to be buried. Ax_1, Ax_2, Ax_n is the allowable quantity to bury of the corresponding enrichment.

- B. Burial Depth: All material buried must be a minimum of 4 feet below grade.
- C. Burial Frequency: 12 pits per calendar year, maximum. (no size restriction).
- D. Separation of Burial Pits: A minimum of six feet between pits.

II. Material Requirements

- A. Each item buried shall be tagged showing enrichment, total U or U-235 content.

PRODUCTION <i>E. J. Anderson</i>	TECHNICAL <i>A. D. Cotton</i>	O.C. <i>R. E. Crumley</i>	SAFETY <i>J. P. Galt</i>	ACCOUNTABILITY <i>J. S. Galt</i>
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ISSUED 10/17/69

SUPERSEDES 7/19/65

SUBJECT: Burial of Residues and Contaminated Material

II. Material Requirements (continued)

- B. All burials must be documented. This record will list the individual items buried, total U or U-235 content and date of burial.
- C. Process residues (such as acid insolubles), MSA filters, contaminated trash, etc., will be packaged in suitable containers to prevent the spread of radioactive contamination during the burial process.
- D. Visible contamination on external surfaces of all containers or equipment shall be removed.
- E. The uranium content of each item buried shall be determined by either sample and chemical analysis, gamma counting or engineering estimate.

III. SOP for Particular Types of Material

A. General Trash from plant area.

This includes paper, rags, empty bottles, etc. Package in poly bags and gamma count. Less than or equal 1 gm. 93% enriched U (or equivalent) per bag: bury. Greater than 1 grams 93% per bag:

1. If concentrated - locate and remove.
2. If dispersed - bury.

B. Process Equipment

1. Remove visible external contamination.
2. Remove internal accumulations as practical.
3. Make "engineering estimate" of total U or gamma count.
4. Dispose of through AEC licensed commercial burial facilities or scrap dealers.

C. Non-Process Equipment from Plant Areas (piping, furnace coils, insulation from non-process piping, etc.)

1. Remove visible contamination and bury. Assume no U value.

D. Glass from Chem. Lab

1. Rinse and collect in 55 gallon drum. Keep separate from other trash. Bury assuming no U value.

PRODUCTION

TECHNICAL

QC

SAFETY

ACCOUNTABILITY

E. J. Sanders

A. P. Colton

B. S. Scarborough

J. W. Miller

B. S. Scarborough

U. S. Patents

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SUBJECT: Burial of Residues and Contaminated Material

E. Acid Insolubles, MSA Filters, other Solid Process Residues

1. Determine U content and bury within AEC limits listed in Section 1 above or forward to licensed commercial burial facilities.

F. Other

Items not specifically fitting the above listed categories will be evaluated as they occur and dispositioned by the scrap engineer.

PRODUCTION

P. Folmer

TECHNICAL

J. D. Patton

QC

B. Dickeberg

SAFETY

[Signature]

ACCOUNTABILITY

[Signature]

Appendix B

Burial Log Excerpts

#3.2

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DATE	DESCRIPTION	RES. No.	GM	QUMU. G/M
11.22.69	OIL & ICE - FILTERED	H33	1003	1.0 Pond
"	" " "	"	1012	1.0 "
"	" " "	"	1004	2.5 "
"	" " "	"	1001	1.0 "
"	" " "	"	1002	1.4 "
"	" " "	"	?	<1.0 "
"	" " "	"	1005	<1.0 "
"	" " "	"	50	<1.0 "
"	" " "	"	1006	2.3 "
"	" " "	"	1007	2.4 "
"	" " "	"	1008	<1.0 "
"	" " "	"	1013	<1.0 "
"	" " "	"	1014	<1.0 "
"	" " "	"	1011	<1.0 "
"	" " "	"	1010	<1.0 "
"	" " "	"	1009	<1.0 "
"	" " "	"	1016	<1.0 "
"	" " "	"	1022	<1.0 "
"	" " "	"	1020	<1.0 "
"	" " "	"	1015	<1.0 "
"	" " "	"	1017	<1.0 "
"	Vac. PUMP OIL	"	?	<1.0 "
"	" " " KOH	H34	3	<1.0 "
11.25.69	Glove LINERS, Rags	H47	155	1.0
"	METAL TRASH FROM INCL.	"	125	4.0
"	" " " "	"	147	1.5
"	" " " "	"	?	3.5
"	" " " "	"	140	3.2
"	Acid INSOLUBLES	"	143	5.4
"	" " "	"	150	9.0
"	" " "	"	149	7.8
"	" " "	"	160	7.7
"	" " "	"	161	4.5
"	GREEN ROOM TRASH	"	?	2.6
"	1B4. BUENEO TRASH	"	122	2.0
"	1B3. " "	"	68	3.2
"	CLEANUP RAGS	"	175	1.0

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#32

DATE	DESCRIPTION	RES. No	SLU	CUMU G/L	DAI	
11.25.69	HEAT TAPES	213	-	<1.0	57.4	11.25
"	COPPER TUBING		-	<1.0	58.4	"
"	GLOVE LINER		-	<1.0	59.4	"
"	"		-	1.2	60.6	"
"	RED ROOM TRASH		-	1.3	61.9	"
"	REACTOR GASKETS		-	5.4	67.3	"
"	SAMPLE BOTTLES		-	1.3	68.6	"
"	T.I.C.E.		-	<1.0	POND	"
"	ACID INSOLUBLES	L18	1001	2.9	71.5	11.25
"	"	K44	2	1.8	73.3	"
"	PRE-FILTERS	L06	1027	<1.0	74.3	"
"	RAGS		-	<1.0	75.3	"
"	ACID INSOLUBLES	L06	1026	<1.0	76.3	"
"	HOOD CLEANUP		-	<1.0	77.3	"
"	RUBBER GLOVES		-	1.4	78.7	"
"	PRE-FILTERS		-	<1.0	79.7	"
"	PLASTIC BAG	H33	1019	<1.0	80.7	"
"	PRE-FILTERS #2 H.D.	"	1030	<1.0	81.7	"
"	LAB. TRASH		-	<1.0	82.7	"
"	"		-	<1.0	83.7	"
"	"		-	<1.0	84.7	12
"	"		-	<1.0	85.7	"
"	"		-	<1.0	86.7	"
"	"		-	<1.0	87.7	"
"	"		-	1.4	89.1	"
"	RECYCLE ROOM TRASH	H61	46	2.3	91.4	"
"	PLASTIC BAG FROM 20 HIND	"	39	<1.0	92.4	"
"	RAGS FROM DECLAD	H62	44	1.9	94.3	"
"	WASA STATION FILTERS	"	36	<1.0	95.3	"
"	"	"	8	<1.0	96.3	"
"	"	"	7	<1.0	97.3	"
"	KOH SOLUTION	"	018	<1.0	POND	"
"	"	"	033	<1.0	"	"
"	"	"	029	<1.0	"	"
"	"	"	080	<1.0	"	"
"	"	"	05	<1.0	"	12
"	"	"	017	<1.0	"	"

#32

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DATE	DESCRIPTION	RES. No.	GLU	CUMU. GLU	
11.25.69	KOH SOLUTION	H62	0.16	<1.0	POND
"	"	"	0.15	<1.0	"
"	NaCl CLEANUP	"	35	<1.0	98.3
"	REACTOR CLEANUP H ₂ O	"	04	<1.0	POND
"	TCE + OIL FROM END SHAKE	H33	1027	<1.0	"
"	" " " " "	"	1026	2.4	"
"	" " " " "	"	1024	<1.0	"
"	N ₂ RESIDUES	-	-	<1.0	99.3
11.26.69	TRAP CLEANUP	H62	18	1.6	100.9
"	"	"	17	1.7	102.6
"	FBR FILTERS	"	314	<1.0	103.6
"	"	"	012	<1.0	104.6
"	"	"	013	<1.0	105.6
"	WASH STATION FILTERS	"	37	<1.0	106.6
"	ACID INSOLUBLES	L06	1025	1.7	107.3
"	"	K44	8	1.6	109.9
"	"	H60	1003	4.3	114.2
"	PRE. FILTERS FROM D.G.	L28	1	4.0	118.2
"	" " " #2 H.D.	H33	8	2.2	120.4
"	TCE	K47	8	2.9	POND
12.4.69	REACTOR CLEANUP FILTERS	H62	036	<1.0	"
"	"	"	034	<1.0	"
"	"	"	037	<1.0	"
"	TRAP CLEANUP	"	60	<1.0	121.4
"	NaCl Var. CLEANUP	"	62	<1.0	122.4
"	KOH Decano SOLUTION	H72	1	<1.0	POND
"	Poly Bags	2	105	<1.0	123.4
"	ACID INSOLUBLES	K35	1003	<1.0	124.4
"	"	H36	1056	<1.0	125.4
"	"	L18	1011	1.9	127.3
"	FILTERED TCE	H36	1035	<1.0	POND
"	PRE. FILTERS #2 D.G.	"	1031	<1.0	129.3
"	Vac. PUMP OIL	-	-	<1.0	POND
"	USED DRILL	-	-	3.1	131.4
"	HEAT TAPE #1 D.G.	L13	148	<1.0	132.4
12.5.69	Red Room TRANSIT	-	-	2.1	134.5
"	"	-	-	<1.0	135.5

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#32

DATE	DESCRIPTION	Res No	GLU	CUMU GLU	
12.5.79	LAB TRASH		-	-1.0	136.5
"	"		-	-1.0	137.5
"	"		-	-1.0	138.5
"	"		-	-1.0	139.5
"	ITEM TRASH	H61	63	-1.0	140.5
"	SAMPLE BOTTLES	"	64	-1.0	141.5
"	ITEM TRASH	H62	55	2.7	144.2
"	POT GASKETS	"	71	-1.0	145.2
"	NITRIC ACID WASH WATER	"	67	-1.0	POWA
"	"	"	66	-1.0	"
"	CLEANUP H ₂ O. FAR	"	039	-1.8	"
"	ROH. FROM FBR	H72	3	-1.0	"
"	GREEN ROOM TRASH	H47	173	1.6	146.8
12.11.79	LAB TRASH		-	-1.0	147.8
"	"		-	-1.0	148.8
"	"		-	-1.0	149.8
"	FILTRATE VIALS		-	-1.0	150.8
"	"		-	-1.0	151.8
"	BOX FILTER	H36	-	-1.0	152.8
"	"	"	-	-1.0	153.8
"	"	L12	-	-1.0	154.8
"	GASKETS		-	3.2	157.0
"	"		-	2.7	160.7
"	RED ROOM TRASH		-	-1.0	161.7
"	"		-	-1.0	162.7
"	"		-	-1.0	163.7
"	GLOVE LINERS		-	-1.0	164.7
"	"		-	1.0	165.7
"	PAPER TOWELS		-	-1.0	166.7
"	LICKING HOODS CLEANUP		-	1.0	POWA
"	H ₂ O CLEANUP		-	-1.0	"
"	ACID INSULATES	K44	-	2.3	169.0
"	PRE-FILTERS		-	-1.0	170.0
"	RUBBER GLOVES & TAPE		-	-1.0	171.0
"	SAMPLE BOTTLES		-	-1.0	172.0
"	"		-	-1.0	173.0
"	"	H61	75	-1.0	174.0

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DATE	DESCRIPTION	Ref. No.	Qty	Cost	CUMM. TOTAL
12-11-69	SAMPLE BOTTLES	H61	74	<1.0	175.0
"	BRUSH FROM 2B Hood	"	71	<1.0	176.0
"	ITEM TRASH	"	72	1.8	177.8
"	GASKETS & TAPE	H62	78	<1.0	178.8
"	TRASH FROM FRA	"	5	2.2	181.0
"	POT ROOM RAGS	"	79	<1.0	182.0
"	"	"	79	<1.0	183.0
"	PRESS CLOTHS	H44	-	2.1	185.1
"	"	H47	-	2.1	187.2
"	PRE-FILTERS	-	-	<1.0	188.2
12-16-69	SAMPLE BOTTLES	-	-	<1.0	189.2
"	"	-	-	<1.0	190.2
"	"	-	-	<1.0	191.2
"	"	-	-	<1.0	192.2
"	"	-	-	3.6	195.8
"	"	-	-	3.7	199.5
"	"	-	-	1.6	201.1
"	GLOVE LINERS	-	-	<1.0	202.1
"	"	-	-	<1.0	203.1
"	"	-	-	<1.0	204.1
"	RED ROOM TRASH	-	-	2.8	206.9
"	"	-	-	<1.0	207.9
"	"	-	-	1.3	209.2
"	"	-	-	<1.0	210.2
"	TAGS FROM SAMPLE BOTTLES	-	-	<1.0	211.2
"	"	-	-	<1.0	212.2
"	ACID INSOLUBLES	L11	2004	<1.0	213.2
"	"	H44	29	<1.0	214.2
"	"	"	27	1.2	215.4
"	GLOVE LINERS & RAGS	H47	147	<1.0	216.4
"	LAB TRASH	-	-	2.0	218.4
"	"	-	-	<1.0	219.4
"	"	-	-	<1.0	220.4
"	ITEM TRASH	H61	5	4.2	224.6
"	"	H62	86	<1.0	225.6
"	POT ROOM RAGS	"	77	<1.0	226.6
"	WASH STATION FILTERS	"	114	<1.0	227.6

DATE	DESCRIPTION	RES. No.	QTY	CUMU. QTY	D.	
12.16.69	GLOVE LINERS	H62	75	<1.0	228.6	12.2
"	MTY BOTTLES & CANS	H72	4	2.9	231.5	"
"	PRE-FILTERS	H36	1041	<1.0	232.5	"
"	"	"	?	1.6	234.1	"
"	ICE	"	1048	<1.0	P.O.N.O.	12/30
"	MTY BOTTLES	-	-	<1.0	235.1	"
"	AL(NO ₂) ₂ FROM CLEANUP	L28	21	<1.0	P.O.N.O.	"
"	USED TAGS	-	-	<1.0	236.1	"
"	FILTER FROM PICKLINE HOOD	-	-	<1.0	237.1	"
"	FILTRATE VIALS	-	-	<1.0	238.1	"
12.19.69	ACID INSOLUBLES	H36	1040	1.9	240.0	"
"	"	"	1051	1.3	241.3	"
"	"	"	1052	<1.0	242.3	"
"	"	K35	2	1.3	243.6	"
"	"	"	2	1.5	245.1	"
"	PRE-FILTERS	H36	1032	2.5	247.6	"
"	"	"	1050	1.3	248.9	"
"	"	"	1043	1.0	249.9	"
"	FILTRATE ICE	L19	1022	<1.0	P.O.N.O.	"
"	RED ROOM TRASH	-	-	1.9	251.8	"
"	"	-	-	2.5	254.3	"
"	"	-	-	3.2	257.6	"
"	SAMPLE BOTTLES & TAGS	-	-	<1.0	258.6	"
"	LAB. TRASH	-	-	<1.0	259.6	"
"	POS LID GASKETS	H62	88	<1.0	260.6	"
12.22.69	LAB. TRASH	-	-	<1.0	261.6	"
"	"	-	-	<1.0	262.6	"
"	"	-	-	<1.0	263.6	"
"	"	-	-	<1.0	264.6	"
"	RECYCLE ROOM TRASH	H61	87	1.2	265.8	"
"	GLOVE LINERS	H62	91	1.0	266.8	"
"	GREEN ROOM TRASH	H44	2	1.1	267.9	"
"	METAL SCRAP	-	-	1.8	269.7	"
"	MTY BOTTLES	H47	180	1.0	270.7	"
"	GLOVE LINERS	L13	97	<1.0	271.7	"
"	PRE-FILTERS	H36	1049	<1.0	272.7	"
"	MTY BOTTLES - TAGS - TAPE	-	-	1.0	273.7	"

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DATE	DESCRIPTION	RES. No.	Qty	CUMULATIVE	QTY
12.22. 9	MTX BOTTLES-TAGS-TAPE	-	<1.0	274	7
"	" " " "	-	<1.0	275	7
"	" " " "	-	<1.0	276	7
"	" " " "	-	<1.0	277	7
12/30/69	TRASH RED ROOM	96	1.2	279	9
"	TRASH LAB.	-	1.1	280	7
"	GLOVE LINERS	MIXED 98	2.5	283	2
"	"	" 97	<1.0	284	2
"	RUBBER GLOVES	" 99	1.6	285	8
"	TRASH ITEM PLANT	97% H62 89	<1.0	286	8
"	RAGS ITEM POT ROOM	97% H62 94	<1.0	287	8
"	MIXED SAMPLE BOTTLES+TRASH	-	<1.0	288	8
"	ITEM TIN PIPE	H61	<1.0	289	8
"	ACID INSOLUBLES	97% L-18 1028	1.6	291	4
"	"	93% K35 1005	4.0	295	4
"	"	97% H36 1057	1.4	296	8
"	"	97% H36 1054	2.7	299	5
"	"	97% H36 1053	2.8	302	3
"	POLY BAGS	97% H36 1056	<1.0	303	3
"	ZR Residues	97% H61	2.2	305	5
"	PRE-FILTERS FROM PUMPING STATION	97% L-18 1029	<1.0	306	5
"	PLASTIC BAGS FROM REACTOR TRAYS	97% L-13	1.1	307	6
"	TCE FROM WASHING U-METAL	93% L-06 129	<1.0	308	6
"	MIXED FILTRATE VIALS	-	<1.0	309	6
"	TRASH LAB.	-	<1.0	310	6
"	"	-	<1.0	311	6
"	GLOVE LINERS RED ROOM	-	<1.0	312	6
"	Rubber Gloves ITEM	97% H62 93	<1.0	313	6
END OF 1969 RESIDUE DISPOSAL					

SEE NEXT PAGE

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Hole # 32

1970 DATE	DESCRIPTION	701 97	50B H-61	Residue 96	g/l 41.0	Nov. 6/71 317.6	1971 Date
1-7-70	Trash from Item Plant	97	H-61	96	41.0	317.6	1/21
"	Trash from Lab.	-	-	-	2.5	320.1	"
"	Tape from Item shipping Cans	97	L-18	1024	41.0	321.1	"
"	KOH filtrate frozen	97	H-36	1061	41.0	322.1	"
"	Prefilters from #2 dunker	97	H-36	1058	41.0	323.1	"
"	Insulation from Fluid Bed	97	H-62	058	2.1	345.2	"
"	Trash Lab.	-	-	-	41.0	346.2	"
"	Plastic Bags	97	H-36	1063	41.0	347.2	"
"	Trash Lab.	-	-	-	41.0	348.2	"
"	Glove liners Item	97	H-61	93	2.6	350.8	"
"	Trash P.P. incinerator	Mixed	-	20048	1.9	352.7	"
"	Plastic bottles	97	H-62	97	1.3	354.0	"
"	Trash incinerator	Mixed	-	20049	41.0	355.0	"
"	Glass wool Item	97	H-62	102	41.0	356.0	"
"	Plastic bags	97	H-62	100	41.0	357.0	"
"	Trash Item	97	H-61	90	41.0	357.0	"
"	Trap element Item	97	H-62	99	41.0	359.0	"
"	Trash B.P.	Mixed	-	20047	1.6	360.6	"
"	Trap element Item	97	H-62	98	41.0	361.6	"
"	Rags Pot Room Item	97	H-62	95	41.0	362.6	"
"	Rags Pot cleanup	97	H-62	96	41.0	363.6	"
"	Trash Red Room	-	-	100	41.0	364.6	"
"	Prefilters from Packing Hood Red Room	97	L-13	170	41.0	365.6	"
"	Labels, towels + Rags - can cleanup Item	97	H-62	113	41.0	366.6	"
"	Heat tape from D.G. Red Room	97	H-60	56	41.0	367.6	"
"	M.T. cut off poly bottles Item	97	H-61	95	41.0	368.6	1/15
"	KOH insolubles	97	H-36	1064	41.0	369.6	"
"	Rags - Pot Lid cleanup	97	H-62	103	41.0	370.6	"
"	Filter from Packing Hood Red Room	97	L-13	98	41.0	371.6	"
"	Glove liners Red Room	-	-	101	41.0	372.6	"
"	Trash Red Room	-	-	-	41.0	373.6	"
"	Trash Lab.	-	-	-	41.0	374.6	"
1/12/70	Trash Lab.	Mixed	-	-	1.8	376.4	"
"	FBR Insulation	97	H-62	061	41.0	377.4	"
"	Tags Item	97	H-61	106	41.0	378.4	"
"	Tags Item	97	H-62	105	41.0	379.4	"
"	Tags Item	97	H-61	103	41.0	380.4	"

Hole #32

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1970 Date	Description	%	Job Stand	Residue No.	GU	Accu. G/W
1/12/70	Plastic bottles	97%	H62	116	<1.0	381.4
"	Trash, Lab.	Mixed			<1.0	382.4
"	Trash, Red R.	"			1.2	383.6
"	Trash, Lab.	"			<1.0	384.6
"	Tags, Item	97%	H61	104	<1.0	385.6
"	Trash, Green R.	20%	H44	42	<1.0	386.6
"	Trash, H.P.	Mixed			<1.0	387.6
"	Glove liners, Red R.	"			<1.0	388.6
"	Poly. bottles, Green R.	97%	H36		<1.0	389.6
"	Filters from H2O	97%	H62	060	1.2	390.8
"	" " "	97%	H62	059	1.5	392.3
"	" " "	97%	H62	056	1.2	393.5
"	MT. bottles	Mixed			<1.0	394.5
"	Trash, Item	97%	H62	56	3.3	397.8
"	Trash, Item	97%	H62	111	2.7	400.5
"	Pot Gaskets, Item	97%	H62	117	<1.0	401.5
"	Lead Crucibles				<1.0	402.5
"	Acid insolubles, Green R.	97%	K35	1010	<1.0	403.5
"	Leak Mgmt. Cleanup of 2002	97%	H62		<1.0	404.5
"	Rags, Pot cleanup	97%	H62	120	<1.0	405.5
"	Cleanup of Vcc. pump	Mixed			<1.0	406.5
"	Filter from H2O, Item	97%	H62	051	<1.0	407.5
"	Acid insolubles	93%	K35		2.0	409.5
"	" "	97%	H60	1004	<1.0	410.5
"	" "	93%	K35	1006	<1.0	411.5
1/13/70	Filters from H2O, Item	97%	H62	057	<1.0	412.5
"	" " " "	97%	H62	055	<1.0	413.5
"	" " Wash sta.	97%	H68	005	1.1	414.6
"	Filters from H2O, Item	97%	H62	053	<1.0	415.6
"	" " " "	97%	H62	052	<1.0	416.6
"	Acid insolubles	97%	L18	1033	<1.0	417.6
"	Sess line = 2 dunker	UNK			<1.0	418.6
"	Acid insolubles	97%	L18		2.5	421.1
"	Prefilter " = dunker	97%	H36	1073	<1.0	422.1
"	Plastic bags	93%	K35	1016	<1.0	423.1
"	" "	93%	K35	1017	<1.0	424.1
"	Prefilters " = dunker	97%	H36	1062	<1.0	425.1

Date	Description	%	Job #/lbs	Residue No.	G/U	425.1 Accu.GU	Date
1/13/70	Plastic bags	93%	K35	1015	<1.0	426.1	1/14/70
"	Acid insolubles	93%	K35	1004	4.3	430.4	"
"	Glove liners Red R.	Mixed	Mixed	107	1.7	432.1	1/15/70
"	Rubber Gloves "	"	"	108	2.3	434.4	"
"	Reactor box gaskets	97%	H60	62	4.9	439.3	"
"	Reactor Cleanout, Green R.	97%	H61		<1.0	443.3	"
"	Plastic bags	93%	K35	1011	1.1	444.4	"
"	Acid insolubles	97%	H36	1071	<1.0	442.4	"
1/14/70	Rags from duct cleanout	97%	HZ		<1.0	443.4	"
"	Plastic bags	97%	K35		<1.0	444.4	"
"	Acid insolubles	93%	K35	1019	3.0	447.4	"
"	" "	93%	K35	1012	<1.0	448.4	"
"	OIL, TCE, H ₂ O	Mixed	Mixed		<1.0	449.4	"
"	Acid insolubles	97%	L18	1034	<1.0	450.4	"
"	Towels, Hood cleanup	95%	BU		<1.0	451.4	"
"	Paper towels, #2 dunker	92%	K47	1076	<1.0	452.4	"
"	Poly bags - reactor trays	93%	K35	100	<1.0	453.4	"
"	Trash, recycle room	97%	H61	124	<1.0	454.4	"
"	Acid insolubles -	97%	L18	1039	2.4	456.8	"
"	Oily TCE, washing metal	93%	L06		1.4	458.2	"
"	Acid insolubles	97%	L18	1037	<1.0	459.2	"
"	" "	97%	L18	1038	2.4	461.6	1/20/70
"	" "	97%	L18	1036	<1.0	462.6	"
"	" "	97%	L18	1017	<1.0	463.6	"
"	" "	97%	L18	1035	2.3	465.9	"
"	Poly Bags	93%	K35	103	<1.0	466.9	"
"	Trash, Lab.	Mixed			<1.0	467.9	"
"	Rags, Pot cleanup	97%	H62	124	1.1	469.0	"
"	Trash, Lab.	Mixed			<1.0	470.0	"
"	Trash, R.R.	Mixed		142	<1.0	471.0	"
"	Poly Bags, R.R.	93%	K35	102	<1.0	472.0	"
"	Trash, Item	97%	H61	127	1.3	473.3	"
"	" "	"	"	128	1.7	475.0	"
"	Trash, R.R.			141	2.6	477.6	"
"	176 Item screen	97%	H61		<1.0	478.6	"
"	Trash, Lab.				<1.0	479.6	"
"	" "				<1.0	480.6	"

Hole #32

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Date	Description	%	Job Symbol	Residue No.	G/L	ACCU. G/L
1/14/70	Trash - G.R.	-	-	-	<1.0	481.6
"	Trash - Lab.	-	-	-	<1.0	482.6
1/15/70	Cans - Item	97%	H61	100	<1.0	483.6
"	Trash - P.R.				<1.0	484.6
"	Trash - Lab.				<1.0	485.6
"	Trash - R.R.	Mixed		83	33	488.9
"	"	"		143	<1.0	489.9
"	Trash - Lab.				<1.0	490.9
"	Gaskets & sandpaper	97%	H62	139	<1.0	491.9
"	Glove liners	97%	H61	123	<1.0	492.9
"	Poly Bags	93%	K35		1.3	494.8
"	Acid insolubles	93%	K35	1018	2.2	497.0
"	Pre-filter - "2 D.G.	70%	L28	13	<1.0	498.0
"	Heat tape - D.G.	93%	K36	37	<1.0	499.0
"	Acid insolubles	97%	L18	1041	1.4	500.4
"	"	97%	L18	1040	<1.0	501.4
"	Filters - wash. etc.	97%	H62	89	<1.0	502.4
"	Vap. cleanout	97%	H62	093	<1.0	503.4
"	Filter - Package hood	Mixed		73	<1.0	504.4
"	Cleanout of reactor	2.85%	H53	61	1.2	505.7
"	Trash - Item yard				2.5	509.2
1/20/70	Trash - packing area			197	<1.0	510.2
"	Labels from cans	97%	H61	114	<1.0	511.2
"	Rags - Pot cleanup	97%	H62	138	<1.0	512.2
"	Poly bags	93%	K35	101	<1.0	513.2
"	Pot room cleanup	97%	H62	118	<1.0	514.2
"	Gaskets & sandpaper	97%	H62	119	<1.0	515.2
"	Item - Tags	97%	H61	102	<1.0	516.2
"	Rags - Pot cleanup	97%	H62	114	<1.0	517.2
"	Filter - Packaging hood	97%	L13		<1.0	518.2
"	Trash - G.R.	1.65%	H23		<1.0	519.2
"	Acid insolubles	97%	L18	1046	1.5	520.7
"	"	97%	L18	1043	2.5	523.2
"	"	97%	L18	1042	1.8	525.0
"	"	93%	K35		1.1	526.1
"	"	97%	L18	1045	1.6	527.7
"	"	97%	L18	1048	1.7	529.4

Date	Description	%	Job Symbol	Residue No.	G/U	Accu. G/U	Date
11/20/70	Acid insolubles	97%	L18	1047	1.5	530.9	11/21/70
"	"	97%	L18	1051	3.4	534.3	"
"	"	97%	L18	1050	1.5	535.8	"
"	"	97%	L18	1049	2.4	538.2	"
"	Rubber glove & Tape	93%	K35	1021	<1.0	539.2	"
"	Vap. cleanout	97%	H62	084	<1.0	540.2	"
"	Tag - Item	97%	H61	101	<1.0	541.2	"
"	Filter	97%	L13	174	<1.0	542.2	"
"	Press cloths	1.65%	H23	25	<1.0	543.2	1/22/71
"	Trash - Lab.				<1.0	546.2	"
"	"				<1.0	545.2	"
"	Reactor Box Gaskets	97%			7.5	552.7	"
"	Metal scrap	1.65%	H23	901	4.9	557.6	"
"	Press cloths	2.08%	H44	47	1.8	559.4	"
"	Acid insolubles	2.54%	H47	159	2.4	561.8	"
"	Press cloths	1.65%	H23	28	2.3	564.1	"
"	Broken Filter	2.54%	H47	133	7.0	571.1	"
"	Oil from sulfate hood pump	97%	Mixed	110	<1.0	572.1	"
"	Acid insolubles	2.08%	H44	229	7.5	579.6	"
"	"	2.91%	H47	582	5.4	585.0	"
"	"	2.54%	H47	695	7.6	592.6	"
"	" Press cloths	2.54%	H47	837	4.1	596.7	"
"	Acid insolubles	2.08%	H44	624	12.0	608.7	"
"	"	2.08%	H44	748	6.3	615.0	"
"	"	2.54%	H47	25	8.8	623.8	"
"	"	2.54%	H47	969	10.6	634.4	"
11/21/70	"	97%	L18		<1.0	635.4	"
"	Prefilter - #2 HD	97%	H36	1075	1.4	636.8	"
"	Acid insolubles	97%	L18	1054	4.9	641.7	"
"	H2O Filters - FBR	97%	H62	0113	<1.0	642.7	"
"	"	97%	H62	0112	<1.0	643.7	"
"	"	97%	H62	0114	<1.0	644.7	"
"	Vap. cleanout - FBR	97%	H62	0105	<1.0	645.7	"
"	Acid insolubles	97%	L18	1044	1.1	646.8	"
"	Filters - Finish wash etc.	97%	H62	149	<1.0	647.8	"
"	Trash - Lab.				1.4	649.2	"
"	"				1.7	650.9	"

Date	Description	%	Job Symbol	Residue Amt.	GM	650.9 Accu GM
1/21/70	Filters - wash sta.	97%	H62	146	<1.0	651.9
"	Heating Blanket #2 D.G.	93%	K36	105	3.9	655.8
"	Trash - recycle room	97%	H61	133	<1.0	656.8
"	Insulation - FBR	97%	H62		4.6	661.4
"	Acid insolubles	209%	H44	48	7.2	668.6
"	Poly bags - reactor trays	93%	K35	104	2.3	670.9
"	Acid insolubles	93%	K35		<1.0	671.9
"	"	93%	K35	102.4	1.0	672.9
1/22/70	Pot lid Gaskets	97%	H62	147	<1.0	673.9
"	MT Poly Bottles	97%	L13		1.6	675.5
"	Acid insolubles	165%		165	2.2	677.7
"	Rags - Pot cleanup	97%	H62	144	2.7	680.4
"	MT Poly Bottles	93%	H20		<1.0	681.4
"	Trash - Item	97%	H62	171	<1.0	682.4
"	Trash - G.R.				<1.0	683.4
"	Trash - Lab.				<1.0	684.4
"	Glove liners & rags	165%	H23	26	<1.0	685.4
"	Trash - Lab.				<1.0	686.4
"	"				<1.0	687.4
"	" R.R.				<1.0	688.4
"	"				<1.0	689.4
"	"				<1.0	690.4
"	" Item	97%	H61	150	2.1	692.5
"	Trash - Lab.				2.2	694.7
"	Acid insolubles		H36		1.1	695.8
"	Trash - Item	97%	H61	151	<1.0	696.8
"	" R.R.				<1.0	697.8
"	" Lab.				<1.0	698.8
"	"				<1.0	699.8
"	Insulation - FBR	97%	H62		<1.0	700.8
"	Prefilter - FER hood	97%	H62	106	<1.0	701.8
"	Trash - Lab.				1.6	703.4
"	Gaskets - Pot area	97%	H74	7	<1.0	704.4
"	Rags - Pot area				<1.0	705.4
"	Trash - Lab.				<1.0	706.4
"	" R.R.				1.4	707.8
"	Plastic Bags	97%	H33		<1.0	708.8

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HOLE #38

DATE	SHEET	DESCRIPTION	%	FOR SYR.	RESIDUE No.	G	ACC.	G/u
7-29-70	1	COUNTING VIALS	MIXED	MIXED	0727-08	1.3		1.3
"	1	WORKED UP PRE-FILTERS	97	H-44	363	1.9		3.2
"	1	ACID INSOLUBLES	1.77	H-86	111	4.1		7.3
"	1	" " & PRESS. CLOTHS	2.34	H-91	117	1.6		8.9
"	1	GD ₂ O ₃ MOP WATER	2.34	H-92	660	21.0		9.9
DRUM # C								
"	1	GR TRASH	LO-ENR	MIXED	121	21.0		11.9
"	1	FBR PRE FILTERS	97	H-86	313	21.0		12.9
"	1	FBR PRE FILTERS	97	H-86	3116	21.0		15.9
"	1	HOSE FROM PRESS	2.34	H-92	670	21.0		14.9
"	1	IP RAGS	97	H-86		21.0		16.9
"	1	GD ₂ O ₃ CLEAN MOP RAGS	2.34	H-92		21.0		15.9
"	1	GASKETS & SAND PAPER	97	H-86		21.0		17.9
"	1	IP TRASH	97	H-86		21.0		17.9
"	1	LAB TRASH	MIXED	MIXED	0727-02	21.0		19.9
"	1	GASKETS & SAND PAPER	97	H-86	260	21.0		20.9
"	1	IP TRASH	97	H-86		21.0		21.9
"	1	LAB TRASH	MIXED	MIXED	0727-04	21.0		22.9
"	1	LAB TRASH	MIXED	MIXED	0727-04	21.0		23.9
"	1	LAB TRASH	MIXED	MIXED	0727-05	21.0		24.9
"	1	FR TRASH	MIXED	MIXED	404	21.0		25.9
"	1	MT BOTTLES	1.72	H-86	736	21.0		26.9
"	1	MT BOTTLES	2.34	H-91	738	21.0		27.9
"	1	MT BOTTLES	2.34	H-91	115	21.0		28.9
7-29-70	1	GASKETS & SAND PAPER	97	H-86	260	21.0		10.9
7-29-70	1	" " " "	97	H-86	269	21.0		11.9
7-30-70	1	RR TRASH	97	H-86	405	2.7		14.6
"	1	FBR TRASH	97	H-86	3115	1.1		15.7
"	1	POT. LID RAGS	97	H-86	268	1.1		16.8
"	1	IP TRASH	97	H-86	270	2.4		19.2
"	1	GR TRASH	2.34	H-91	127	2.4		21.6
7-31-70	1	GRANULATOR SCREEN	LO-ENR	MIXED	702	21.0		22.6
7-31-70	1	GRANULATOR SCREEN	LO-ENR	MIXED	774	21.0		23.6
8-3-70	1	METAL PREFILTER	HI-LO	MIXED	816	21.0		24.6
"	1	METAL PREFILTER	"	"	820	21.0		25.6
"	1	METAL PREFILTER	"	"	818	21.0		26.6

HOLE #38

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DATE	SHEET	DESCRIPTION	%	JOB SYMBOL	RESIDUE No.	Q	Acc.	Q	Wt. %
8-4-70	1	DRUM #C-1	HI-LO MIXED	MIXED	—	24.0	50.6		
8-4-70	1	SCREEN FILTERS	2.34	H-91	498	7.0	57.6		
"	1	GD ₂ O ₃ TRASH (METAL)	2.34	H-92	768	1.1	58.7		
"	1	INSULATION	2.34	H-91	429	4.7	62.4		
"	1	NATURAL UO ₂	NAT.	NATURAL	0803-02	4.9	70.3		
"	1	R-2 PRE-FILTER	2.34	H-91	421	7.4	71.7		
"	1	GD ₂ O ₃ TRASH	2.34	H-92	776	1.2	72.9		
"	1	GASKETS & SAND PAPER	97	H-88	280	1.3	74.2		
"	1	GRANULATOR SCREEN	2.34	H-91	872	1.4	75.6		
"	1	INCINERATOR FILTER	HI-LO MIXED	MIXED	814	1.8	77.4		
"	1	INCINERATOR FILTER	"	"	810	2.1	79.5		
"	1	GRANULATOR SCREEN	2.34	H-91	824	1.0	80.5		
8-10-70	1	"	2.34	H-91	886	4.0	81.5		
"	1	FBR HOOD FILTER	97	H-88	0124	4.0	82.5		
"	1	GASKETS & SAND PAPER	97	H-88	299	4.0	83.5		
8-11-70	1	ELECTRIC DRILL MOTOR	HI-LO MIXED	MIXED	415	1.6	85.1		
8-11-70	1	ACID INSOL.	2.34	H-91	129	5.0	90.1		
8-12-70	1	GRANULATOR SCREEN	2.34	H-91	982	4.0	91.1		
8-12-70	1	DRUM #C-2	HI-LO MIXED	MIXED	—	22.0	113.1		
8-13-70	1	GLOVES FROM D.G.	97	H-81	422	4.0	114.1		
8-13-70	1	GRANULATOR SCREEN	2.34	H-91	1012	1.6	115.2		
8-13-70	1	METAL PANS	97	H-87	186	2.1	117.8		
8-17-70	1	GASKETS & SAND PAPER	97	H-88	313	4.0	118.8		
8-24-70	1	GR FILTER	2.34	H-91	147	4.0	119.8		
8-24-70	1	ACID INSOLUBLE PRESS CLOTHS	2.34	H-91	137	4.0	120.8		
8-24-70	1	IP FILTER	97	MIXED	0131	4.0	121.8		
8-24-70	1	GASKETS & SAND PAPER	97	H-88	334	4.0	122.8		
8-24-70	1	SCRAP METAL	97	H-88	338	4.0	123.8		
8-24-70	1	SCRAP METAL	97	H-88	337	4.0	124.8		
8-24-70	1	IP FILTER	97	H-88	335	4.0	125.8		
8-25-70	1	DRUM #L-3	HI-LO MIXED	MIXED	—	32.5	158.3		
"	1	ACID INSOL.	97	H-81	432	3.6	161.9		
"	1	ACID INSOL.	97	H-81	435	4.3	166.2		
"	1	ACID INSOL.	97	H-81	436	1.1	167.3		
"	1	ACID INSOL.	1.77	H-86	142	5.2	172.5		
"	1	GD ₂ O ₃ CLEAN UP H ₂ O	2.34	H-92	1234	1.3	173.8		
"	1	FILTER BOARDS	2.34	H-91	150	4.0	177.8		

DATE	QTY	DESCRIPTION	T. No.	RESIDUE No.	g/u	ACC. g/u	DE
8-26-70	1	ACID INSOL.	2.34 H-91	141	1.1	178.9	9
"	1	FILTER BOARDS	2.34 H-91	145	1.6	180.5	
"	1	FBR SCRAP	97 H-88	0140	1.9	182.4	
"	1	FILTER BOARDS	2.34 H-91	149	1.6	184.0	9
"	1	GRANULATOR SCREEN	2.34 H-91	1254	1.3	185.0	
"	1	FILTER BOARDS	2.34 H-91	148	1.2	186.5	
"	1	SCRAP METAL FROM INCINERATOR	2.34 H-91	1072	6.0	192.5	
"	1	OP TRASH	2.01 L-60	519	3.1	195.6	
"	1	FILTER BOARDS	2.34 H-91	151	3.6	199.2	
"	1	GRANULATOR SCREEN	2.34 H-91	1032	1.3	200.5	
"	1	ACID INSOL.	2.34 H-91	135	7.4	207.9	
"	1	R-2 FILTER	2.34 H-91	525	1.1	209.0	
"	1	FILTER BOARDS	2.34 H-91	146	3.3	212.3	
"	1	FILTER BOARDS	2.34 H-91	144	1.0	213.3	
"	1	SCRAP METAL	2.34 H-91	1178	1.2	214.5	
8-27-70	1	GASKETS & SANDPAPER	97 H-88	353	21.0	215.5	9
"	1	GRANULATOR SCREEN	2.34 H-91	1232	21.0	216.5	
"	1	GRANULATOR SCREEN	2.34 H-91	1198	21.0	217.5	
"	1	GRANULATOR SCREEN	2.34 H-91	918	21.0	218.5	
"	1	ACID INSOL.	2.34 H-91	154	21.0	219.5	
"	1	PRESS CLOTHS - ACID INSOL.	2.34 H-91	175	21.0	220.5	
8-28-70	1	DRUM # C-4	97 H-88	—	17.0	227.5	
"	1	ACID INSOL.	97 H-88	440	21.0	238.5	
"	1	CLEAN UP H ₂ O # 014	2.34 H-92	1298	5.2	242.8	
"	1	CLEAN UP H ₂ O	2.34 H-92	1300	1.7	245.5	
"	1	ACID INSOL.	2.34 H-91	158	4.9	250.4	
"	1	BAGS & RAGS - 5 GAL. PAUL	2.34 H-92	1296	2.0	252.4	
"	1	BROKEN BOATS	97 H-88	205	6.3	258.7	
8-31-70	1	GRANULATOR SCREEN	2.34 H-92	1316	21.0	259.7	
"	1	GA ₂ O ₃ CLEAN UP H ₂ O	2.34 H-92	1322	21.0	260.7	
"	1	GASKETS & SANDPAPER	97 H-88	380	21.0	261.7	
"	1	GA ₂ O ₃ CLEAN UP H ₂ O	2.34 H-92	0831.02	21.0	262.7	
"	1	" " "	2.34 H-92	0831.03	21.0	263.7	
"	1	" " "	2.34 H-92	0831.04	21.0	264.7	
"	1	" " "	2.34 H-92	758	21.0	265.7	
9-1-70	1	BOX FILTER	2.34 H-91	553	21.0	266.7	
"	1	RAGS, BAGS, ETC.	2.34 H-92	1354	1.1	267.8	

HOLE #38

DATE	SHEET	DESCRIPTION	%	SYMBOL	RESIDUE		G	ACC.	G	WT
					NO.	%				
1-1-70	1	ACID INSOL.	2.34	H-91	161	2.4		270	2	
"	1	ACID INSOL.	2.34	H-91	162	2.0		272	2	
"	1	ACID INSOL.	2.34	H-91	163	11.4		283	6	
9-4-70	1	CLEAN UP H ₂ O	2.34	H-92	1220	41.0		284	6	
"	1	CLEAN UP H ₂ O	2.34	H-92	1222	41.0		285	6	
"	1	GRANULATOR SCREEN	2.01	H-97	1378	41.0		286	6	
"	1	BROKEN FILTERS - 5 GAL PAIL	2.34	H-91	577	41.0		287	6	
"	1	GASKETS & SAND PAPER	97	H-88	384	41.0		288	6	
"	1	FILTER BOARDS	2.34	H-91	167	41.0		289	6	
"	1	FURNACE GASKETS	2.34	H-91	170	41.0		290	6	
"	1	GRANULATOR SCREEN	2.01	H-97	1426	41.0		291	6	
"	1	FILTER BOARDS	2.34	H-91	166	41.0		292	6	
"	1	ACID INSOL.	10	HK	719	13.4		306	0	
"	1	FS LID CLEAN OUT	97	H-88	371	41.0		307	0	
"	1	TRASH	20	WP	448	41.0		308	0	
9-14-70	2	GASKETS I.P.	97%	H88	404	41.0		309	0	
"	2	R.R. TRASH R.R.	92%	MIX	453	41.0		310	0	
"	2	SCREENS I.P.	97%	H87	243	1.3		311	3	
"	2	" I.P.	97%	H87	245	2.0		313	3	
"	2	GRAN. SCREENS O.P.	2.01	H97	1578	41.0		314	3	
"	2	ITEM 51. BISON EQUIPT.	97%	H32	"A"	41.0		315	3	
"	2	SCREEN I.P.	97	H87	"AA"	41.0		316	3	
"	2	LID FOR SCREEN LID FOR REB. MILL	97%	H87	242	41.0		317	3	
"	2	SCRAP SCREEN I.P.	97%	H87	244	41.0		318	3	
"	2	GLOVE LINERS I.P.	97%	H87	246	2.2		320	5	
"	2	PLASTIC BAGS	97	H87	237	41.0		321	5	
"	2	SCREEN I.P.	93	L-51	31	41.0		322	5	
"	2	M.T. SAMPLE BOTTLES R.R.	92	MIX	452	41.0		323	5	
"	2	PRE-FILTERS R.R.	90	L59	244	1.1		324	6	
"	2	PRESS CLOTHS G.R.	2.34	H91	181	41.0		325	6	
"	2	POLY BAGS I.P.	97%	MIX	1456	2.5		328	1	
"	2	Paper I.P.	97	H88	393	1.0		329	1	
"	2	METAL FROM H... G.R.	2.34	H91	177	41.0		330	1	
"	2	LAB. TRASH	92	MIX	LAB	41.0		331	1	
"	2	"	92	"	"	41.0		332	1	
"	2	TRASH I.P.	97	H87	236	41.0		333	1	
"	2	VALVE R.P.	2.01	H97	1472	41.0		334	1	

DATE	SHEET	DESCRIPTION	70	70 IS SYMBOL	RESIDUE NUMBER	G/U	ACC.	G/U	D
9-14-70	2	TRASH LAB.	92	MIX	LAB.	FORWARDED 334.1 21.0	335.1		9
"	2	GRAN. SCREEN P.P.	2.01	H97	1498	21.0	336.1		
"	2	PRE-FILTER FRAME G.R.	2.34	H91	176	21.0	337.1		9
"	2	GRAN. SCREEN P.P.	2.01	H97	1476	21.0	338.1		
"	2	RAGS & GLOVES G.R.	2.34	H91	169	1.1	339.2		
"	2	RUBBER GLOVES I.P.	97	H88	395	21.0	340.2		
"	2	RAGS I.P.	97	H88	394	21.0	341.2		
"	2	PRE FILTER G.R.	2.34	H91	175	1.5	342.7		
"	2	8d203 P.P.	2.34	H92	436	1.7	344.4		
"	2	ACID INSOLU. G.R.	2.34	H91	172	1.1	345.5		
9-16-70	2	ACID INSOLU. G.R.	2.34	H91	164	3.1	348.6		
"	2	ACID INSOLU. G.R.	2.34	H91	182	4.7	353.3		
"	2	VAL. FILTER P.P.	2.01	L60	601	1.8	355.1		
"	2	ACID INSOLU. PRESS CLOTHS G.R.	2.34	H91	183	3.7	358.8		
9-17-70	2	POLYBAGS GRANULATOR SCREEN P.P.	2.01	H97	1570	2.1	359.8		
"	2	POLY BOTTLES P.P.	2.0	MIX	1546	2.1	360.8		
"	2	GRANULATOR SCREEN P.P.	2.01	H97	1590	2.1	361.8		
"	2	GRANULATOR SCREEN P.P.	2.01	H97	1554	2.1	362.8		
"	2	INCEN. CLEAN-OUT P.P.	2.01	H97	1555	1.3	364.1		
"	2	ACID INSOL. 7 PRESS CLOTHS G.R.	2.01	L61	184	1.7	365.8		
"	2	BALL MILL BALLS I.P.	97	L51	30	2.1	366.8		
"	2	ACID INSOLUBLES R.R.	97	H81	454	3.9	370.7		
"	2	WASHED PRE-FILTER R.R.	97	H81	457	21.0	371.7		
"	2	ACID INSOL. R.R.	97	H81	449	4.5	376.2		
"	2	WASHED PRE-FILTER R.R.	97	H81	458	1.8	378.0		
"	2	ACID INSOL. R.R.	97	H81	455	21.0	379.0		
"	2	PENTACHLORIDE VAP. CLEAN-UP I.P.	97	H88	385	21.0	380.0		
9-18-70	2	DRUM # C-5	92	MIXED		19.5	399.5		
9-23-70	2	Granular screen P.P.	2.01	H91	1690	2.0	401.5		
"	2	" " P.P.	2.01	H97	1660	21.0	402.5		
"	2	Reactors gaskets G.R.	2.0	MIX	195	21.0	403.5		
"	2	TRASH LAB	92	MIX	0923-04	21.0	404.5		
"	2	Granulator Screens P.P.	2.01	H97	1646	1.7	406.2		
"	2	" " P.P.	2.01	H97	1648	21.0	407.2		
"	2	" " P.P.	2.0	MIX	1642	21.0	408.2		
"	2	" " P.P.	2.01	H97	1622	21.0	409.2		
"	2	Ball mill balls I.P.	93	L51	29	21.0	410.2		

HOLE #38

DATE	SHEET	DESCRIPTION	70	300	RES. DUE	NUMBER	6/4	ACC	G/W	...
9-23-70	2	Straw filter screen	P.P.	2.01	H97	1610	2.10	411	2	
"	2	Bearings	I.P.	97	H87	263	2.10	412	2	
9-29-70	2	Generator Cleanout	RR	2.01	H97	1794	1.4	413	6	
"	2	Trash	LAB	92	MIX	0929-01	2.1	415	7	
"	2	Trash	I.P.	97	H87	270	2.7	418	4	
"	2	Trash	R.R.	92	MIX	470	1.3	419	7	
"	2	acid insoluble + Pass Filter	R.R.	2.01	H97	194	2.1	421	8	
"	2	Reactors Snakes	R.R.	92	MIX	471	2.2	424	0	
"	2	Hard S.T. (Wear)	I.P.	97	H88	0121	2.1	425	0	
"	2	Trash	I.P.	97	H88	424	3.0	428	0	
"	1	Pap - Trench	I.P.	97	H87	249	2.10	429	0	
"	1	W.K. from Vacuum pump	R.R.	92	MIX	463	2.10	430	0	
"	1	HCL + H2O	I.P.	97	H88	0165	2.10	431	0	
"	1	TCE-OIL-BAGS	RR	92	MIX	461	2.10	432	0	
"	1	acid insoluble	RR	97	H36	464	2.8	434	8	
"	1	TCE-OIL-BAGS	RR	92	MIX	462	2.10	435	8	
"	1	acid insoluble	RR	97	H36	452	4.2	440	0	
"	1	Straw filter screen	P.P.	2.01	H97	1752	2.10	441	0	
"	1	"	PP	2.01	H97	1748	2.10	442	0	
"	1	"	PP	2.01	H97	1812	2.10	443	0	
"	1	"	PP	2.01	H97	1236	2.10	444	0	
"	1	M.T. Sample Bottle	LAB.	1.77	H86	0927-12	2.10	445	0	
"	1	acid insoluble	I.P.	97	H88	423	2.10	446	0	
"	1	Straw filter screen	PP	2.01	H97	1848	2.10	447	0	
"	1	Trash	LAB.	92	MIX	0930-01	2.10	448	0	
"	1	Trash	I.P.	97	H88	433	2.10	449	0	
"	1	Trash	C.P.	2.01	L60	693	2.10	450	0	
"	1	Straw filter screen	PP	2.01	H97	1332	2.10	451	0	
"	1	Trash	LAB.	92	MIX	0930-02	2.10	452	0	
"	1	acid insoluble	I.P.	97	H88	0190	2.10	453	0	
"	1	acid insoluble from hand bin	I.P.	97	H88	0189	2.10	454	0	
10-6-70		DRUM #C-6 contaminated trash		HI-LO MIXED	MIXED		42.0	496	0	
10-10-70	1	Trash	LAB	92	MIXED	10-8-1	2.10	497	0	
"	1	Rags + Pat cleanup	I.P.	97	H88	436	2.10	498	0	
"	1	M.T. Sample Bottle	LAB.	2.0	MIX	10-9-2	2.10	499	0	
"	1	Straw filter screen	PP	2.01	H97	1962	2.10	500	0	
"	1	"	PP	2.01	H97	1926	2.10	501	0	

		HOLE #38			JOB	RESIDUE				
DATE	SHEET	DESCRIPTION		QTY	SYMBOL	NUMBER	G/W	ACCU.	G/U	DATE
10-9-70	1	POT LID CLN. UP	IP	97	H88	341	<1.0	501	0	
"	1	RED VALVE	OP	2.01	L-60	757	<1.0	502	0	
"	1	GLOVE LINERS	IP	97	H88	449	<1.0	503	0	
"	1	Rags	IP	97	H88	454	<1.0	504	0	
"	1	Insulation from	OP	2.0	MIX	735	<1.0	505	0	
"	1	GRANULATOR SCREENS	PP	2.01	H97	1886	<1.0	506	0	
"	1	INCINERATOR FILTER	PP	2.01	H97	1896	<1.0	507	0	
"	1	M.T. SAMPLE BOTTLES	OP	2.01	L60	717	<1.0	508	0	
"	1	" " "	LAB.	2.0	MIX	10-8-3	<1.0	509	0	
"	1	GRANULATOR SCREENS	PP	2.01	H97	1916	<1.0	510	0	
"	1	GASKETS + SANDPAPER	IP	97	H88	453	<1.0	511	0	
"	1	TRASH	LAB.	92	MIX	10-8-4	<1.0	512	0	
"	1	TRASH	LAB.	92	MIX	10-8-5	<1.0	513	0	
"	1	GASKETS + SANDPAPER	IP	97	H88	434	<1.0	514	0	
"	1	TRASH	LAB.	92	MIX	10-8-6	<1.0	515	0	
"	1	GRANULATOR SCREEN	PP	2.01	L60	1868	<1.0	516	0	
"	1	INCINERATOR FILTER	PP	2.01	H97	1894	<1.0	517	0	
"	1	" - "	PP	2.01	H97	1892	<1.0	518	0	
"	1	TRASH	IP	97	H88	435	<1.0	519	0	
"	1	"	IP	97	H87	282	<1.0	520	0	
"	1	"	LAB.	92	MIX	10-8-7	<1.0	521	0	
"	1	"	PP	2.01	H97	1870	<1.0	522	0	
10/20/70	1	Rags	IP	97	H87	455	<1.0	523	0	
"	1	Trash	SHOP	92	MIX	1076-02	<1.0	524	0	
"	1	Trash	LAB.	92	MIX	10-16-03	<1.0	525	0	
"	1	Trash	LAB.	92	MIX	10-16-04	<1.0	526	0	
"	1	Insulation from OP	OP	2.01	L60	779	<1.0	527	0	
"	1	Trash	IP	97	H88	1016-05	<1.0	528	0	
"	1	Trash	LAB.	97	MIX	1016-06	<1.0	529	0	
"	1	Trash	PP	2.01	L60	775	<1.0	530	0	
"	1	Trash	OP	2.01	L60	773	<1.0	531	0	
"	1	Trash	LAB.	92	MIX	101607	<1.0	532	0	
"	1	Broken multi filters	OP	2.01	L60	777	<1.0	533	0	
"	1	Trash	RR	2.0	MIX	212	<1.0	534	0	
"	1	Insulation + Paper	OP	2.01	L60	771	<1.0	535	0	
"	1	Trash	LAB.	92	MIX	10-16-08	<1.0	536	0	
"	1	Rock cement	RR	90	L28	478	<1.0	537	0	

G/U	DATE	SHEET	DESCRIPTION	LAB.	JOB SYMBOL	RESIDUES NUMBER	G/U	Accd.	G/U
0	10-20-70	1	trash	LAB.	92	Mix	10-20-01	<1.0	539.0
0	"	1	"	"	92	"	10-20-02	<1.0	540.0
0	"	1	"	"	92	"	10-20-03	<1.0	541.0
0	"	1	"	"	92	"	10-20-04	<1.0	542.0
0	"	1	"	"	92	"	10-20-05	<1.0	543.0
0	"	1	"	"	92	"	10-20-06	<1.0	544.0
0	"	1	"	"	92	"	10-20-07	<1.0	545.0
0	"	1	"	"	92	"	10-20-08	<1.0	546.0
0	"	1	trash Recycle Room	IP	97	H87	300	<1.0	547.0
0	"	1	Paps, Pat. element	IP	97	H88	478	<1.0	548.0
0	"	1	Paps + insulation	FB	97	H88	0207	<1.0	549.0
0	"	1	Stannic Chloride	PP	201	H97	2022	<1.0	550.0
0	"	1	Labels + Sample	IP	97	H88	479	<1.0	551.0
0	"	1	Paps, Pat. element	IP	97	H88	473	<1.0	552.0
0	"	1	insulation	O.P.	201	L60	781	<1.0	553.0
0	"	1	"	CI	201	L61	783	<1.0	554.0
0	"	1	Paps	IP	97	H87	295	<1.0	555.0
0	"	2	insulation	RR	93	H06	477	2.0	557.0
0	"	2	Acid Insulation	RR	177	H86	205	2.5	559.5
0	"	2	Trash	LAB.	92	Mix	10-20-01	1.2	560.7
0	"	2	"	IP	92	H88	457	1.7	562.4
0	"	2	Labels + Sample + element	IP	201	L61	1952	1.5	563.9
0	"	2	"	PP	201	L61	2076	1.6	565.5
0	"	2	Labels + Paps + Paper	RR	201	L61	211	1.1	566.6
0	"	2	M.T. Sample	LAB.	97	MIX	254	1.6	568.2
0	"	2	Papertape	P.P.	201	H97	1590	1.4	569.6
0	"	2	Paps + Sam	RR	92	H92	10-20-09	2.7	572.3
0	10-30-70	1	Acid Insulation	RR	93	H77	491	4.8	572.1
0	"	1	Project Paper + Sam	IP	97	H87	307	<1.0	578.1
0	"	1	Acid Insulation	RR	97	H81	475	<1.0	579.1
0	"	1	Map + Sam	IP	97	H83	503	<1.0	580.1
0	"	1	Acid Insulation	RR	93	H77	477	<1.0	581.1
0	"	1	"	RR	93	H77	477	<1.0	582.1
0	10-30-70	2	insulation	CI	201	L60	781	1.3	583.4
0	11-2-70	1	FILTERS FROM TUCCO	IP	97	H88	0202	<1.0	584.4
0	"	1	FILTERS FROM TUCCO	IP	97	H88	0203	<1.0	585.4
0	"	1	ACID INSUL		93	H77	491	4.8	590.2

Gamma Survey Data Evaluation Report

Rev 1

prepared for



WESTINGHOUSE ELECTRIC COMPANY
Hematite, Missouri

prepared by



SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
St. Louis, Missouri

MAY 2004

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ACRONYMS	
⁹⁹ Tc	Technicium-99
AOC	Area of concern
ATV	All terrain vehicle
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Cm	Centimeter
cpm	Counts per minute
DQOs	Data quality objectives
ft	Feet
GIS	Geographic information system
GPS	Global positioning system
GWS	Gamma walkover survey
HSA	Historical Site Assessment
HEU	High enriched uranium
HF	Hydrogen fluoride gas
LEU	Low enriched uranium
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDNR	Missouri Department of Natural Resources
QA	Quality assurance
QC	Quality control
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
SAIC	Science Applications International Corporation
UF ₆	Uranium hexafluoride

1.0 INTRODUCTION

The Westinghouse Electric Corporation, LLC (Westinghouse) nuclear fuel manufacturing facility at Hematite, Missouri ceased operation in June 2001 after nearly 47 years under various owners and operators. Westinghouse now seeks to decommission the plant and release the property. The United States Nuclear Regulatory Commission (NRC) is the primary agency for the plant decommissioning. The Missouri Department of Natural Resources (MDNR) is the primary regulatory agency for the remedial investigation/feasibility study (RI/FS) that is being performed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). Both agencies are expected to provide critical roles in defining the regulatory path to decontamination and decommissioning, site assessment and remediation, and eventual release.

This gamma walkover survey was conducted as an initial phase of the RI/FS at the site and, as such, MDNR provided oversight for this work. MDNR representatives were on-site on a daily basis, attended the daily meetings, and observed work being performed. Typically there was only one representative present at a time and there were times when activities were occurring in more than one location.

The plant is located on approximately 228 acres of property (Property) that is currently owned by Westinghouse. The plant and production related activities are located on approximately 8 acres of the Property.

1.1 SURVEY PURPOSE

Science Applications International Corporation (SAIC) performed a Gamma Walkover Survey (GWS) at the Hematite Facility (Figure 1) during the period April 7-24, 2003 in accordance with the *Gamma Survey Plan for the Hematite Site* (Survey Plan (Rev 0)). The purpose of the GWS was to identify the presence of low level gamma radiation that could indicate the presence of uranium including natural uranium, low enriched uranium (LEU), high enriched uranium (HEU), and thorium 232 (Th-232) and progeny in surface soils. For the purposes of this report, surface soils are defined as the thickness of soil that can be measured using direct measurement or scanning techniques (MARSSIM). Typically, this layer is represented as the top 15cm (6 inches) of soil (40 CFR 192). This information will be used to aid in area classification and future characterization planning at the site.

The survey was conducted with the intent of maximizing the use of all data collected in future site evaluations, specifically the Remedial Investigation/Feasibility study (RI/FS). The GWS has been designed to follow the guidance for scoping surveys presented in Section 5.2 of the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). Although this survey was conducted to aid in classification of site areas as impacted or non-impacted, all available data must be evaluated prior to classification of the site. The GWS detection ability is limited to the gamma signature of site specific radionuclides and is typically limited to surface soils.

1.2 SURVEY SCOPE

The GWS data will assist Westinghouse in verifying the conclusions of previous Historical Site Assessments (HSA) and provide input for identifying potential sample locations as part of the Remedial Investigation (RI). Other uses of the survey data include:

1. Determining the magnitude of surface contamination in the soils immediately surrounding the plant area.
2. Determining the lateral extent of surface contamination extending out from the plant.

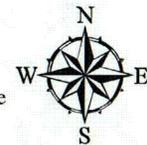
U:\GPS\GPS Westinghouse\Projects\Westinghouse Figure 1.mxd



Legend:

 Westinghouse Property

MO-East State Plane
(NAD 83, Feet)



290 0 290 Feet

Westinghouse Electric Company
Gamma Walkover Survey
Hematite, Missouri



DRAWN BY:
David Lawson

REV:
1

DATE:
06/09/03

Figure 1. Westinghouse Property Map

3. Detecting, as is possible with surface gamma detectors, the presence of any burial pits and other areas of concern known or unknown to exist at this time.
4. Determining the extent, if any, of the spread of surface contamination by the existing natural migration pathways (ditches, streams, low points, surface water flow, etc.).
5. Identifying non-impacted areas that may be appropriate for obtaining reference areas samples to be used to estimate the background soil concentration for contaminants of concern at the site.
6. Providing input to future site evaluations to determine the risk posed by the uranium, and/or thorium contamination by locating areas and media impacted by the spread of contamination and determining the magnitude of the contamination present on the site.

2.0 SURVEY DESIGN AND METHODOLOGY

The survey was designed to cover 100% of the areas directly adjacent to the plant as shown on Figure 2, which includes the areas surrounding the buildings and other obstructions. It was expected that 70% of this area would be surveyed using a multi-pass conveyance and 30% by technician-conveyed global positioning system (GPS)/gamma detector assemblies. The multi-pass conveyance was planned for use over most of the grass-covered areas located outside the fence line. Technician-conveyed detectors were planned to survey the evaporation ponds, ditches, mounds, sedimentation pond, and drainages along or through the rail line, and in the densely wooded areas outside the fence line.

The survey was designed to cover approximately 10% of the remaining areas as shown on Figure 2. The survey was originally designed to be a roughly systematic survey of the remaining areas of the site. In densely wooded areas, the surveys were planned to maximize peak periods of satellite availability. The survey in the 10% coverage areas focused on locations with higher potential for detection of elevated gamma radiation levels, such as in drainage ditches, pond banks, and disturbed areas. It was expected that approximately 30% of these areas would be surveyed using a multi-pass conveyance and 70% by technician-conveyed GPS/gamma detector assemblies. The multi-pass conveyance was planned for use over the open farmland located on the eastern side of the site and the semi-open hilly site terrain located north of State Road P. The technician-conveyed GPS/gamma detector assemblies would be used to survey the remainder of these areas.

Uranium and its short-lived daughters (e.g., Th-234, Pa-234m, Th-231), as well as Thorium 232 (Th-232) short-lived daughters (e.g. Ac-228, Th-228) have associated gamma radiation. A sodium iodide scintillation detector (NaI 2"x2") was selected to detect the gamma radiation. The NaI 2"x2" was coupled to a rate meter, which transfers detector count-rate data to a Trimble XRS (or equivalent) global positioning system (GPS) data logger. In addition, the scaler/ratemeter combinations were upgraded with Ludlum's "one-second count microchip" to achieve a gamma count for every one-second GPS position location. The 2"x2" NaI detector was selected over other radiological instrumentation for the following reasons:

- It is a multi-purpose detector capable of low and high energy gamma ray detection with no appreciable loss of low level gamma ray detection ability;
- It is rugged and durable and requires less instrument maintenance or surveyor downtime;
- It is a lighter detector resulting in less surveyor fatigue that would otherwise produce a less efficient survey;
- It can be equipped with Ludlum's "one-second count microchip" to achieve a gamma count for every one-second GPS position location;
- It allows an increased ability to pin point the source of elevated gamma signal;
- It is cost effective, less expensive to procure and maintain.

The 2"x2" NaI detector detects gamma levels from surface sources and indicates the presence of these levels in corresponding "cpm" (counts per minute) readings. The 2"x2" NaI detector has varying sensitivities to different gamma ray energies and does not distinguish the "cpm" readings for the various energies. The inability to discriminate between the different energies does not allow a direct correlation of "cpm" readings to activity in a mixed radionuclide field. Therefore, the results of the GWS are reported in "cpm".

Prior to site mobilization, Westinghouse and SAIC, with MDNR in attendance, conducted a kickoff meeting. The scope of the walkover was slightly modified as a result of the meeting in that the Property would be assessed as seven areas identified by surface water drainage boundaries or other physical features. The original 100% coverage area was slightly increased to provide coverage in areas that may have been affected by past activities at the plant. The 10% systematic coverage of the remaining portion of the Property was modified to allow for more investigational coverage. In those areas where plant related contamination was not expected, the area perimeter, disturbed areas, and any internal drainage ways were surveyed to provide data to verify the assumption that the areas were not impacted. In some areas, closer to the plant site, more systematic coverage was performed to provide data to assess potential impacts.

The modified survey areas are described below and are identified along with approximate property lines on Figure 3.

- Area A – 100% Inside Fence
- Area B – 100% Outside Fence
- Area C – 10% South of Southern Drainage
- Area D – 10% South of Rail
- Area E – 10% South State Road P Between Drainages
- Area F – 10% East Farm Area
- Area G – 10% North of State Road P

U:\GPS\GPS Westinghouse\Projects\Westinghouse Figure 3.mxd

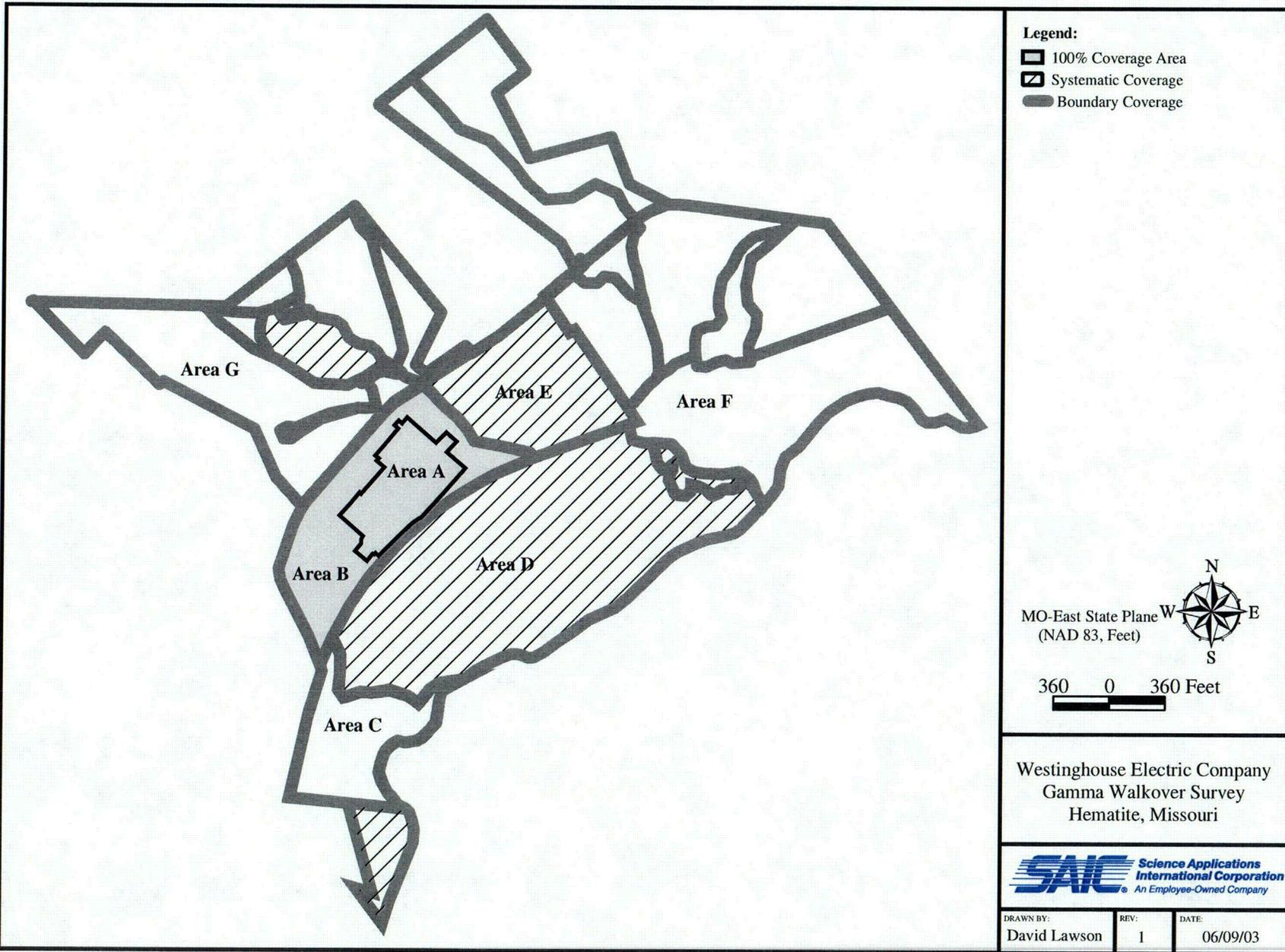


Figure 3. Final Survey Plan

C03

During the kickoff meeting a decision was made to implement the survey by concentrating the technician-conveyed GPS/gamma detector assemblies in areas with pending overhead tree canopies. The survey team decided to conduct the technician-conveyed GPS/gamma detector survey in areas C, D, E, and G and, finally, A. This would concentrate most of the survey crew in densely wooded areas before the tree canopy developed. In addition, the survey was modified to concentrate the survey in the areas covered with the densest vegetation during times when the most satellites were available to minimize the need for manual recording of data. The all terrain vehicle- (ATV) mounted GPS/gamma detector assemblies would begin in Area B and the 100% coverage area outside the controlled area fence, followed by Areas F, G, and, finally, A.

The ATV-mounted GPS/gamma walkover was conducted by mounting three individual detectors with independent GPS assemblies to the front of the ATV. The detectors were mounted 10 centimeters (cm) from the surface, and 70 cm apart to allow for sufficient overlap of each detector's viewing window of 82 cm at the top of the detector crystal. The viewing window is defined as the area capable of contributing gamma levels to the detector in a specific geometry within acceptable scan minimum detectable concentrations. The viewing window of the 2"x2" NaI detector was based on a detector height of 10 cm, crystal dimension of 5 cm x 5 cm with the ability to accurately detect gamma radiation at a 70 degree angle to the source. The scan minimum detectable concentrations presented in the Survey Plan (Rev 0) were calculated on a postulated hotspot with a radius of 28 cm or diameter of 56 cm. If the postulated hotspot was located directly between any two detectors, each detector could detect or view the elevated gamma radiation. For the purposes of this report "hot spot" is defined as areas that have significantly different count rates than the surrounding area and require additional investigation. The data collected during this investigation will be reevaluated after a determination of the site specific radionuclide ratios. The collective gamma contributions from the site specific radionuclides will be evaluated, modeled and correlated to a site specific scan minimum detectable concentration (MDC). Once the scan MDC and gamma contributions from site specific radionuclides are known, a qualitative concentration to count rate comparison can be made. The ATV was driven at a speed that would roughly equate to 0.5 meter/second or less. The operator continuously monitored at least one of the instrument readouts with frequent monitoring/comparison of all instrument responses.

The technician-conveyed GPS/gamma walkover was conducted by the technician maintaining the detector approximately 10 cm from the surface progressing at a speed of 0.5 meters/second or less. The technicians moved the detectors in a slightly serpentine pattern, where possible, taking care to maintain the 10 cm distance from surface to detector. Frequently, the technicians substituted a controlled side-to-side pattern so the serpentine motion could maintain correct detector alignment with the survey surface. The technicians continuously monitored the audible instrument response.

Outside the 100% coverage area, the survey team was instructed on the general location of the required survey coverage and areas of interest. Technicians were instructed to use their experience to investigate the areas of highest contamination potential encountered in each area. The team used the Trimble mapping tool to maintain roughly parallel paths in areas requiring systematic coverage. Within the 100% coverage area, the survey team attempted to use the ATV-mounted GPS assemblies wherever possible. When technician-conveyed GPS assemblies

were necessary, the survey team used constant communication and the Trimble mapping tool to ensure adequate survey coverage.

Daily tailgate safety/planning meetings were held. The previous day's events, issues, and progress were discussed, in addition to the areas to be surveyed that day. Each technician was assigned to a specific area with coverage instructions, expected progress, and relative background, with an associated investigation level (a scanning response which is detectable above the background level) depending on the area to be surveyed. Upon completion of the survey, the survey team and Westinghouse conducted a daily debrief meeting. The daily debrief consisted of the survey progress, anomalies, issues, concerns, and a discussion of survey progress and areas to be surveyed the following day.

3.0 SURVEY QUALITY CONTROL

3.1 DATA QUALITY OBJECTIVES

Table 3-1 Data Quality Objectives

DQOs	DQO Attainment
The initial mean background count-rate for each NaI 2"x 2" will be within 10% of the mean background count-rate (at the same location) for all instruments used for the survey.	All instruments used for the survey were within 10% of the mean background count-rate (at the same location). Instrumentation QA records are included in Attachment 1.
All survey instruments will be calibrated at least annually using calibration sources traceable to the National Institute of Standards and Technology (NIST).	All instruments were calibrated at least annually in accordance with ANSI N323A, Radiation Protection Instrumentation Test and Calibration-Portable Survey Instruments (ANSI, 1997). Instrumentation QA records are included in Attachment 1.
All survey instruments will be performance checked at the beginning of each survey day to determine the usability of data collected. The established acceptance criteria for background and source response will be $\pm 20\%$ of the mean value determined during the initial instrument setup procedure.	All radiological field instruments were performance checked at the beginning and end of each day. All acceptance criteria checks for all field instruments were met as required by the plan. Instrumentation QA records are included in Attachment 1.

3.2 INSTRUMENTATION QUALITY ASSURANCE

Each GPS instrument was paired with a survey meter/detector and assigned a pack number. This was accomplished by giving all the GPS packs a letter from A to G and doing the same for the radiological instruments. The GPS packs were then matched up with the radiological instrument that had the same letter. The exception was GPS Pack A. It was paired with Meter H.

3.2.1 Radiological Instrumentation Quality Assurance/Quality Control

Gamma walkover survey instrumentation was calibrated annually in accordance with ANSI N323A, *Radiation Protection Instrumentation Test and Calibration – Portable Survey Instruments* (ANSI, 1997) for the spectrum of radiation energies expected at the Hematite facility.

Gamma walkover survey instrumentation was operated by qualified personnel in accordance with SAIC's Health Physics Procedure HP-30, *Radiological Instrumentation*, and Health Physics Instruction HPI-001, *Performance of a GPS Gamma Walkover Survey*.

All instruments were initially processed to determine if the general area gamma radiation levels would interfere with the initial instrument setup and the acceptance criteria determined prior to arrival. All instruments were within tolerance of the acceptance range. All instruments were verified to meet the established site-specific background acceptance criteria with the exception of instrument "A". Instrument "A" exceeded the background and source values on the high end during the initial on-site instrument check in. This instrument was tagged out of service and removed from the site. No data was collected with Instrument "A".

Table 3-2 Instrument Background Comparison

Instrument	Mean Background cpm
B	5,493
C	5,135
D	5,418
E	5,315
F	5,263
G	5,322
H	5,405
Site Mean	5,343
10% range	4,809-5,877

Daily performance checks were conducted on each instrument as defined in HP-30 and as summarized in the Survey Plan (Rev 0). Only data obtained using instruments that satisfied these performance requirements were accepted for use in this investigation.

3.2.2 Global Positioning System Quality Assurance/Quality Control

The daily QC check of the GPS units was performed and recorded for use post-survey. The accuracy of the GPS system is dependent on many factors, mainly the number of visible satellites, which will vary throughout the day. The manufacturer's stated accuracy is sub-meter; the actual accuracy or Position Dilution of Precision (PDOP) of the GPS units varies and is dependent on satellite visibility. Each data point collected has a PDOP value attached as a measurement of the coordinate accuracy. PDOP simply provides an indication of the expected accuracy of GPS positions based on the relative positions of the satellites. Lower PDOP values provide more accurate data. The accuracy of single data point can be determined by the PDOP value associated with the point.

The daily positions check on a known or identified location assists the project in determining if data files collected on a given day require post processing. The northern most monitoring well located just west of the Building 231 was used as the known location for this survey.

The data collected from each pack at the beginning and the end of each survey day is collected for use post-survey while the data is evaluated. The relative differences between the

pre- and post-survey check, the drift during check, and the relative differences between GPS units are all evaluated. This evaluation helps to quantify the degree of confidence in the reported coordinates for each data point across the project. In addition, the check pinpoints suspect coordinate data associated with a particular GPS unit, a particular GPS unit on a given survey day, or all GPS units on a given survey day.

If one of the GPS units indicates a significant difference in reported locations when compared to known or other GPS units, all position data collected that day with that unit is suspect and is evaluated. The evaluation will inspect the position of all data points in relation to property boundaries, known areas covered that day, and in relation to data points collected on other packs in the general vicinity. In addition, the corresponding radiological count rate for a reported area will be compared to known or collected radiological count rates from other instruments in the same area. If the above data checks indicate an unreasonable amount of error in the reported coordinate data, the specific data files are post-processed to increase coordinate position accuracy.

3.3 SURVEY QUALITY ASSURANCE

The survey team performed numerous performance, operation, and continuity quality checks during implementation of the survey. Instrument response is continuously checked in the field by referencing adjacent meter responses. The technicians, constantly monitoring the instrument response, periodically verify abnormal (either relatively high or low count rates) by comparing their instrument output with other instruments in the general vicinity. This check occurred frequently as the observed "relative background" count rate decreased as the technicians moved from the plant site toward the Joachim Creek. The technicians also perform an additional instrument response check during data evaluation. Instruments within the same general proximity should have recorded relatively similar count rates. All data were checked for erroneous data patterns that would suggest a faulty instrument response.

Position accuracy is checked upon completion of each day's survey. The collected data is downloaded and the data plotted on the site map. The site map, which was based on a February 2003 aerial flight by Sanborn and included a State plane grid prepared by Metropolitan Engineering, was provided by Westinghouse. Each technician verified that all the data they collected were captured and that the data were in the correct general area. The position is further verified during data evaluation by comparing data collected by adjacent technicians and instruments. This check is easily accomplished for the data collected with the ATV-mounted GPS assemblies. The three data streams are plotted and the plots are evaluated for erroneous or out-of-place data points. This check is more difficult to quantify for the data collected by the technician-conveyed GPS assemblies. The check, in this case, is performed by having the technician who collected the data review a plot of all collected data. Technicians check the location of their plotted data in relation to other data collected at the same time by other technicians. Technicians note the position of their data streams in relation to the adjacent data streams to determine if data is missing or erroneous coordinates have been recorded.

Data accuracy/reproducibility is checked during data evaluation. If relatively low or high-count rates that do not adhere to the surrounding data are identified in the data, additional

investigation is warranted in these areas. These areas are identified during data evaluation and performance of an additional gamma walkover to verify the abnormality is conducted.

Survey accuracy is checked by evaluating the entire data set for gamma radiation trends and patterns. If the patterns or trends do not make sense considering the topography, known operating history, field observations, or experience of the field team, additional investigation is warranted. For instance, high gamma radiation levels adjacent to a drainage ditch should indicate a high potential for elevated gamma radiation levels within the ditch. Conversely, small areas of elevated gamma radiation levels surrounded by large areas of background or near background gamma radiation levels with no obvious transport mechanism are suspect and are further investigated.

3.4 DATA MANAGEMENT

Pre-Survey

- Prior to the start of the survey, the site was divided into seven survey areas with common geographic features, such as roads, railroads, creeks, and drainages, which provide easily recognized boundaries. The survey areas are described below and are shown on Figure 3.

A-Inside Fence
B-100% Area Outside Fence
C-South of Southern Drainage
D-South of Rail
E-South State Road P East of Drain
F-East Farm Area
G-North of State Road P

- Once the survey areas were designated and the equipment was labeled, the format for the file naming system was established. File names consisted of seven digits that included GPS pack letter (A-G), (W) for Westinghouse, Survey area letter (A-G), Media type letter, example (S) for soil and (G) for gravel, and a three-digit file number, example (001). An example of a filename follows:

BWDS002

B-GPS Pack 'B'
W-Westinghouse
D-Survey Area 'D'
S-Soil
002-File number

Post-Survey

- At the end of each day of field activities, all gamma walkover data was downloaded from the TDC1 data collector flash memory card to a site computer via Pathfinder software.
- The Pathfinder software was also used to export the raw field data into Microsoft Access. Microsoft Access was used to convert the data into a format that can be imported into Arc View Geographic Information System (GIS) software.
- Once formatted, the survey data was placed into an Arc View project file, and a survey map was created to be presented in the daily post-survey briefing.

Following each day of surveying, the GWS survey files were backed up by copying the data to CD-R disks. After each week, the data was copied to SAIC's St. Louis office server.

4.0 SURVEY RESULTS

Due to various backgrounds, as described below, encountered across the site, it is difficult to provide an accurate visual display of all the data on one map. Figure 4 shows the survey coverage of the entire Property with the data color-coded at 2,000 counts per minute (cpm) increments, starting with 10,000 cpm for soil and 5,000 cpm for gravel and asphalt. This map provides the greatest amount of detail for examining trends and general gamma radiation levels across the Property. Figure 5 shows the survey coverage for the entire Property with the data color-coded at 2,000 cpm increments, starting with 11,000 cpm for soil and 6,000 cpm for gravel and asphalt. This figure, when used in conjunction with Figure 4, provides evidence of a gradual decrease in count rate from the railroad south to Joachim Creek. Figure 6 shows the survey coverage for the entire Property with data color-coded at 3,000 cpm increments, starting with 10,000 cpm for soil and 5,000 cpm for gravel and asphalt. The figure proves that the majority of the collected data is between 10,000 – 13,000 cpm. The reference area average was approximately 10,500 cpm. Figure 7 shows the survey coverage of the entire Property in two colors, with the discriminator at 16,000 cpm. This figure is designed to show the areas of the Property that are significantly above background.

4.1 BACKGROUND VALUE DETERMINATION

SAIC used three types of background values: instrument, reference, and relevant, to fulfill the objectives of the survey. SAIC evaluated all the collected data to determine the background value to be applied during data evaluation.

Individual instrument background values were determined to verify that the gamma detectors being used for the survey are responding similarly to low gamma flux levels. All individual instrument mean background values were within 10% of the mean for all detectors, ensuring all data collected could be evaluated and depicted on one color-coded map without data misrepresentations resulting from variations in detector response.

SAIC performed this background check by collecting individual instrument background values prior to mobilization to the site. The average or mean value of all the individual instrument values was calculated, in addition to the 10% range around the mean. All instruments

were checked upon arrival at the site to verify not only that the instruments were still within 10% of each other but also to verify that the "site" instrument background was not significantly different than initial instrument background calculation. The "site" background was not significantly different upon initial check and all instruments were well within the 10% range of the mean, with the exception of Instrument "A", which was removed from service. The individual instrument background values were on average 1.67% of the mean with the largest deviation individual instrument background being 3.89% below the mean. All of the instruments were determined to be responding similarly within tolerance to low level gamma flux radiation, and as such, were acceptable for use on this project.

U:\GPS\GPS Westinghouse\Projects\Westinghouse Landscape2.mxd

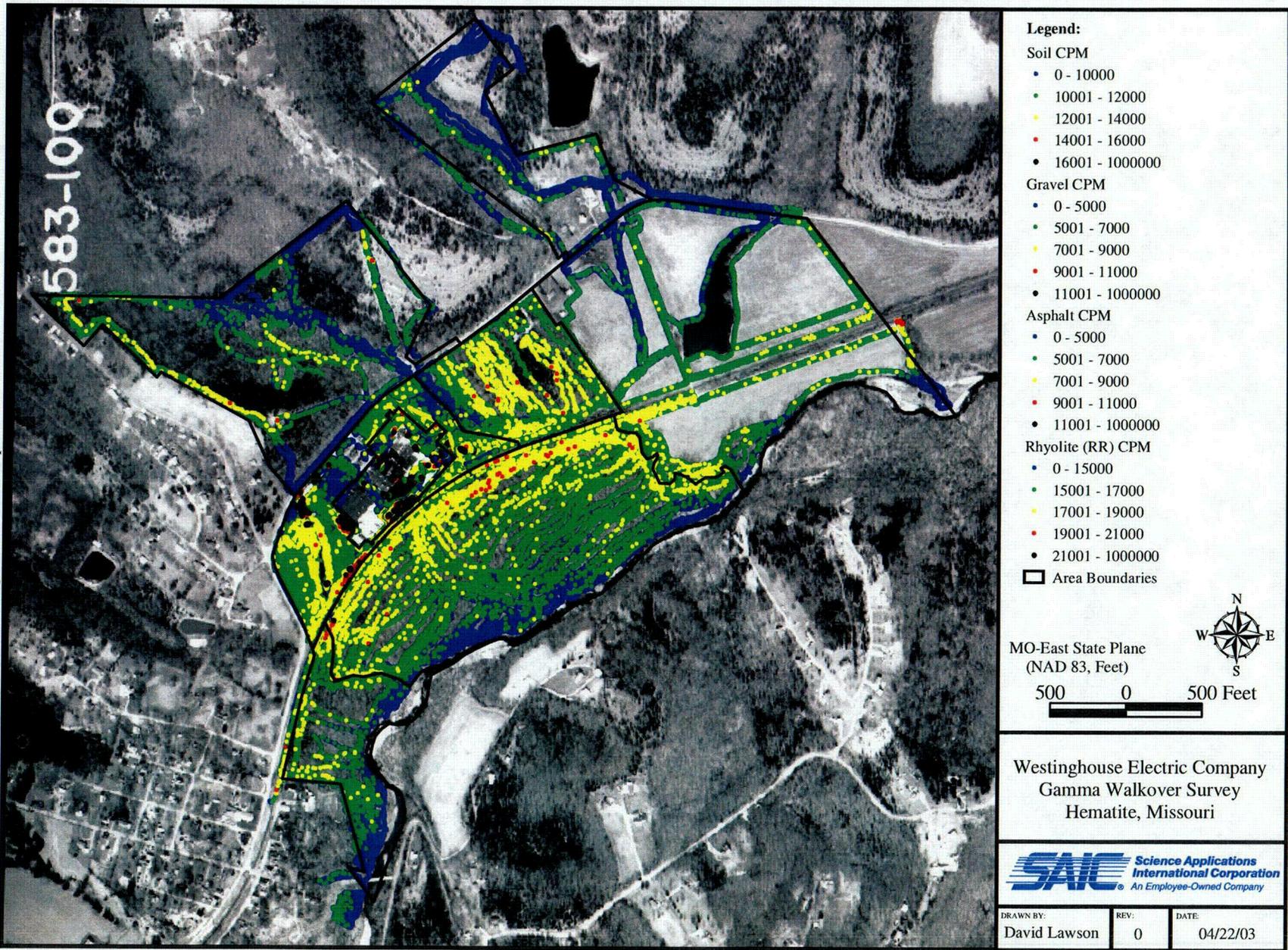


Figure 4. Westinghouse Gamma Walkover Survey (Soil Background 10001-12000 cpm)

C04

U:\GPS\GPS Westinghouse\Projects\Westinghouse\Figure 5.mxd

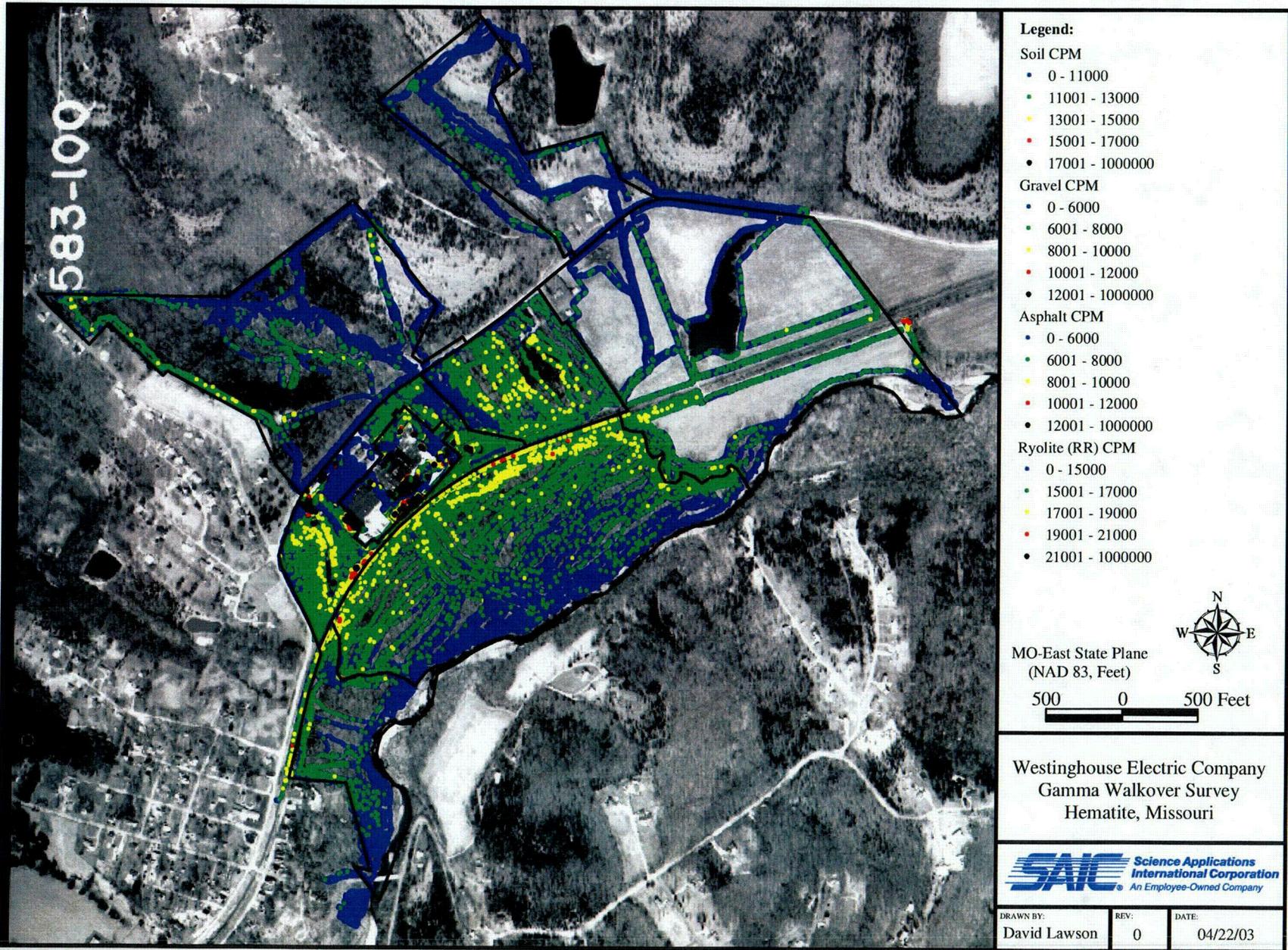


Figure 5. Westinghouse Gamma Walkover Survey (Soil Background 11001-13000 cpm)

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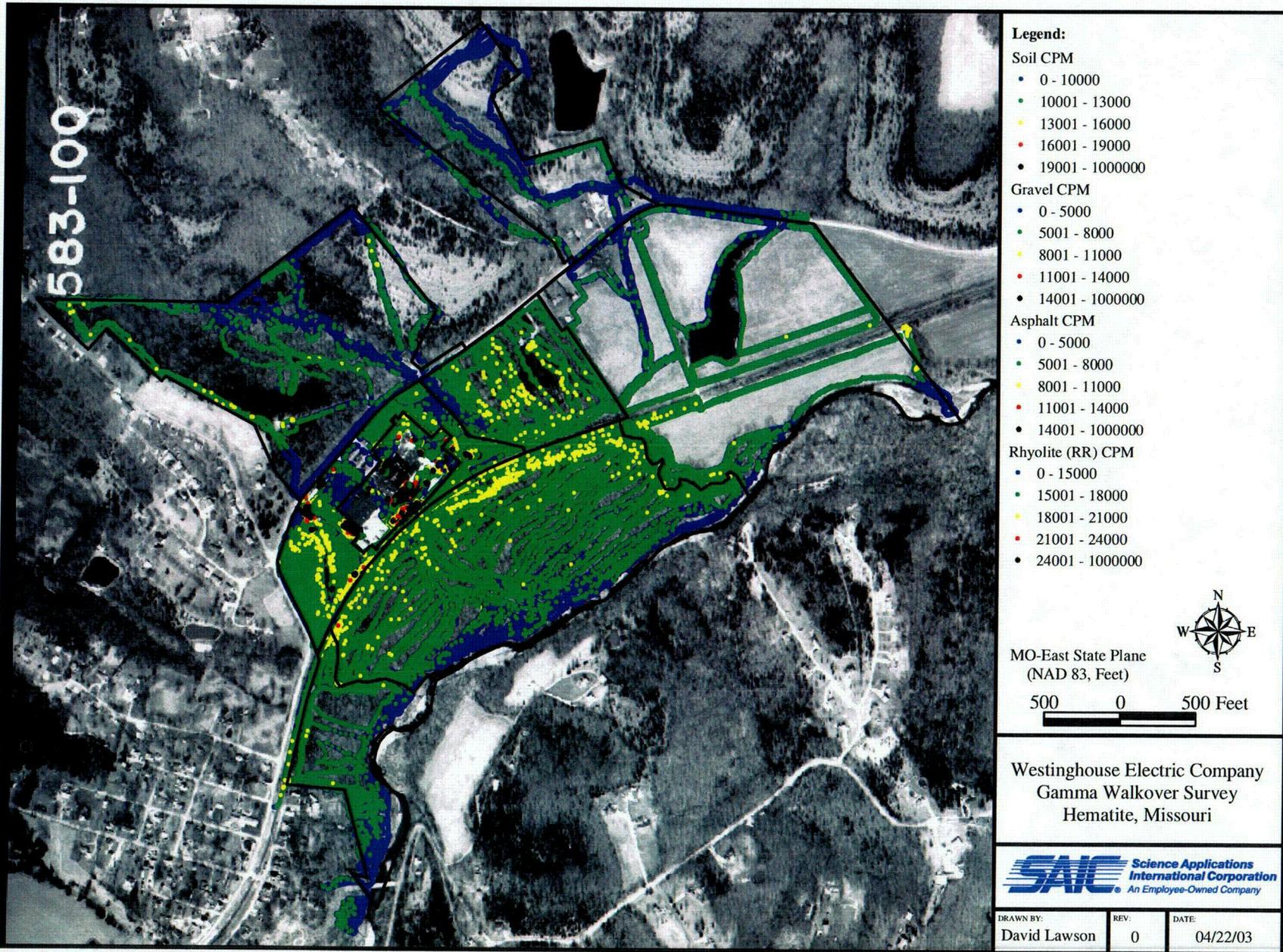


Figure 6. Westinghouse Gamma Walkover Survey (Soil Background 10001-13000 cpm)

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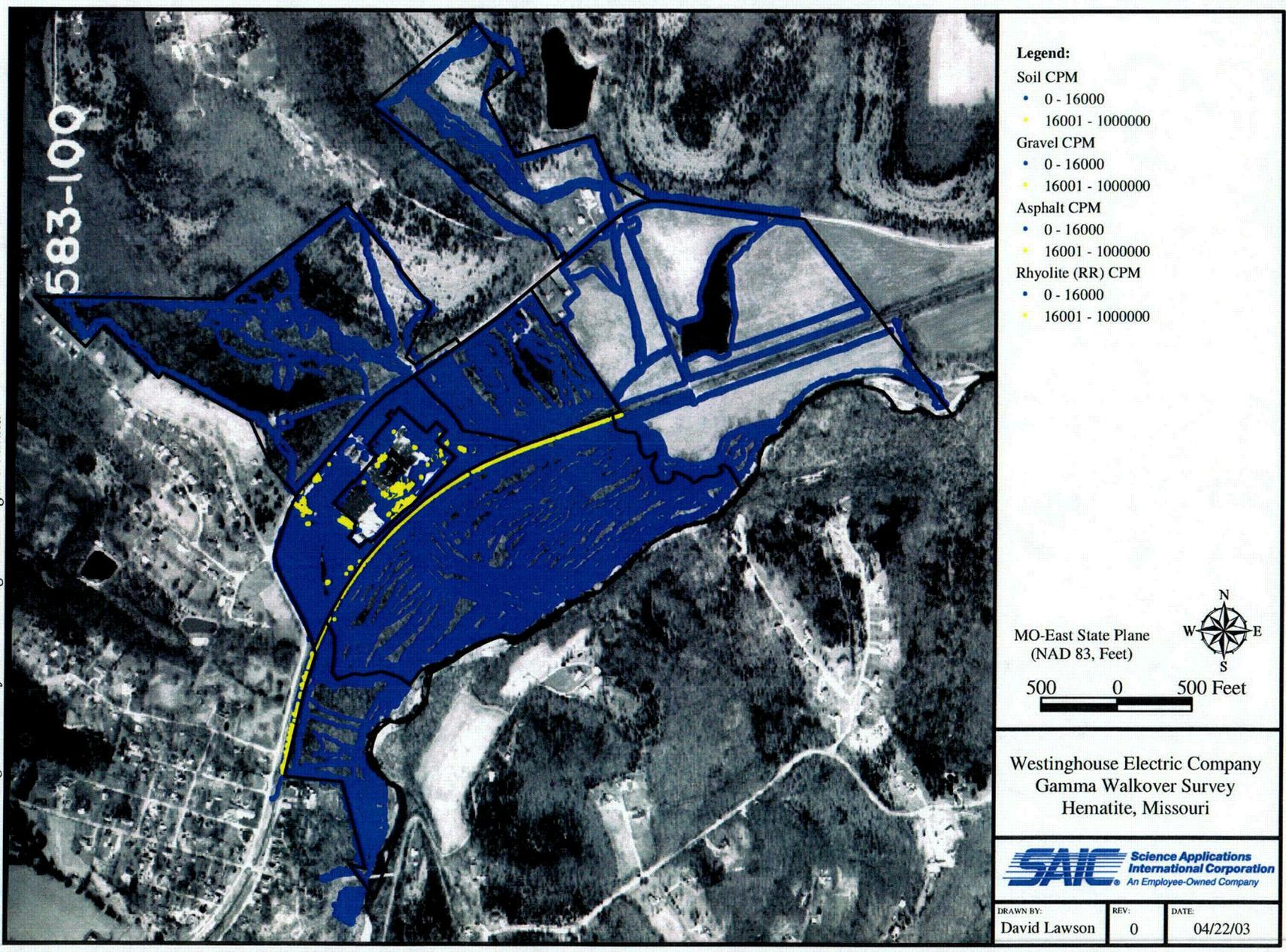


Figure 7. Westinghouse Gamma Walkover Survey (Two Color Illustration)

Reference background gamma count rates of soil and other media with similar physical and geological characteristics as the soil/material being investigated were collected in non-impacted areas surrounding the site. The reference background count rate was used to determine which areas on the Property had gamma count rates in excess of the local background gamma levels. No reference area measurements were initially going to be obtained unless media or background count rate fluctuations indicated that multiple background populations were present on the Property. We determined on the first day of surveying that reference area measurements would be beneficial and should be collected as time allowed. It was apparent that the background gamma flux radiation levels for the railroad rock, the asphalt, the gravel, the grassy soil, and the soil background in the tree-covered areas were all significantly different. There was an obvious difference in the count rates between the different media types, with gravel/asphalt being on the low end and the railroad rock being on the high end. It was also noted that the general trend of gamma count rates tended to decrease as the survey progressed from the site or railroad, down the hill toward Joachim Creek. There may be different soil background count rates present on the site due to the varying soil types. The gamma count rate was relatively low near the creek in the presence of coarse-grained soils (i.e. sand and gravel); the gamma count rate had a tendency to decrease in direct proportion to the amount of visible sand-like material in the surveyed soil.

After discussion with the project team, it was decided to attempt to locate a suitable reference area south of the site, preferably south of State Road P. The need for quick access and the ability to obtain the numerous media and soil type backgrounds limited the potential sites. A limited amount of effort was expended to locate a suitable reference area that met the initial criteria. No suitable area was identified that met all the criteria. The closest reference area that met most of the criteria was the U.S. National Guard Armory Site, located east and north of the site near the junction of State Road P and State Road A.

Access was requested and granted. SAIC mobilized two individuals to the site for reference area measurements to obtain at least 100 measurements in each media type: asphalt, gravel, soil adjacent to railroad under trees, uncultivated grass covered soil, and rhyolite (non-native rock used to support railroad tracks).

After obtaining these measurements, SAIC also gathered additional measurements adjacent to Joachim Creek at the bridge on State Road A. These measurements were obtained on the east side of the creek, just upstream of the bridge. Table 4-1 summarizes the results of these measurements.

Table 4-1 Reference Area Measurements

	Asphalt	Gravel	Grass Soil	Soil Adjacent to Railroad	Rhyolite Railroad Rock	Sandy Soil
# measurements	371	407	171	250	262	352
Mean	4,904	4,360	9,415	10,402	14,867	7,624
Std Dev	391	416	1,012	836	874	1,507

Further evaluation of this reference may be necessary during later site investigations to verify that it is an appropriate reference area based on soil classification of on-site surface soils conducted during the Remedial Investigation. The evaluation of the gamma walkover data was performed primarily using relevant background not reference area background. The use of relevant background allows the evaluator to determine which locations within an area exhibit higher gamma levels when compared to surrounding soils. The reference data collected was only used to establish the baseline count rate expected within a given area.

Report results primarily addressed areas that contain elevated activity significantly above background. Reference area measurements were taken to provide a basis for comparison with gamma survey readings collected on-site.

The basis for acceptance of the area selected for reference area measurements was based on accessibility, like terrain the presence of most of the media encountered on the site (gravel, asphalt, rhyolite, grass covered soil, tree covered soil, and sandy soil) and may require further evaluation based on actual classification of on-site surface soils conducted during the Remedial Investigation.

The reference data collected was only used to establish the base line count rate expected within a given area.

Other locations were investigated for inclusion as potential reference areas within several miles surrounding the site; however, no other area was located that provided all media types, open access or similar terrain as compared to the area selected for reference area gamma measurements.

Survey area relevant background was used for evaluation of specific areas within the site. Relevant background is the comparison of count rates to count rates in the surrounding immediate area of impacted locations on site. Relevant background is used during performance of the gamma survey to alert the technician to isolated "hot spot" areas that are different from the surrounding area and require additional investigation.

Relevant background was used during this survey, primarily in the 100% covered area and to a limited extent on the remainder of the Property. All the surveyors consistently monitored their instrument's audible and visible response. The technician noted any appreciable increase or decrease in count rate and additional data were collected in the area of concern to investigate the abnormality.

Not all instruments were continuously monitored during the use of the ATV; however, the operator did monitor at least one instrument and periodically compare the readings of the instrument to adjacent meters. The data collected by the ATV-mounted instruments were evaluated in comparison to data collected by the adjacent instruments to detect deviation in relevant background.

The technicians performing the survey in the heavily vegetated areas monitored the audible response of their instruments as conditions allowed. There were times that the thorny vegetation, briars, tree limbs, or other obstructions removed the headphones from the technicians' range of hearing and some portion of the survey continued until it was possible to replace the headphones to within hearing range.

Relevant background was used during the evaluation of the collected data. Data points that were either relatively high or low were scrutinized to determine the deviation in background. If evidence could not be produced to explain the deviation, a survey team was mobilized back to the location to investigate the deviation in relevant background.

For the purposes of data evaluation, SAIC assigned the following background values for the various media types:

Gravel	5,000 cpm
Asphalt	5,000 cpm
Soil	10,000 cpm
Rhyolite	15,000 cpm

It should be noted that applying a single soil background count rate could potentially lead to misrepresentation of the soil data due to the various apparent fluctuations in the soil media background count rate.

4.2 AREA A

The gamma walkover survey in this area was designed to provide 100% coverage of all accessible areas that were not beneath buildings or covered with asphalt or concrete. Other ground covering includes gravel, soil, and water. This area consisted of all accessible areas within the outer boundary fence or controlled area. There were numerous areas of concern within Area A, including the evaporation ponds, Deul's Mountain, the fenced-off restricted area, the area surrounding the spent limestone piles, and drainage ditches.

Approximately 50% of the surveying was performed by the use of an ATV with three front-mounted GPS/gamma detector assemblies. The remaining 50% of the area was performed by technician-conveyed GPS/gamma detector assemblies.

The spent limestone piles were not surveyed as part of this walkover effort, although no significant readings were found in the vicinity of these features. Small drainages in this area that led under the fence were noted and surveyed as well, with no significant readings observed at the surface. Also, no elevated readings were observed in the northeast corner of Area A.

As expected, there were many areas of elevated gamma radiation identified within Area A. Areas with elevated gamma readings were centered within the restricted areas, around the evaporation ponds, and near the foot of Deul's Mountain. Although, the portion of Deul's Mountain that was covered with plastic was excluded from the effort, the highest reading obtained within Area A was collected at the foot of Deul's Mountain where a piece of sheet plastic was found protruding from the soil. Readings at this location were as high as 874,000 cpm.

Figure 8 depicts the survey coverage of Area A with the standard 2,000 cpm increment. Figure 9 depicts the survey coverage of Area A with a two-color coding, separated at 18,000 cpm. The purpose of Figure 9 is to show the areas that clearly have elevated gamma levels above background, additional investigation will be required in the other areas to determine if radiological contamination above background is present. Due to the relatively high levels of gamma radiation detected within this area, Figure 10 depicts Area A survey data with 20,000 cpm increments.

4.3 AREA B

This area is bounded to the north and west by Highway P, to the south by the railroad, and to the east by a tributary that separates it from Area E. Area B does not include anything located within the facility security fence, as this is designated as Area A. The terrain of Area B is relatively level and covered primarily by grass. Other surface features include trees, brush, buildings, trailers, an asphalt parking area, gravel roads, a small pond, ditches, monitoring wells, and air sampling stations.

Complete coverage was provided in Area B. Most of the surveying was performed by the use of an ATV with three front-mounted GPS/gamma detector assemblies. In areas where the use of the ATV was not practical, manual surveying was performed by technicians.

No significant areas of elevated gamma radiation were identified in the large grassy area to the west of the pond and east of Highway P. In fact, only one small area of elevated readings west of the pond was identified toward the northern end of the area. This location was less than 0.5 m² in size and was found to be approximately 24,000 cpm above local background.

The area just north of the pond and west of the Tile Barn had several areas of elevated readings. This was especially true around the cistern burn pit area. Areas of elevated readings ranged in size from less than 0.5 m² to several square meters. Two very small areas north of the Tile Barn and west of the silo were also found to show elevated readings. Although the glazing material used on the Tile Barn bricks is suspected to contain uranium, this did not appear to

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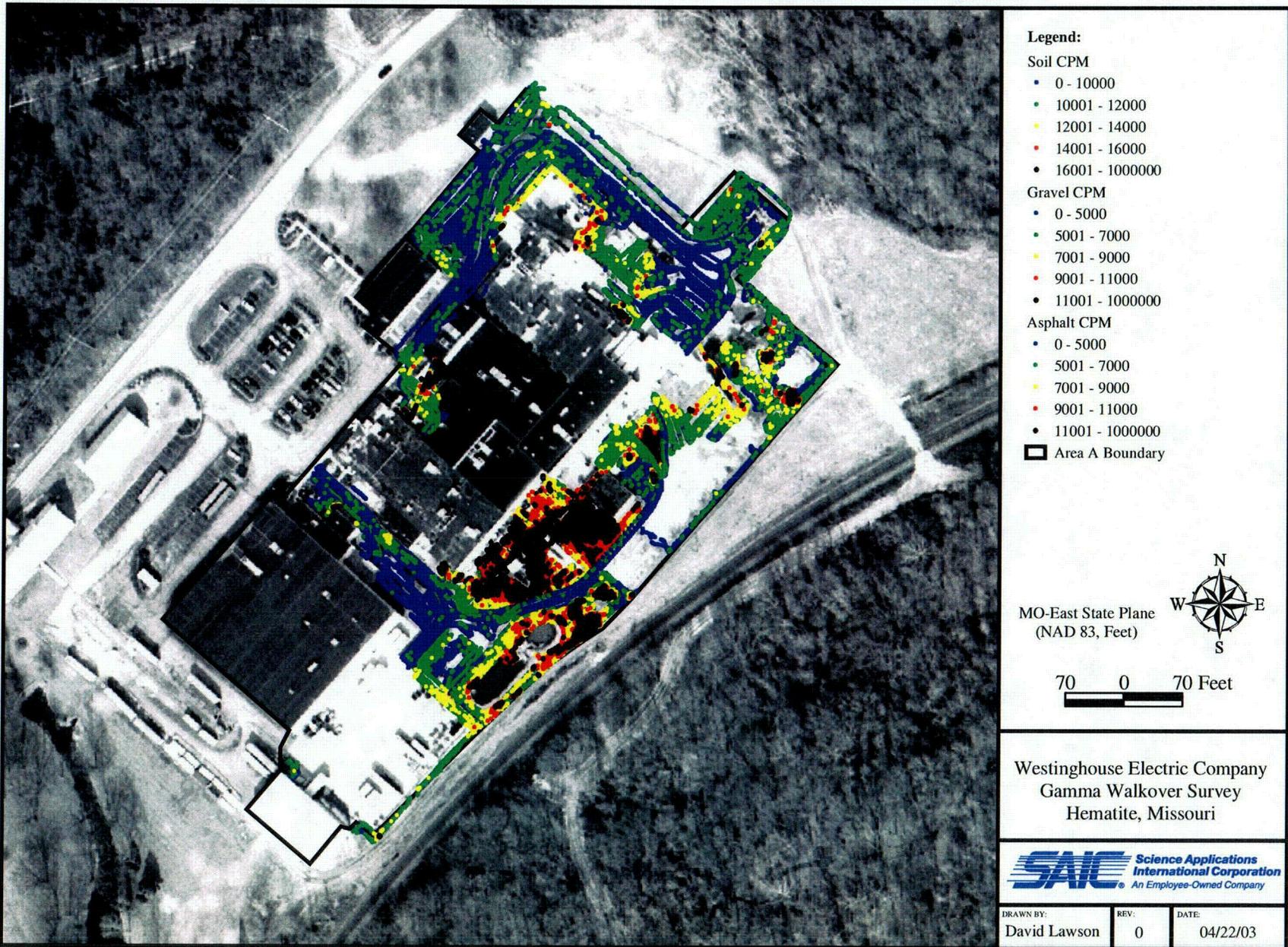


Figure 8. Area 'A' Gamma Walkover Survey (Soil Background 10001-12000 cpm)

COB

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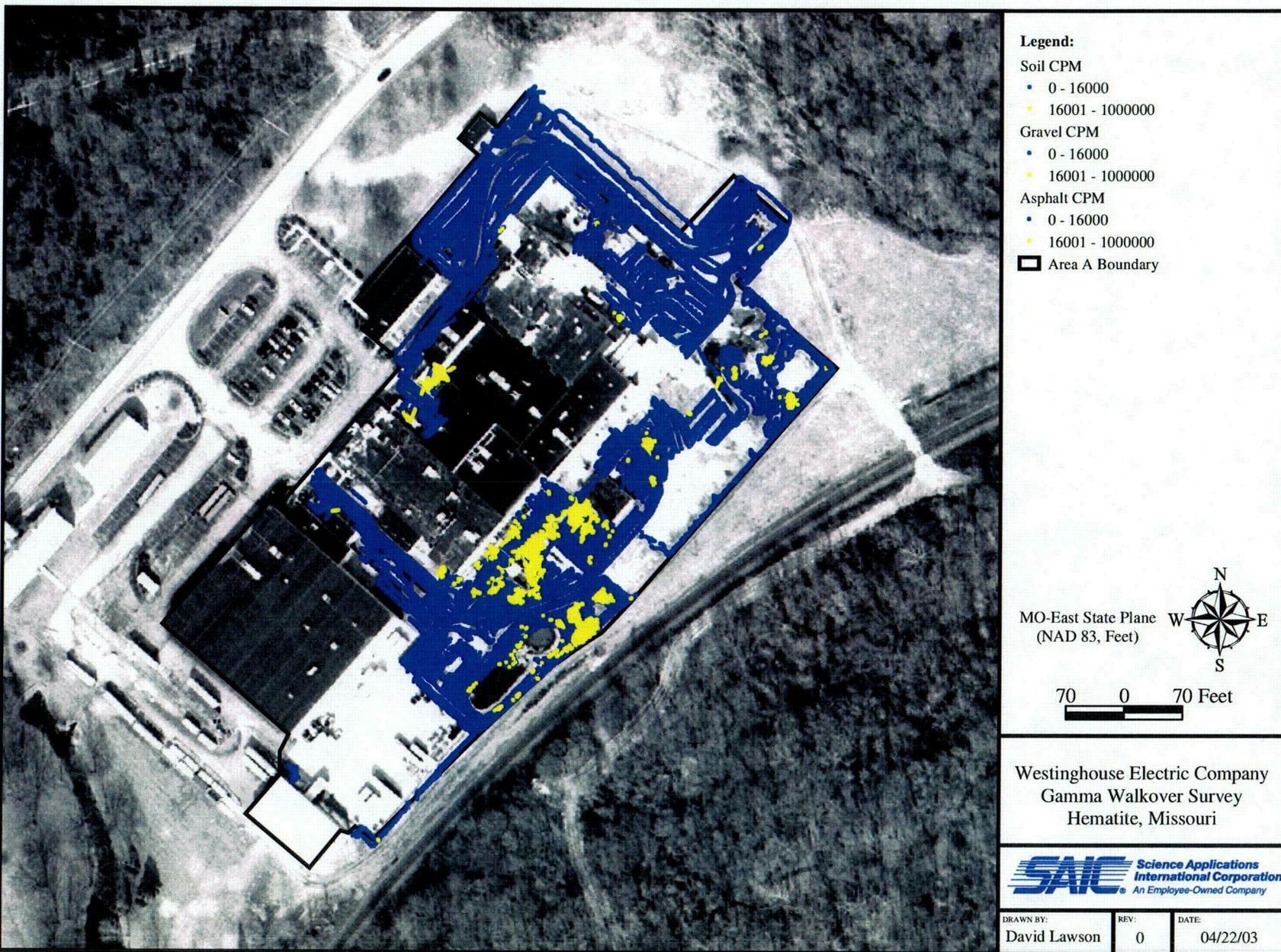


Figure 9. Area 'A' Gamma Walkover Survey (Two Color Illustration)

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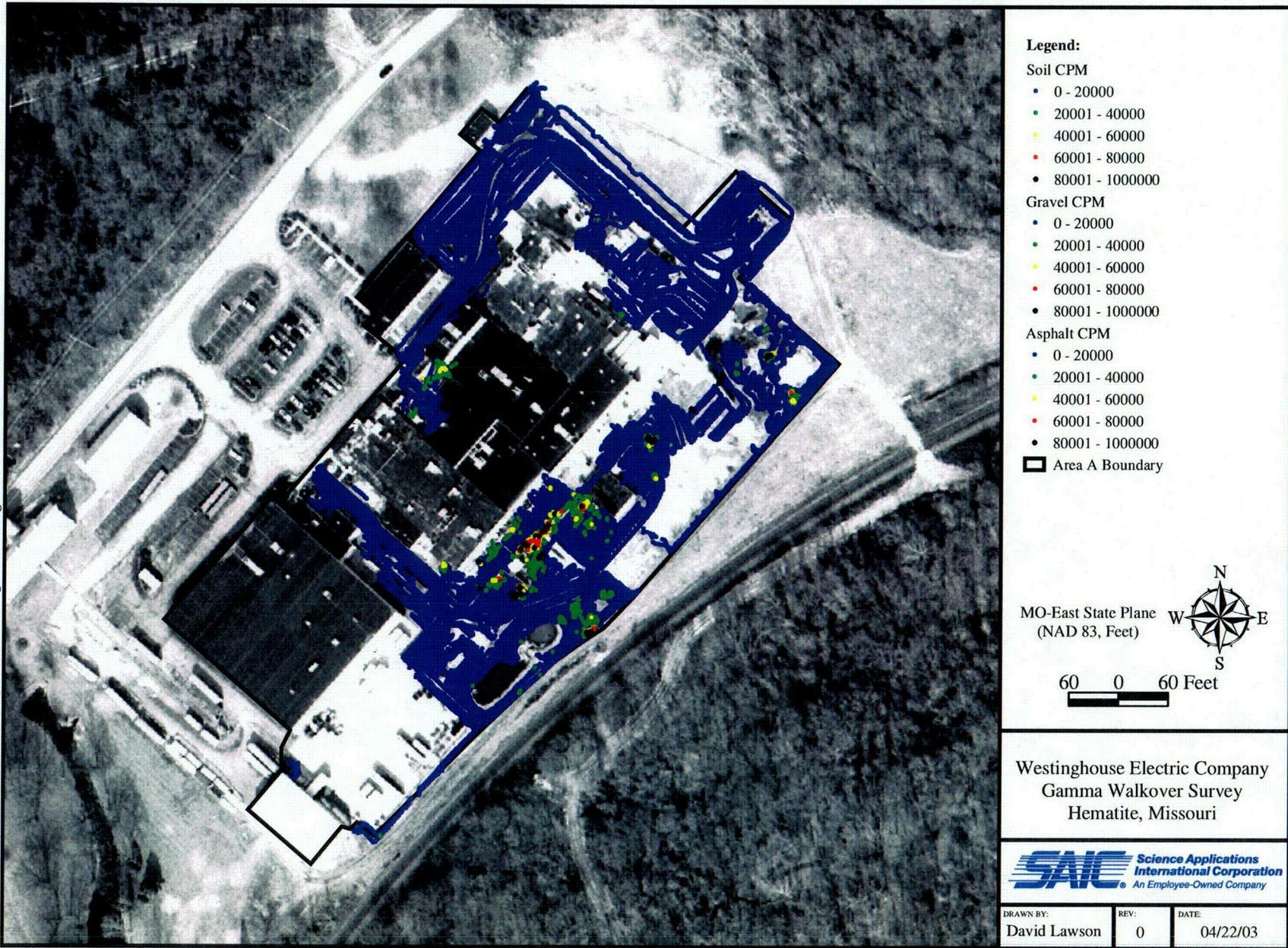


Figure 10. Area 'A' Gamma Walkover Survey (Modified Ranges)

C10

increase background gamma radiation levels in the area immediately surrounding the barn at the plane where the gamma survey was conducted (10 cm above ground surface). A contact reading of the bricks was taken for informational purposes and only a slight increase of approximately 1,000 cpm was detected. Just a few inches away from the bricks the instrument readings returned to ambient levels of gamma radiation.

A grassy area between the barns was surveyed and found to contain several areas of elevated readings. This grassy area is surrounded to the east, south, and west by an asphalt walkway and to the north by a wooden fence. One small area less than 0.5 m² was identified just off the northeast corner of the east barn.

A ditch southwest of Building 231 and north of the rail line showed an increase in count rate at the bottom of the ditch. This ditch was surrounded in dense vegetation and the actual bottom was physically quite shallow; therefore, the increase in count rate is not expected to be caused by geometry issues between the detector and the soil surface. A section of old fencing ran along a portion of the north slope of this ditch. A small area less than 0.5 m² north of the fence was also identified.

An asphalt drive to the west of Building 230 was initially thought to have significantly elevated gamma radiation levels. Upon further investigation it was discovered that containers of radioactive material had been stored inside Building 230 in close proximity to the western wall. It cannot be determined, however, that these containers are the sole contributor to the increased gamma radiation levels outside of Building 230. Upon removal of the containers, additional investigation in this area is warranted to verify the actual gamma levels present.

A survey along the southern fence line of the facility revealed a narrow strip of elevated readings just east of the two evaporation ponds. A count rate of almost 200,000 cpm was noted in this area. Drainages originating from within the fenced area were noted along the southern fence line and also surveyed. No significant increase in gamma levels was noted in these drainages outside the fence.

In the area of the burial pits, east of the facility, several limited areas of elevated readings were identified as expected. Also, the wooded areas in the western portion of Area B contained several piles of debris such as concrete, wood, asphalt, and sheet plastic. A piece of metal protruding from the ground was found in this wooded area. The metal showed gamma radiation levels of approximately 24,000 cpm. This location was flagged for future reference and later Westinghouse employees retrieved this metal, which turned out to be what was left of a severely rusted metal bucket with soil residue. The bucket appeared to be painted white and showed no identifiable markings. Westinghouse performed a contamination survey of the bucket, which is included as Attachment 2. The area where the bucket was removed was resurveyed and found to contain residual gamma radiation levels of approximately 16,000 cpm.

Figure 11 depicts the survey data with the standard 2,000 cpm increment starting at 10,000 cpm for soil. Figure 12 depicts the survey data on a two-color map with the discriminator at 18,000 cpm. The purpose of this map is to show the areas that clearly have elevated gamma levels above background, additional investigation will be required in the other areas to determine if radiological contamination above background is present.

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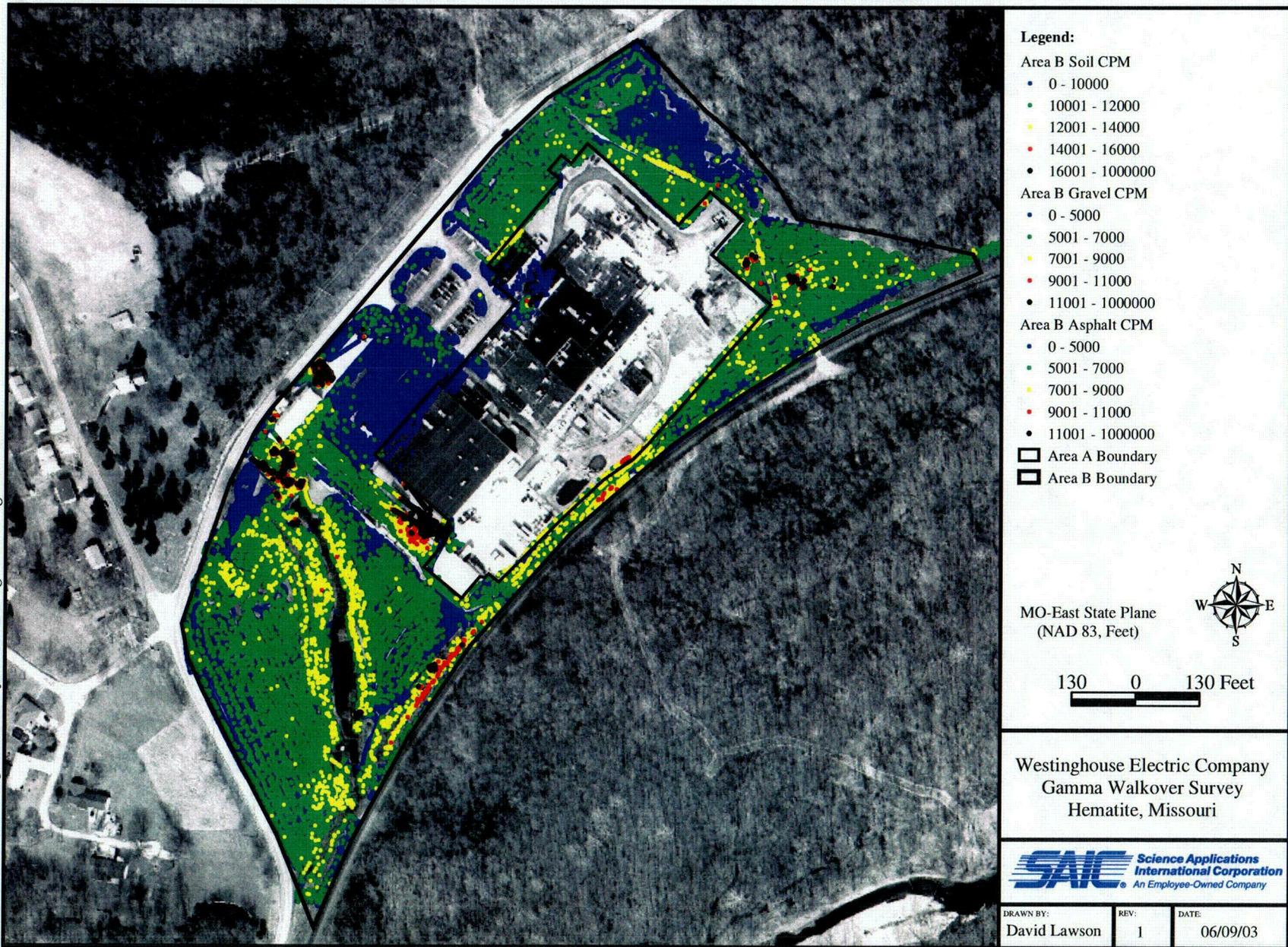


Figure 11. Area 'B' Gamma Walkover Survey (Soil Background 10001-12000 cpm)

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Legend:

- Area B Soil CPM
 - 0 - 16000
 - 16001 - 1000000
- Area B Gravel CPM
 - 0 - 16000
 - 16001 - 1000000
- Area B Asphalt CPM
 - 0 - 16000
 - 16001 - 1000000
- Area A Boundary
- Area B Boundary

MO-East State Plane
(NAD 83, Feet)



125 0 125 Feet



Westinghouse Electric Company
Gamma Walkover Survey
Hematite, Missouri



DRAWN BY: David Lawson	REV: 1	DATE: 06/09/03
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Figure 12. Area 'B' Gamma Walkover Survey (Two Color Illustration)

C12

4.4 AREA C

This area is bounded to the north by a drainage ditch and to the east by Joachim Creek; the area extends south slightly past the bridge, then the Property boundary roughly follows a fence back north until it runs into a small drainage. The area boundary then turns at a right angle and heads due west to the railroad. The extreme western boundary of this area is the railroad. The terrain of Area C is generally wooded with limited underbrush; the brush, briars, and thickets tend to increase near the boundary in cleared areas, with some open areas located in the extreme southern part of Area C.

The gamma walkover of this area was designed to provide limited coverage in the areas of higher probability of contamination deposition. The survey was to provide coverage adjacent to all boundaries of the area with more concentrated coverage in the area near the bridge. Local citizens had reported that material might have been buried on or near the southwest portion of the property, in the vicinity of Joachim Creek bridge.

The survey was conducted initially by concentrating on the northern drainage. The team concentrated on benches, low areas of sedimentation deposits, erosion ditches, and potential areas for silt deposition during flooding. All areas of high probability were adequately covered in addition to varying distances (10-30 feet [ft]) from the drainage. An area surrounded by drainages and Joachim Creek was identified at the discharge of the northern drainage into Joachim Creek. This area was thought to have a high probability of contamination and was given thorough systematic coverage. The bank of Joachim Creek along the eastern boundary of this area is vertical in most places with a deep drop to the creek bottom. Limited coverage was used in this area, concentrating on the upper creek bank edge, drainage or erosion ditches going to Joachim Creek, and any areas of obvious flood deposition.

The exact site boundaries were not known to the survey team at the time of the survey, so a limited amount of coverage was conducted south of the bridge in potential dumping areas that are actually outside the Westinghouse property boundary. Concentrated systematic coverage was performed in the area just north of bridge in areas of obvious dumping. The concentrated coverage continued to the north until there was no further evidence of dumping that is, trash was not present. The survey continued along the perimeter fence, focusing the effort around a small drainage, once again concentrating on potential areas of contamination deposition as mentioned above. The survey team performed limited coverage adjacent to the railroad. This area is sparsely populated with mature trees and many briars, and follows the power lines. The extreme northern portion of Area C consists of a small triangle of land bounded on one side by the railroad and drainages on the other two sides. Gamma walkover coverage was concentrated in this area due to close proximity to the plant and relatively higher probability of contamination from flood deposition.

No significant areas of elevated gamma radiation were identified in Area C. The relative count rates did tend to decrease as the survey progressed east or downhill from the railroad to the creek. The decrease in count rate was noticeable but not significant during the transition. However, the count rate decrease was significant when comparing the relative count rates adjacent to the creek to the count rates adjacent to the railroad. The survey team verified the

count rate decrease across the three meters and commented on the obvious decrease. The gradual decrease could be due to a number of various reasons, but is most likely due to a change in soil type. Figure 13 depicts the survey data with the standard 2,000 cpm increments starting at 10,000 cpm for soil.

4.5 AREA D

Area D is located directly south and east of the main site facility. This area is bounded by the railroad to the north, Joachim Creek to the south, and on the east and west by drainages. The farm is located east of this area and Area C is located to the west. The terrain in this area was very similar to Area C. The northern portion of Area D is a gradual hill that flattens nearing Joachim Creek. The area adjacent to the railroad was heavily covered with briars and underbrush. The underbrush gradually decreased as the survey moved south toward Joachim Creek, giving way to mature trees with limited underbrush.

The gamma walkover of this area was designed to provide roughly systematic coverage of the entire area. The survey initially concentrated on the boundaries, with an emphasis on areas that were more likely to be contaminated. After the boundaries were established, the rest of Area D was adequately covered by surveying with varying distances (10-30 ft) between surveyors.

In general, the count rates observed in Area D ranged from 6,000 cpm to 14,000 cpm. The highest count rates were observed in the northern portion adjacent to the railroad and decreased in a roughly uniform pattern as the survey progressed south and east toward Joachim Creek. The most abrupt or noticeable count rate deviation was observed at the foot of the small hill that lies adjacent to the railroad in the north portion of Area D. The roughly uniform deviation in count rates tends to indicate a gradually changing background or potentially systematic windblown contamination. However, if the area had been contaminated by windblown contamination, localized elevated readings in the low areas where water tends to collect and evaporate would be expected. We identified many low areas and identified no localized elevated count rates.

There were two isolated areas within Area D that require additional investigation. The first area is located in the northwest corner of Area D at the culvert outlet from the site pond. The culvert allows for flow of water from the site pond under the railroad. The increase in gamma activity in this area could be due to the presence of Rhyolite rock that had fallen from the railroad roadbed. Rhyolite was observed and an increase in count rate was detected in the presence of this material; however, additional increases were noted without visible Rhyolite. It is possible that the increases were due to the presence of Rhyolite slightly beneath the surface, but this could not be confirmed in all cases. The second location requiring additional investigation is slightly southwest of the first location near the convergence of the two drainages. The spot is roughly in the middle of converging ATV paths prior the stream crossing. A sustained count rate of 14,000-15,000 cpm was identified in this area. The relative background in this area ranged from 11,000-13,000 cpm. This area with elevated gamma radiation readings was fairly small: 1-2 square meters, and is only slightly elevated above relative background. Figure 14 depicts the entire Area D with the standard 2,000 cpm increment starting at 10,000 cpm. Figure 15 depicts an enlarged view of the two local isolated elevated readings.

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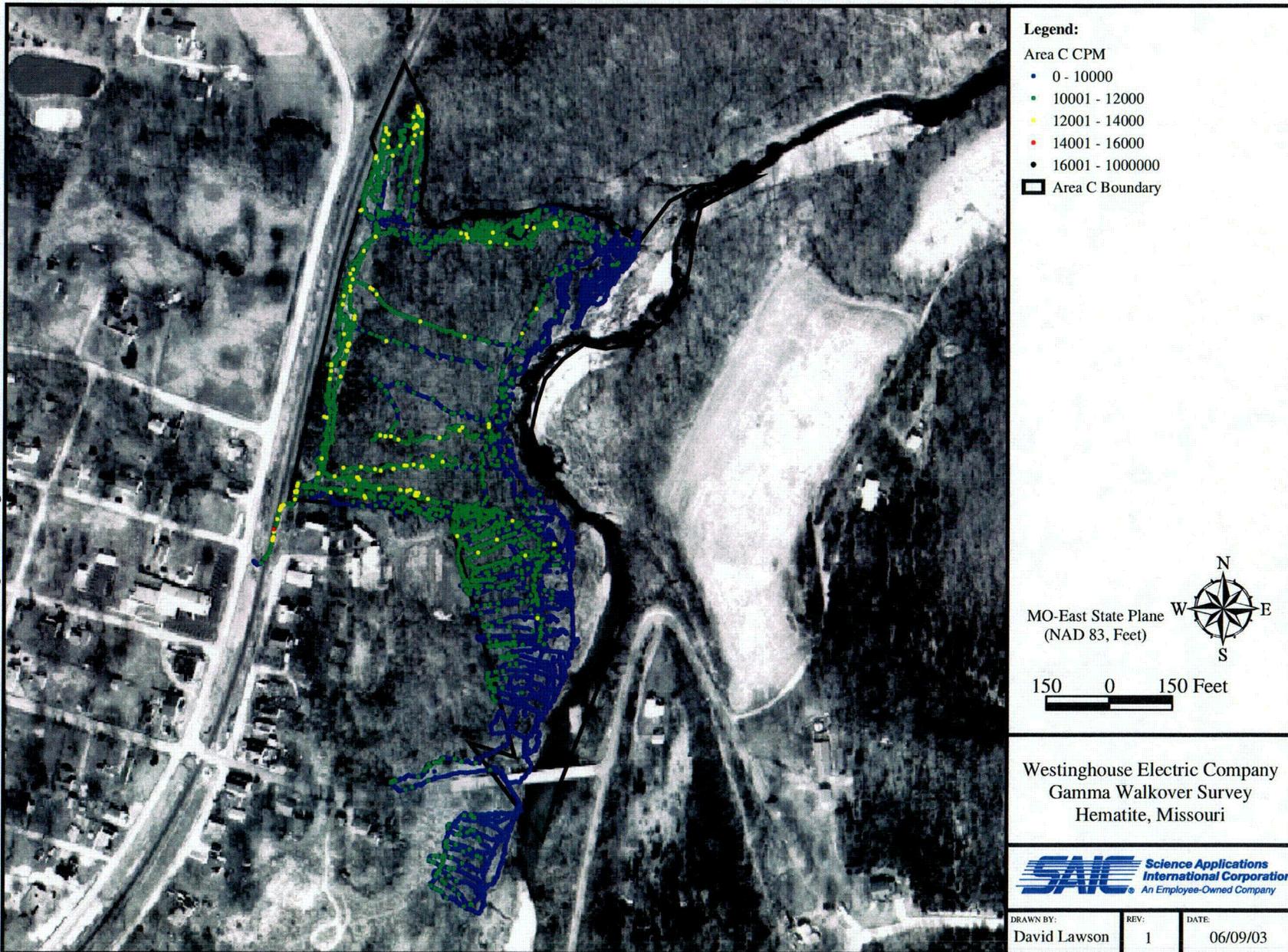
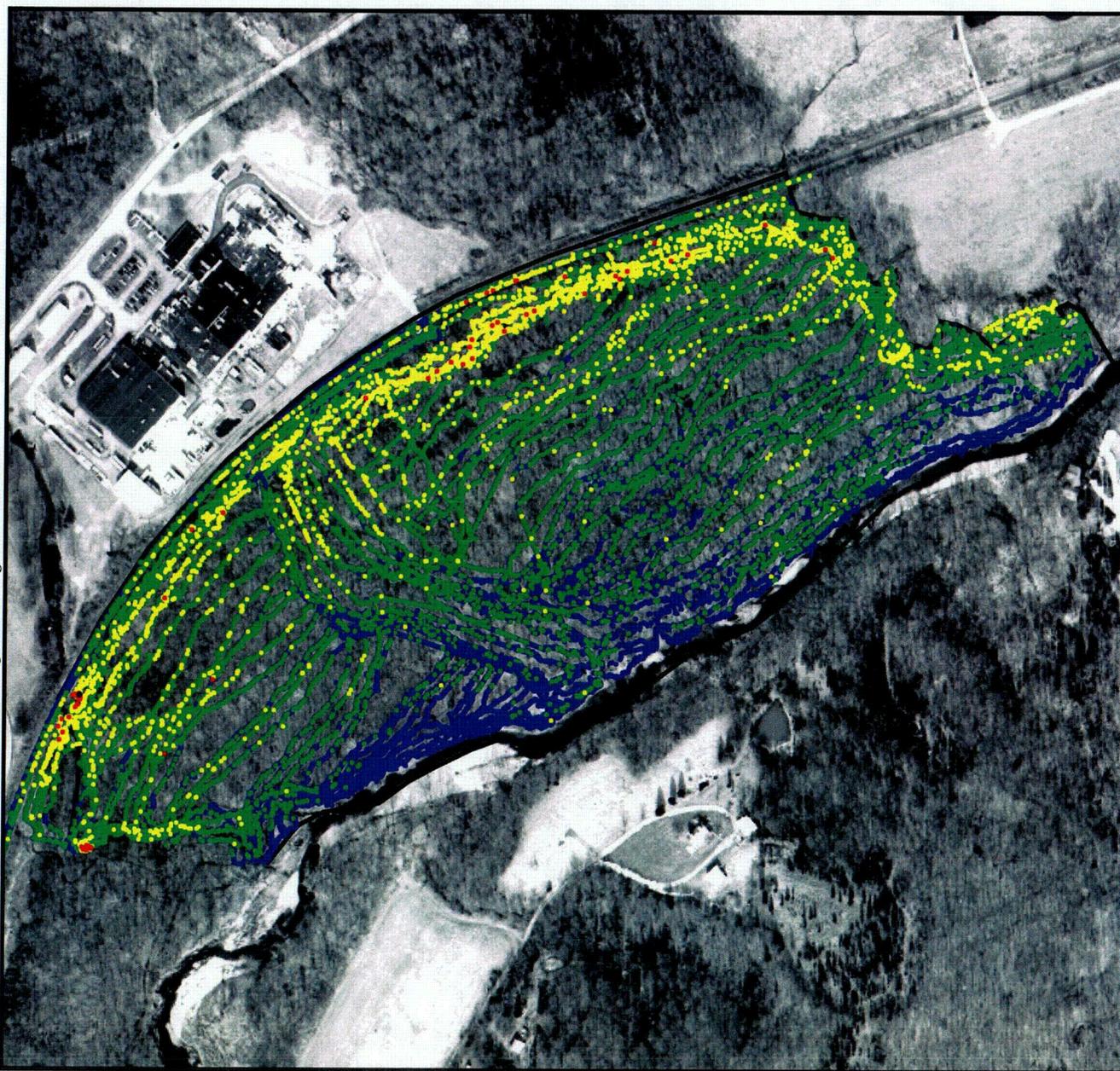


Figure 13. Area 'C' Gamma Walkover Survey

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Legend:

Area D Soil CPM

- 0 - 10000
- 10001 - 12000
- 12001 - 14000
- 14001 - 16000
- 16001 - 1000000

Area D Gravel CPM

- 0 - 7000
- 7001 - 9000
- 9001 - 11000
- 11001 - 13000
- 13001 - 1000000

Rhyolite (RR) CPM

- 0 - 15000
- 15001 - 17000
- 17001 - 19000
- 19001 - 21000
- 21001 - 1000000

□ Area D Boundary

MO-East State Plane
(NAD 83, Feet)

Westinghouse Electric Company
Gamma Walkover Survey
Hematite, Missouri

DRAWN BY: David Lawson REV: 1 DATE: 06/09/03

Figure 14. Area 'D' Gamma Walkover Survey

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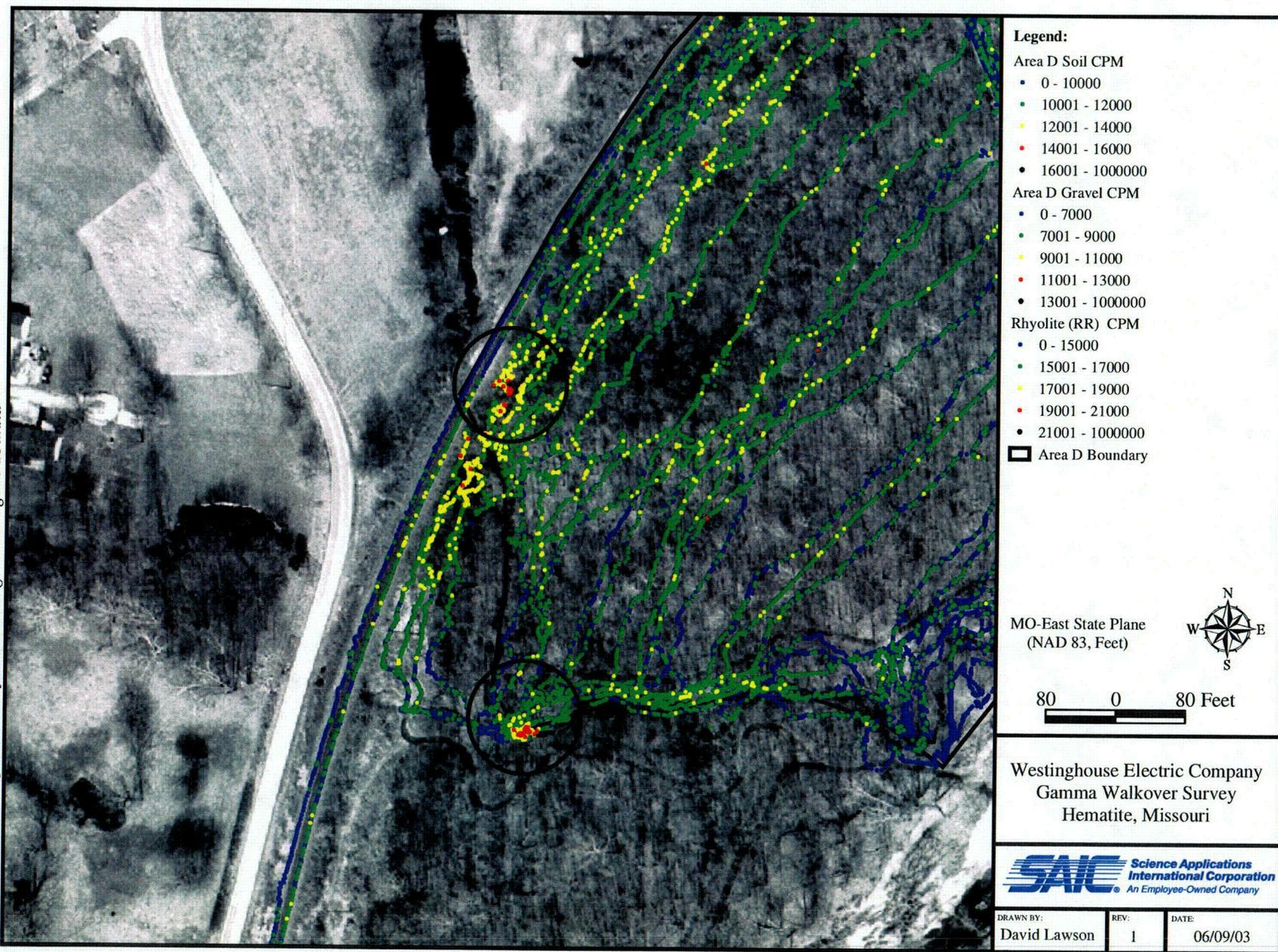


Figure 15. Area 'D' Isolated Elevated Areas

4.6 AREA E

Area E is the area located just east of the facility. Area E is bordered on the west and east by drainages, to the south by the railroad, and to the north by Hwy P. Area E was densely covered with trees, briars, and brush. This area was generally level, with intermittent ditches and drainages. The area did not appear to drain well, as evidenced by the presence of standing water in numerous locations and generally muddy terrain.

The gamma walkover of this area was designed to provide roughly systematic coverage of the entire area. The survey was conducted by initially concentrating on the boundaries, with an emphasis on areas that were more likely to be contaminated. After the boundaries were established, we attempted the survey of the remaining portion of Area E by surveying with varying distances (10-30 ft) between surveyors. Due to the very thick underbrush and briars, systematic coverage was difficult to obtain. The initial attempt failed to provide adequate coverage, the second attempt resulted in GPS cord damage, and the majority of the data from the walkover was not collected. If additional walkovers are to be conducted in this area, some limited amount of clearing and grubbing will be required.

In general, the gamma radiation levels in this area ranged from 8,000-14,000 cpm. The count rate was relatively lower adjacent to and around the western drainage. This was the area expected to have the highest probability of contamination due to its proximity to the site. Additional walkovers were performed adjacent to the drainage that verified the decreased count rate. One area, slightly south of the gravel-parking pad in the northeast portion of the area, indicated a single elevated data point. The count rate associated with this data point was not verified by the surrounding count rates of the surrounding data points. An additional gamma walkover was conducted in the vicinity of the original data point to verify the existence of elevated gamma radiation. No elevated gamma radiation was detected at the point or the area surrounding the original data point.

The map of this area indicates one isolated elevated reading adjacent to Area B along the bank of the west drainage of Area E. This location has been included in the Area B evaluation. It consists of the metal debris that was removed by Westinghouse.

Figure 16 depicts the data collected for Area E with the standard 2,000 cpm increment starting at 10,000 cpm.

U:\GPS\GPS Westinghouse\Projects\Westinghouse\Projects\Westinghouse Figure 16.mxd

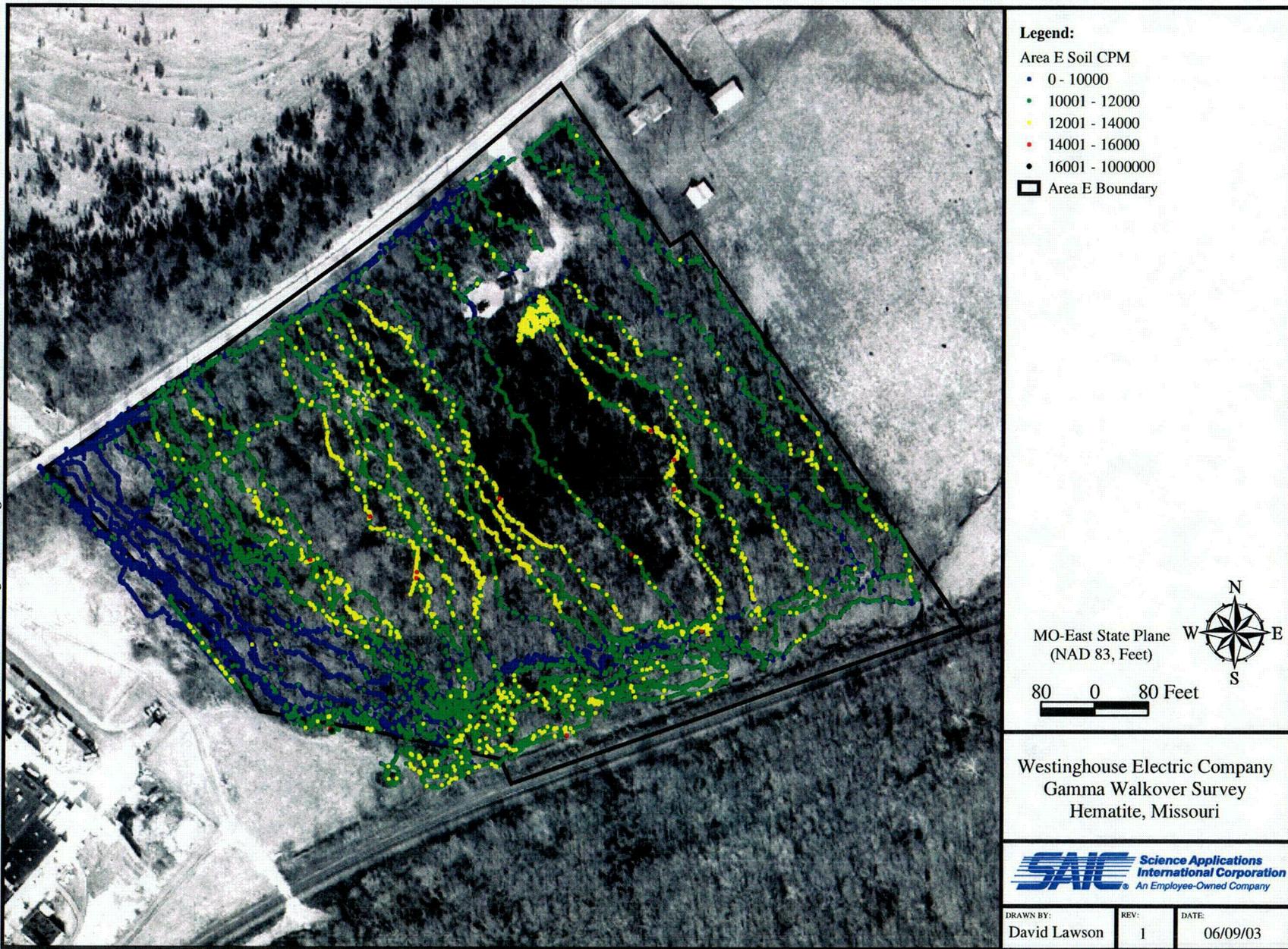


Figure 16. Area 'E' Gamma Walkover Survey

4.7 AREA F

Area F is comprised primarily of the farm that is to the east of Area E and the facility. Most of Area F consists of grassy grazing areas, a pond, and a small wooded area. The railroad splits this area in two. The area is bordered in the south by Joachim Creek. Hwy P is the boundary to the north. Area E and Area D make up the boundary to the west. Additional farmland, not part of the Property, is located to the east.

As in Area C and D, relative elevated count rates are identified just south of the railroad in areas covered with mature timber. A drainage ditch was identified during the survey on the far southeast portion of Area F. The survey of this ditch resulted in two areas of interest. The first area was further investigated and the increase in count rate was proved to be due to a change in the geometry of the survey. As the ditch deepened and sidewalls became closer to the detector, an increased count rate was observed. The survey identified elevated gamma radiation levels at the extreme northern portion of the same drainage. This apparent increase was investigated and determined to be due to the presence of Rhyolite.

Figure 17 depicts the data collected for Area F with the standard 2,000 cpm increment starting at 10,000 cpm.

4.8 AREA G

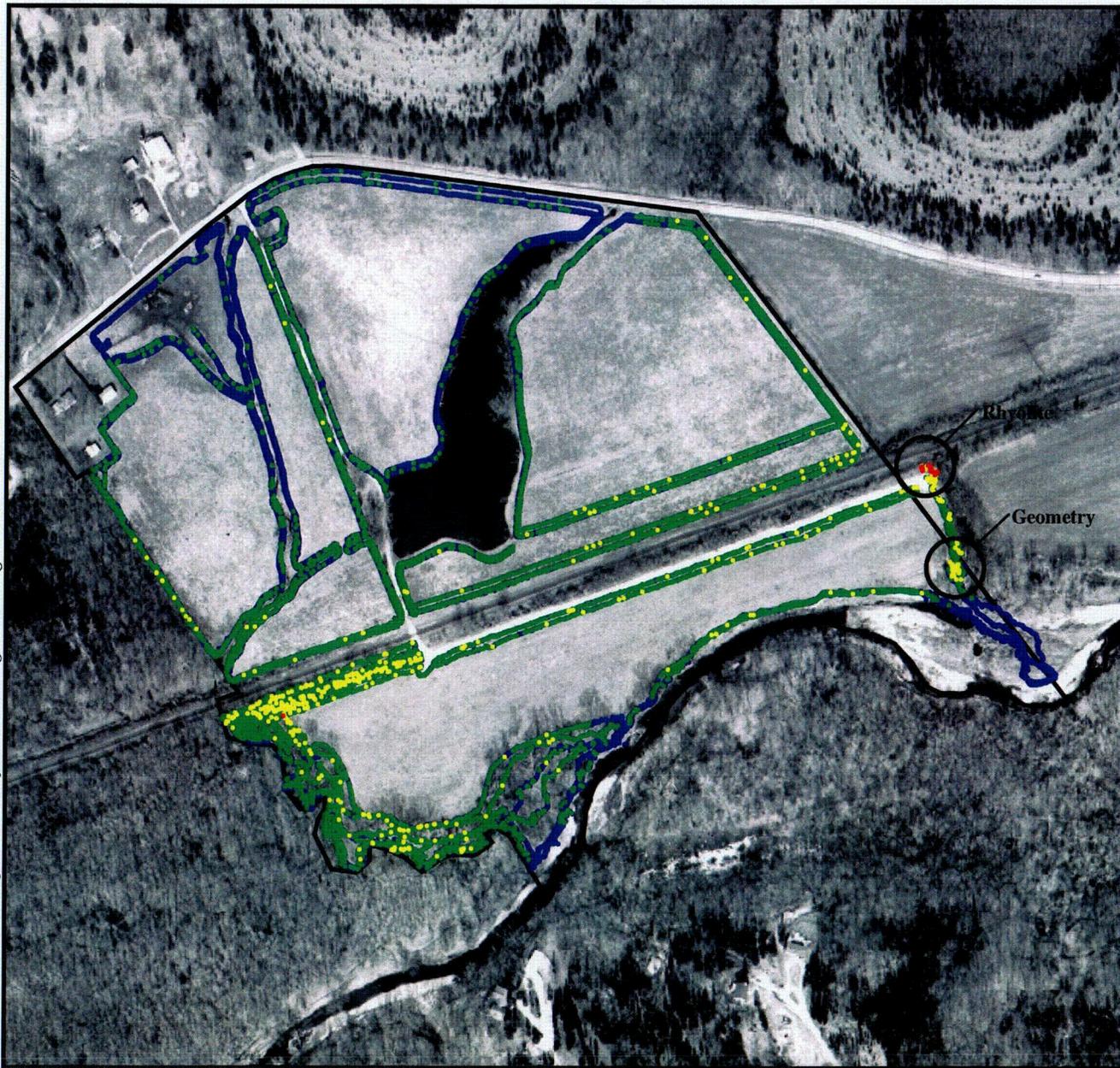
Area G is divided into two sections that are north of the facility. Both sections are mostly tree covered and are more elevated in topography than the rest of the areas.

The gamma walkover of this area was designed to provide limited coverage. The survey was to provide coverage adjacent to all boundaries, roads, and drainages within the area. Additional coverage was requested in the flat areas adjacent to the drainages in the western parcel.

In general, the survey of this area showed only a slight deviation in count rates. The largest deviation occurred due to changing media, switching between gravel, gravel/soil mixture, and soil. One area of interest was discovered on the power line road in the western parcel. This area exhibited count rates around 8,000 cpm with the relative background in this area ranging from 4,000-6,000 cpm. There was no logical explanation or recognized transport mechanism for contamination to have reached this location. The area was resurveyed and the original count rates were verified as accurate.

Figure 18 depicts the data collected for Area G with the standard 2,000 cpm increment starting at 10,000 cpm.

U:\GPS\GPS Westinghouse\Projects\Westinghouse\Figure 17.mxd



Legend:

Area F CPM

- 0 - 10000
- 10001 - 12000
- 12001 - 14000
- 14001 - 16000
- 16001 - 1000000

▭ Area F Boundary

MO-East State Plane
(NAD 83, Feet)



210 0 210 Feet

Westinghouse Electric Company
Gamma Walkover Survey
Hematite, Missouri



DRAWN BY:

David Lawson

REV:

1

DATE:

06/09/03

Figure 17. Area 'F' Gamma Walkover Survey

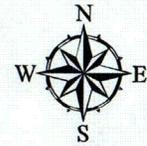
U:\GPS\GPS Westinghouse\Projects\Westinghouse\Figure 18.mxd



583-100

Legend:

- Area G Gravel CPM
 - 0 - 5000
 - 5001 - 7000
 - 7001 - 9000
 - 9001 - 11000
 - 11001 - 1000000
- Area G Soil CPM
 - 0 - 10000
 - 10001 - 12000
 - 12001 - 14000
 - 14001 - 16000
 - 16001 - 1000000
- ▭ Area G Boundary



MO-East State Plane
(NAD 83, Feet)

290 0 290 Feet

Westinghouse Electric Company
Gamma Walkover Survey
Hematite, Missouri



DRAWN BY: David Lawson	REV: 1	DATE: 06/09/03
---------------------------	-----------	-------------------

Figure 18. Area 'G' Gamma Walkover Survey

5.0 CONCLUSIONS/RECOMMENDATIONS

The survey progressed as planned with limited unexpected discoveries. The elevated gamma radiation identified within the 100% coverage area was not significantly greater in magnitude or extent than what was anticipated. Areas of interest or concern did in fact prove to have elevated levels of gamma radiation. The evaluation of the collected data did not reveal a significant amount of elevated gamma radiation beyond the anticipated area.

Areas of concern for the survey were identified in the plan and during the kickoff meeting. The areas of concern that were investigated follow:

Burial Pits

The burial pits were actively used from the late 1950s to 1970, and they are reportedly located to the east of the plant. Individual elevated count rates were identified and confirmed in the general vicinity of the area where the burial pits are expected to be located. Based on the equipment utilized for this survey, the burial pits cannot be confirmed to be present, but the locations of the elevated gamma radiation on the east side of the plant in Area B are potential starting points for the burial pits investigations.

Limestone Storage and Limestone Fill Areas

Limestone (calcium carbonate) was used to capture hydrogen fluoride gas (HF) from the uranium hexafluoride (UF₆) conversion facility. Spent limestone was generated from 1968 to 1998. Currently the spent limestone is stored in one pile within the fenced area of the plant. At least two other areas, one near the site spring and the other in the northeast section of the burial pits, may have been filled with the limestone. No indication of elevated gamma radiation was identified due to the existence of the spent limestone pile within the fenced area or in either location outside the fence. A gamma walkover survey was not specifically performed on the spent limestone pile within the fence, but only along the edges of the pile.

Outdoor and Shallow Surface Areas

Several areas around the site (soils within the fence line and soil adjacent to the barns) are known to have surface uranium contamination. Adjacent to the Tile Barn is an area that was used to store excess contaminated equipment. Several isolated areas of elevated gamma radiation were detected around the Tile Barn, adjacent to the fence line, and in drainage ditches located within Area B. The presence of these elevated gamma radiation measurements confirms the presence of gamma emitting radionuclides in excess of background values at these locations.

Railroad

The railroad easement that cuts through the site is not considered a potential AOC; however, a portion of the ballast used to construct the railroad is Rhyolite. The Rhyolite is known to have naturally occurring radioactivity. Increased gamma radiation levels were confirmed to be associated with the Rhyolite. The railroad easement that cuts through the site exhibited elevated count rates in the range of 14,000-16,000 cpm. In addition, the railroad adjacent to the United States National Guard Armory exhibited similar count rates. The

measurements from the Rhyolite in the vicinity of the site are consistent with those from the railroad adjacent to the armory.

Red Room Roof Burial Area/Cistern Burn Pit Area

The roof of the Red Room (Building 240) was reportedly buried in an area south of the Tile Barn. Elevated gamma radiation readings were identified south-southwest of the Tile Barn; however, we could not conclude that this was due to the presence of the Red Room roof burial. Additional investigation to determine the cause of the elevated gamma radiation is required to confirm or negate the presence of this burial. The elevated gamma radiation readings may be due to Cistern Burn Pit Area.

Deul's Mountain

During the construction of the Building 256 warehouse, a large area of potentially contaminated soil was removed and stored along the southeast corner of the fence line. No elevated gamma radiation levels were obtained during the walkover of part of Deul's Mountain; however, an area with elevated gamma radiation readings was identified at the foot of the mountain.

Joachim Creek Bridge

Citizens have reported that material may have been buried on or near the southwest portion of the property, in the vicinity of the Joachim Creek bridge. No abnormal or elevated gamma radiation levels were obtained during the investigation of this area.

Potential additional investigations that may be beneficial based on the results of this survey outside the 100% coverage area are to:

- Investigate the obvious difference in general gamma radiation levels south of the railroad tracks decreasing toward Joachim Creek. Although the "reference area" walkover did confirm a decrease in count rates with proximity to Joachim Creek, a few soil samples analyzed for gamma emitters would verify the actual gamma emitters present adjacent to the railroad. The analysis of these samples could confirm the gamma emitters as naturally occurring, or link them to potential contamination from site activities.
- Investigate the isolated spot identified in Area G on the power line road. This area should be sampled for gamma emitters. It may be prudent to obtain a soil sample in adjacent, lower reading areas to verify which gamma emitters are contributing to the difference between the two areas.
- Investigate and discover the cause of the elevated readings in the two isolated areas within Area D.
- Verify the area at the outlet of the culvert by physically removing all Rhyolite and performing an additional gamma survey, or obtaining a soil sample free of Rhyolite residue.

- Sample the area near the convergence of the drainages. The depth of the elevated gamma readings should be verified during the sampling to obviate subsequent field mobilizations.

Potential additional investigations that may be beneficial based on the results of this survey within the 100% coverage area are:

- Investigate a specific number of identified “hotspots” to determine magnitude and depth of contamination.
- Obtain soil samples at various “hotspot” locations with varying count rates. This sampling effort would attempt to quantify the range of contamination across the site, the deviation of the radionuclide ratio, and the resultant count rates associated with the various radionuclide ratios.
- Obtain samples at specific “hotspots” based on process knowledge to attempt to establish if the radionuclide ratios are significantly different between locations based on site historical uses.
- Use the information obtained from this survey with historical information to guide future subsurface investigation activities.
- Confirm that elevated gamma radiation readings adjacent to Building 230 are due to waste stored within the building. This could be accomplished by performing a gamma walkover survey upon removal of the waste.

In addition:

- A limited number of investigational samples may need to be obtained from the banks of the site evaporation ponds. All the soils surrounding the ponds tend to indicate slightly higher gamma radiation levels. This could be due to a number of reasons, but could be answered by obtaining soil samples in this area.

In general, contamination appears to be limited to the area in the vicinity of the plant site, which was investigated within the 100% coverage area. Contamination does not appear to have significantly migrated from the site by any of the normal transport modes (i.e. airborne release or migration with surface water). There is no general observable pattern of a decrease of gamma readings with distance from the plant. Joachim Creek does not indicate the presence of elevated gamma levels. With the exception of a few anomalies described herein, the survey data indicate that there is no obvious surficial contamination north of Hwy P, south of the railroad, in the farm area, or east of the first drainage.

6.0 REFERENCES

Westinghouse, 2003. *Gamma Survey Plan for the Hematite Site Rev 0*. St. Louis, MO, April 2003.

SAIC, 2002. Radiological Instrumentation HP-30 Rev 1. St. Louis, MO, December 2002.

ATTACHMENT 1
SURVEY INSTRUMENT QA RECORDS

	INSTRUMENT #	AVERAGE BKG	AVERAGE SOURCE
A	86306	5391	145052
B	117336	5493	146025
C	154232	5135	145862
D	117652	5418	135118
E	117634	5315	140510
F	105934	5263	143012
G	127217	5322	146113
H	154196	5405	129385

MEAN	5343	141385
10% RANGE	4809 - 5877	127246 - 155523

All readings in cpm.

Performed by: _____

J. Mary

Date: _____

4/5/03

Reviewed by: _____

Paul J. Allen

Date: _____

4/5/03



Environmental Restoration Group, Inc.
 12809 Arroyo de Vista, NE
 Albuquerque, NM 87111
 (505) 298-4224

EQUIPMENT PACKING SLIP

Company Name: SAIC	Order Number: 167
Contact Name: Bob French	P.O. or Reference Number: 4500666160
Contact Telephone: 314-486-6908	
Date Ordered: 4/1/2003	Shipping Method: Fedex Standard Overnight
Date Shipped: 4/1/2003	Shipping Number: 2458-3753-4
Date of Delivery: 4/2/2003	
Ship To Information: Bob French 9921 St. Charles Rock Rd. St. Ann, MO 63074 314-486-6908	Billing Address: SAIC Central Accounts Payable 10260 Campus Point Dr., MS E-2 San Diego, CA 92121

Equipment Enclosed:

<i>Instrument</i>	<i>Serial Number</i>
Ludlum 2221r	86306
Ludlum 2221r	117336
Ludlum 2221r	117652
Ludlum 2221r	117634
Ludlum 2221r	105934
Ludlum 44-10	PR122628
Ludlum 44-10	PR118986
Ludlum 44-10	PR122613
Ludlum 44-10	PR154615
Ludlum 44-10	PR122612
Ludlum 44-10	PR150642
Ludlum 44-10	PR112840
Ludlum 44-10	PR150786
Eberline Cs-137	4054-02

Special Instructions:

Certificate of Calibration

Rateometer / Scaler Certificate of Calibration



Environmental Restoration Group, Inc.
12809 Arroyo De Vista NE
Albuquerque, NM 87111
(505) 298-4224

Manufacturer: Ludlum Model: 2221 Serial No.: 86306

All Ranges Calibrated Electronically; Ludlum Pulser Generator S.N. 97743

Temp.: 70 °F Rel. Humidity 18 % Bar. Pressure 30.1 in. of Hg

Reset Audio Mechanical Battery Window Operation

High Voltage 500v 1000v 1500v

Instrument found within tolerance (+/- 10%) Yes No

Reference Setting	Rateometer	Instrument "As found reading"
400 Kcpm	<u>400 KCPM</u>	<u>+/- 10%</u>
100 Kcpm	<u>100 KCPM</u>	
40 Kcpm	<u>40 KCPM</u>	
10 Kcpm	<u>10 KCPM</u>	
4 Kcpm	<u>4 KCPM</u>	
1 Kcpm	<u>1 KCPM</u>	
400 cpm	<u>400 CPM</u>	
100 cpm	<u>100 CPM</u>	

Reference Setting	Integrated Counts (1-minute count)	Log Scale Count Rate	Instrument "As found reading"
400 Kcpm	<u>400359</u>	<u>400 KCPM</u>	<u>+/- 10%</u>
40 Kcpm	<u>40004</u>	<u>40 KCPM</u>	
4 Kcpm	<u>4001</u>	<u>4 KCPM</u>	
400 cpm	<u>400</u>	<u>400 CPM</u>	

Calibrated By: Charles P. Furr

Calibration Date: 4/1/03

Calibration Due: 4/1/04

Reviewed By: Kenneth R. Bahr

Date: 4/1/03

Certificate of Calibration

Environmental Restoration Group, Inc.
 12809 Arroyo De Vista
 Albuquerque, NM 87111
 (505) - 298 - 4224

Manufacturer: LUDLUM Model: 2221 Serial No.: 117336
 All Ranges Calibrated Electronically: Ludlum Pulsar Generator S.N. 97743
 Temp.: 70 F Rel. Humidity 18 % Bar. Pressure 30.1 in. of Hg

FUNCTION CHECKS:

Reset Audio Window Operation Mechanical Battery
 High Voltage 500v 1000v 1500v

Instrument found within tolerance (+/- 10%) YES NO

COMMENTS:

Reference Setting	Ratemeter	Instrument "As found reading"
<u>400 Kcpm</u>	<u>400 KCPM</u>	<u>+/- 10%</u>
<u>100 Kcpm</u>	<u>100 KCPM</u>	
<u>40 Kcpm</u>	<u>40 KCPM</u>	
<u>10 Kcpm</u>	<u>10 KCPM</u>	
<u>4 Kcpm</u>	<u>4 KCPM</u>	
<u>1 Kcpm</u>	<u>1 KCPM</u>	
<u>400 cpm</u>	<u>400 cpm</u>	
<u>100 cpm</u>	<u>100 cpm</u>	

Reference Setting	Digital Readout	Log Scale	Instrument Received
<u>400 Kcpm</u>	<u>400790</u>	<u>400 KCPM</u>	<u>+/- 10%</u>
<u>40 Kcpm</u>	<u>40057</u>	<u>40 KCPM</u>	
<u>4 Kcpm</u>	<u>4002</u>	<u>4 KCPM</u>	
<u>400 cpm</u>	<u>400</u>	<u>400 cpm</u>	

Calibrated By: Charles P. Farn Calibration Date: 4/1/03

Calibration Due: 4/1/04

Reviewed By: Kenneth R. Baker Date: 4/1/03

Certificate of Calibration

Environmental Restoration Group, Inc.
 12809 Arroyo De Vista
 Albuquerque, NM 87111
 (505) - 298 - 4224

Manufacturer: LUDLUM Model: 2221 Serial No.: 117634
 All Ranges Calibrated Electronically; Ludlum Pulsar Generator S.N. 97743
 Temp.: 70 F Rel. Humidity 18 % Bar. Pressure 30.1 in. of Hg

FUNCTION CHECKS:

Reset Audio Window Operation Mechanical Battery
 High Voltage 500v 1000v 1500v

Instrument found within tolerance (+/- 10%) YES NO

COMMENTS:

Reference Setting	Ratemeter	Instrument "As found reading"
<u>400 Kcpm</u>	<u>400 KCPM</u>	<u>+/- 10%</u>
<u>100 Kcpm</u>	<u>100 KCPM</u>	
<u>40 Kcpm</u>	<u>40 KCPM</u>	
<u>10 Kcpm</u>	<u>10 KCPM</u>	
<u>4 Kcpm</u>	<u>4 KCPM</u>	
<u>1 Kcpm</u>	<u>1 KCPM</u>	
<u>400 cpm</u>	<u>400 cpm</u>	
<u>100 cpm</u>	<u>100 cpm</u>	

Reference Setting	Digital Readout	Log Scale	Instrument Received
<u>400 Kcpm</u>	<u>400745</u>	<u>400 KCPM</u>	<u>+/- 10%</u>
<u>40 Kcpm</u>	<u>39975</u>	<u>40 KCPM</u>	
<u>4 Kcpm</u>	<u>3999</u>	<u>4 KCPM</u>	
<u>400 cpm</u>	<u>400</u>	<u>400 cpm</u>	

Calibrated By: Charles P. Foss Calibration Date: 4/1/03
 Calibration Due: 4/1/04
 Reviewed By: Kenneth A. Buehler Date: 4/1/03

Certificate of Calibration

Environmental Restoration Group, Inc.
 12809 Arroyo De Vista
 Albuquerque, NM 87111
 (505) - 298 - 4224

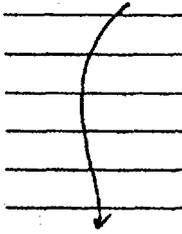
Manufacturer: LUDLUM Model: 2221 Serial No.: 105934
 All Ranges Calibrated Electronically; Ludlum Pulsar Generator S.N. 97743
 Temp.: 70 F Rel. Humidity 18 % Bar. Pressure 30.1 in. of Hg

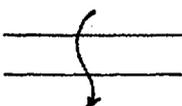
FUNCTION CHECKS:

Reset Audio Window Operation Mechanical Battery
 High Voltage 500v 1000v 1500v

Instrument found within tolerance (+/- 10%) YES NO

COMMENTS:

Reference Setting	Ratemeter	Instrument "As found reading"
<u>400 Kcpm</u>	<u>400 KCPM</u>	<u>+/- 10%</u> 
<u>100 Kcpm</u>	<u>100 KCPM</u>	
<u>40 Kcpm</u>	<u>40 KCPM</u>	
<u>10 Kcpm</u>	<u>10 KCPM</u>	
<u>4 Kcpm</u>	<u>4 KCPM</u>	
<u>1 Kcpm</u>	<u>1 KCPM</u>	
<u>400 cpm</u>	<u>400 cpm</u>	
<u>100 cpm</u>	<u>100 cpm</u>	

Reference Setting	Digital Readout	Log Scale	Instrument Received
<u>400 Kcpm</u>	<u>399320</u>	<u>400 KCPM</u>	<u>+/- 10%</u> 
<u>40 Kcpm</u>	<u>39935</u>	<u>40 KCPM</u>	
<u>4 Kcpm</u>	<u>4001</u>	<u>4 KCPM</u>	
<u>400 cpm</u>	<u>401</u>	<u>400 cpm</u>	

Calibrated By: Charles P. Furr Calibration Date: 4/1/03

Calibration Due: 4/1/04

Reviewed By: Kenneth R. Baker Date: 4/1/03

Certificate of Calibration

Voltage Plateau Form



Environmental Restoration Group, Inc.
12809 Arroyo De Vista NE
Albuquerque, NM 87111
(505) 298-4224

Detector Mfg.: Ludlum Model: 44-10 Serial No.: 1R150786

Counter Mfg.: Ludlum Model: 2221 Serial No.: 86306

Temp.: 70 °F Rel. Humidity 18 % Bar. Pressure 30.1 in. of Hg

Counter Threshold Setting: 10 mV Geometry / Distance to source: 6-inches

Source: Th230 @ 13,500 dpm sn: 4098-03 Tc99 @ 18,100 dpm sn: 4099-03

Cs137 @ 8.5 µCi sn: 4054-02 Other: _____

Count Time: 1 minute(s)

High Voltage	Gross Source Counts	Background Counts
600	47360	
700	81460	
800	91596	
900	98708	
1000	99379	
825	93572	11683

Recommended Operating Voltage: 825 volts

Calibrated By: Charles P. Furr

Calibration Date: 4/1/03

Reviewed By: Kenneth R. Balch

Calibration Due: 4/1/04

Date: 4/1/03

Certificate of Calibration

Voltage Plateau Form



Environmental Restoration Group, Inc.
 12809 Arroyo De Vista NE
 Albuquerque, NM 87111
 (505) 298-4224

Detector Mfg.: Ludlum Model: 44-10 Serial No.: PR112840
 Counter Mfg.: Ludlum Model: 2221 Serial No.: 117336

Temp.: 70 °F Rel. Humidity 18 % Bar. Pressure 30.1 in. of Hg
 Counter Threshold Setting: 10 mV Geometry / Distance to source: 6-inches
 Source: Th230 @ 13,500 dpm sn: 4098-03 Tc99 @ 18,100 dpm sn: 4099-03
 Cs137 @ 8.5 µCi sn: 4054-02 Other: _____

Count Time: 1 minute(s)

High Voltage	Gross Source Counts	Background Counts
600	26181	
700	56800	
800	79600	
900	87779	
1000	93711	
1100	94676	12154
1200	96013	

Recommended Operating Voltage: 1100 volts

Calibrated By: Charles P. Farr

Calibration Date: 4/1/03

Calibration Due: 4/1/04

Reviewed By: Kenneth R. Baker

Date: 4/1/03

Certificate of Calibration

Voltage Plateau Form



Environmental Restoration Group, Inc.
 12809 Arroyo De Vista NE
 Albuquerque, NM 87111
 (505) 298-4224

Detector Mfg.: Ludlum Model: 44-10 Serial No.: PR150642

Counter Mfg.: Ludlum Model: 2221 Serial No.: 14993B

Temp.: 70 °F Rel. Humidity 18 % Bar. Pressure 30.1 in. of Hg

Counter Threshold Setting: 10 mV Geometry / Distance to source: 6-inches

Source: Th230 @ 13,500 dpm sn: 4098-03 Tc99 @ 18,100 dpm sn: 4099-03
 Cs137 @ 8.5 µCi sn: 4054-02 Other: _____

Count Time: 1 minute(s)

High Voltage	Gross Source Counts	Background Counts
<u>600</u>	<u>23819</u>	
<u>700</u>	<u>56602</u>	
<u>800</u>	<u>83456</u>	
<u>900</u>	<u>92988</u>	
<u>1000</u>	<u>99617</u>	
<u>950</u>	<u>95131</u>	<u>11954</u>

Recommended Operating Voltage: 950 volts

Calibrated By: Charles P. Farn

Calibration Date: 4/1/03

Reviewed By: Kenneth R. Baker

Calibration Due: 4/1/04

Date: 4/1/03

Certificate of Calibration

Voltage Plateau Form



Environmental Restoration Group, Inc.
 12809 Arroyo De Vista NE
 Albuquerque, NM 87111
 (505) 298-4224

Detector Mfg.: Ludlum Model: 44-10 Serial No.: PR154615
 Counter Mfg.: Ludlum Model: 2221 Serial No.: 149938

Temp.: 70 °F Rel. Humidity 18 % Bar. Pressure 30.1 in. of Hg
 Counter Threshold Setting: 10 mV Geometry / Distance to source: 6-inches
 Source: Th230 @ 13,500 dpm sn: 4098-03 Tc99 @ 18,100 dpm sn: 4099-03
 Cs137 @ 8.5 µCi sn: 4054-02 Other: _____

Count Time: _____ minute(s)

High Voltage	Gross Source Counts	Background Counts
600	52245	
700	84124	
750	93013	11403
800	95218	
850	100075	
900	100944	

Recommended Operating Voltage: 750 volts

Calibrated By: Charles P. Farn

Calibration Date: 4/1/03

Reviewed By: Kenneth Bahr

Calibration Due: 4/1/04

Date: 4/1/03

Certificate of Calibration

Voltage Plateau Form



Environmental Restoration Group, Inc.
12809 Arroyo De Vista NE
Albuquerque, NM 87111
(505) 298-4224

Detector Mfg.: Ludlum Model: 44-10 Serial No.: PR 122613
Counter Mfg.: Ludlum Model: 2221 Serial No.: 117652

Temp.: 70 °F Rel. Humidity 18 % Bar. Pressure 30.1 in. of Hg

Counter Threshold Setting: 10 mV Geometry / Distance to source: 6-inches

Source: Th230 @ 13,500 dpm sn: 4098-03 Tc99 @ 18,100 dpm sn: 4099-03
 Cs137 @ 8.5 µCi sn: 4054-02 Other: _____

Count Time: 1 minute(s)

High Voltage	Gross Source Counts	Background Counts
700	44689	
800	72978	
900	83968	
1000	90457	
1100	92956	
1200	94396	12295
1300	94023	
1400	113123	



Recommended Operating Voltage: 1200 volts

Calibrated By: Charles P. Farr

Calibration Date: 4/1/03

Reviewed By: Kenneth A. Baber

Calibration Due: 4/1/04

Date: 4/1/03

Certificate of Calibration

Voltage Plateau Form



Environmental Restoration Group, Inc.
12809 Arroyo De Vista NE
Albuquerque, NM 87111
(505) 298-4224

Detector Mfg.: Ludlum Model: 44-10 Serial No.: PA118986
Counter Mfg.: Ludlum Model: 2221 Serial No.: 117634

Temp.: 70 °F Rel. Humidity 18 % Bar. Pressure 30.1 in. of Hg
Counter Threshold Setting: 10 mV Geometry / Distance to source: 6-inches
Source: Th230 @ 13,500 dpm sn: 4098-03 Tc99 @ 18,100 dpm sn: 4099-03
 Cs137 @ 8.5 µCi sn: 4054-02 Other: _____

Count Time: 1 minute(s)

High Voltage	Gross Source Counts	Background Counts
500	3281	
600	49052	
700	79498	
800	88012	
900	94234	
1000	94783	12579
1100	95491	
1200	97678	

Recommended Operating Voltage: 1000 volts

Calibrated By: Charles P. Farr

Calibration Date: 4/1/03

Reviewed By: Kenneth R. Bohm

Calibration Due: 4/1/04
Date: 4/1/03

Certificate of Calibration

Voltage Plateau Form



Environmental Restoration Group, Inc.
 12809 Arroyo De Vista NE
 Albuquerque, NM 87111
 (505) 298-4224

Detector Mfg.: Ludlum Model: 44-10 Serial No.: PR122628

Counter Mfg.: Ludlum Model: 2221 Serial No.: 105934

Temp.: 70 °F Rel. Humidity 18 % Bar. Pressure 30.1 in. of Hg

Counter Threshold Setting: 10 mV Geometry / Distance to source: 6-inches

Source: Th230 @ 13,500 dpm sn: 4098-03 Tc99 @ 18,100 dpm sn: 4099-03

Cs137 @ 8.5 µCi sn: 4054-02 Other: _____

Count Time: 1 minute(s)

High Voltage	Gross Source Counts	Background Counts
500	35818	
600	76338	
700	88480	
800	93538	
900	94449	12627
1000	95749	

Recommended Operating Voltage: 900 volts

Calibrated By: Charles P. F.

Calibration Date: 4/1/03

Calibration Due: 4/1/04

Reviewed By: Kenneth Baker

Date: 4/1/03

Automated Engineering & Electronic Services Inc.

AEES Inc. 165 Deer Run Ridge Road Kingston TN 1-865-376-0220 www.radprobe-aees.com

Calibration Certificate

Received Within Tolerance

Instrument Model No. 2221 Instrument Serial No. 154232 Misc1 EDI Misc2 MB

Battery Check Batt.Voltage: 5.8

Test Range	Scale Range Testing				As Found		As Left	
	100	200	400	100	200	400	200	400
1	100	200	400	100	200	400	200	400
10	1000	2000	4000	1000	2000	4000	2000	4000
100	10000	20000	40000	10000	20000	40000	20000	40000
1000	100000	200000	400000	100000	200000	400000	200000	400000
10000								

High Voltage Test		
Test Point	As Found	As Left
500	507	507
1000	1005	1005
1500	1508	1508
2000	2015	2015

Logarithmic Meter Test				
Range	1	10	100	1000
As Found	400	4000	42500	400000
As Left	400	4000	42500	400000

Time Tests	
Test Point	Count Results
0.1	100
0.2	200
0.5	499
1	999
2	1999
5	4997

Time base testing default = 1000 CPM

Functional Tests	
<input checked="" type="checkbox"/> Fast/Slow	<input type="checkbox"/> Thermo Dynamic
<input checked="" type="checkbox"/> Reset	<input checked="" type="checkbox"/> Geotropism
<input checked="" type="checkbox"/> Lights	<input checked="" type="checkbox"/> HV Push Button
<input checked="" type="checkbox"/> Zero Push	<input type="checkbox"/> Over Range
<input checked="" type="checkbox"/> Count Push	<input type="checkbox"/> Alarm Ack
<input checked="" type="checkbox"/> Hold Push	

Electronic Checks / Set Points		
	As Found	As Left
Mechanical Zero:	0	0
High Voltage:	750	750
Threshold 1	8.5	10
Threshold 2	na	na
Threshold 3:	na	na
Over Load	na	na

Parts Replaced during Calibration and or Repair.

Audio Tests	
<input checked="" type="checkbox"/>	Audio Test
<input checked="" type="checkbox"/>	Audio Divide
<input checked="" type="checkbox"/>	Audio Volume
<input type="checkbox"/>	Audio Alarm
<input checked="" type="checkbox"/>	HeadPhone

Calibration Date: 4/2/03 Cal Cycle / Months 12

Calibration Due Date: 4/2/04

Calibrated By: K Murphy

Signature: *Kenneth Murphy*

Remarks: ESV#917231 Due 3-3-04

Certificate

Automated Engineering & Electronic Services
 185 Deer Run Ridge RD. Kingston Tennessee 37763 1-423-376-0228 Fax 1-423-376-0229 www.radprobe-aees.com

Certificate of Calibration

For

Rateometer/Scaler

Model Number: 2221

Serial Number: 127217 ED# 232

Client: EDI

Probe No.: NA

Serial Number: NA

PO #: COLONIE

The subject instrument was calibrated to the indicated specifications using standards traceable to the National Institute of Standards and Technology or to accepted values of natural physical constraints. This document certifies that the instrument met the following specifications upon its return to the submitter. Upon receipt the instrument was found: **Within Specs.**

AES Inc. calibrations control system complies to the guides lines of ANSI N323-1997, ANSI/NCCL Z540-1-1994 and MIL Std 45662A

Electronic files are identified by MDL SN DATE PROBE MDL PROBE SN

Scale / Range	Test Value	As Found Value	Variance 0.1 Max Value	As Left Value	Variance 0.1 Max Value	Calib. Tol.
1	100	100	0.00	100	0.00	0.1
1	400	400	0.00	400	0.00	0.1
10	100	1000	0.00	1000	0.00	0.1
10	400	4000	0.00	4000	0.00	0.1
100	100	9900	-0.01	9900	-0.01	0.1
100	400	40000	0.00	40000	0.00	0.1
1000	100	99000	-0.00	99000	-0.00	0.1
1000	400	399000	-0.00	399000	-0.00	0.1

Log	Test Point	As Found	As Left
X1	400	400	400
X10	4000	4000	4000
X100	40000	40000	40000
X1000	400000	400000	400000

ERR	Time	Test	Delta	As Found	As Left	
NA	1000	100	0.00	100	0.00	
NA	1	1000	998	-0.00	998	-0.00
NA	5	1000	4998	-0.00	4998	-0.00
NA	10	1000	9998	-0.00	9998	-0.00

PROB-100 Amplifier Calibrations	SN	Due Date	MATE	SN	Due Date
PROB-200 Counters Calibrations	Geom Post tested: No	Geotropic Tested: Yes			
PROB-300 Support Circuits Tests	Repairs performed: No	Thermo Tested: No			
PROB-400 -- Not Required	Response Tests: Yes	Functional Tests: Yes	MP-1	132	8-12-2002
PROB-600 Geotropic Tests	Speaker Tested: Yes	Timer Tested: Yes	ESV	817231	2-18-2003
PROB-600 -- Not Required	Battery Level: Good	Alpha threshold	100		Temperature in Deg. F 738.27
PROB-900 -- Not Required	Flow Rate (col/min) na	Beta threshold	600		Pressure in mmHg 738.27
					Relative Humidity 85

Source	SN	DPM	Cal Date	Source	SN	DPM	Cal Date	Source	SN	DPM	Cal Date
NA											

Remarks: HV as found @1020 HV as left @1050 Threshold as found 10 mv =100 Threshold as left 10 mv = 100

Performed By: Coral King Date: 05-06-2002
 Reviewed By: [Signature] Date: 05-07-2002

Not Used/No/NA = Not Req. or needed

Certificate

Automated Engineering & Electronic Services
 165 Deer Run Ridge RD. Kingston Tennessee 37763 1-423-578-0220 Fax 1-423-578-0229 www.redprobe-aees.com

Certificate of Calibration

For

Ratemeter/Scalar

Type

Model Number: 2221

Serial Number: 154196

Client: EDI

Probe No.: NA

Serial Number: NA

PO #: CISS

The subject instrument was calibrated to the indicated specifications using standards traceable to the National Institute of Standards and Technology or to accepted values of natural physical constraints. This document certifies that the instrument met the following specifications upon its return to the submitter. Upon receipt the instrument was found: **Within Specs. As Found**

AEEES Inc. calibrations control system complies to the guides lines of ANSI N323-1997, ANSI/NCCL Z540-1-1994 and MIL Std 45662A

Electronic files are identified by: MDL, SN, DATE, PROBE MDL, PROBE SN

Analog Cal		Data				
Scale / Range	Test Value	As Found Value	Variance 0.1 Max Value	As Left Value	Variance 0.1 Max	Calib Tol
.1	100	100	0.00	100	0.00	0.1
1	400	400	0.00	400	0.00	0.1
10	100	1000	0.00	1000	0.00	0.1
10	400	4000	0.00	4000	0.00	0.1
100	100	10000	0.00	10000	0.00	0.1
100	400	40000	0.00	40000	0.00	0.1
1000	100	100000	0.00	100000	0.00	0.1
1000	400	400000	0.00	400000	0.00	0.1

Not Required

Emergency

NA

ERR

Voltage Increment

50

Volts

Simple Plateau

Dual Plateau

NA

ERR

Time

Test

Data

Digital Cal

HV

As Found As Left

NA

ERR

Time

Test Val

As Found

Variance

As Left

Variance

500

400

400

0.1

1000

100

0.00

100

0.00

1000

1000

1000

1

1000

997

-0.00

997

-0.00

1500

1500

1500

5

1000

4999

-0.00

4999

-0.00

2000

1996

1996

10

1000

9998

-0.00

9998

-0.00

2500

NA

NA

PROS-100 Amplifier Calibrations	Procedures	Test	MSTE	SN	Due Date	MSTE	SN	Due Date
PROS-200 Counters Calibrations	Com Port tested: No	Geotropic Tested: Yes						
PROS-300 Support Circuits Tests	Repairs performed: No	Thermo Tested: No						
PROS-400 - Not Required	Response Tests: Yes	Functional Tests: Yes	MP1	132	1-8-2003			
PROS-500 Geotropic Tests	Speaker Tested: Yes	Timer Tested: Yes	ESV	917231	2-19-2003	Temperature in Deg F		78
PROS-600 - Not Required	Battery Level: 7.3	Alpha threshold: 100				Pressure in mmHg		748
PROS-800 - Not Required	Flow Rate (cc/min): NA	Beta threshold: NA				Relative Humidity		61

Source	Source	SN	DPM	Cal Date	Source	SN	DPM	Cal Date	Source	SN	DPM	Cal Date
Non Required												

PROS-100 Amplifier Calibrations

PROS-200 Counters Calibrations

PROS-300 Support Circuits Tests

PROS-400 - Not Required

PROS-500 Geotropic Tests

PROS-600 - Not Required

PROS-800 - Not Required

Source

Non Required

Remarks: HV As Found @ 985 As Left @ 900
 Threshold As Found @ 100 As Left @ 100

Not Used/No/NA = Not Req. or needed

Performed By: Sam Murphy Date: 9-12-02
 Reviewed By: Sam Murphy Date: 9-12-02



EBERLINE SERVICES

CERTIFICATE OF CALIBRATION

Gamma Standard

S.O.# 3951
P.O.# N/A

Description of Standard:

Model No. CS-7AS Serial No. 4054-02 Isotope Cs-137
The source of gamma radiation is mounted on a 2.54 cm diameter PLASTIC
also, 3 mm thick and sealed in a PLASTIC RESIN.

Measurement Method:

The gamma ray emission rate was compared with a similar standard, which was calibrated by NIST S/N 2752-91. The comparison of relative gamma ray emission rates was accomplished using a high resolution gamma-ray detector (nominal active volume 100 cm³) and a multichannel pulse height analyzer.

Measurement Result:

The gamma ray activity of the standard on 10-03-2002 was 8.5 μ Ci.
The uncertainty of the measurement is 5 %, which is the sum of the uncertainty assigned to the NIST reference (2.2 %), random counting error at the 99% confidence level, and the estimated upper limit of systematic errors.

Calibrated by: ART REUST

Reviewed by: [Signature]

Calibration Technician: [Signature]

Q.A. Representative: Anthony W. John

Calibration Date: 10-03-2002

Reviewed Date: 10-4-02

Initial 44-10 A Instrument Check In

Meter Number: 86306
 Meter Model: 2221
 Cal. Due: 4/1/2004

Detector Number: PR150786
 Detector Model: 44-10
 Cal. Due: 4/1/2004

Source=Cs 137
 S/N-4054-02

Threshold = 10mV
 High Voltage = 825V

Source GCPM	BKG CPM
146277	5430
144275	5321
145516	5281
145180	5420
145093	5221
145525	5478
145118	5461
143585	5392
144740	5392
145209	5516

Average Bkg. (CPM): 5391
 Average Source (GCPM): 145052
 Average Net Source (NCPM): 139661
 Source Range (GCPM): 116041 to 174062
 Background Range (CPM): 4313 to 6469

 Source Range +/- 20%
 Background Range +/- 20%

Performed By: *J. Wang* Date: 4/5/03

Reviewed By: *[Signature]* Date: 4/7/03

Initial 44-10 B Instrument Check In

Meter Number: 117336
 Meter Model: 2221
 Cal. Due: 4/1/2004

Detector Number: PR112840
 Detector Model: 44-10
 Cal. Due: 4/1/2004

Source=Cs 137
 S/N-4054-02

Threshold = 10mV
 High Voltage = 1100V

Source GCPM	BKG CPM
146655	5440
146217	5412
146755	5542
146289	5416
145407	5569
146713	5512
145978	5494
145590	5561
145272	5487
145373	5494

Average Bkg. (CPM): 5493
 Average Source (GCPM): 146025
 Average Net Source (NCPM): 140532
 Source Range (GCPM): 116820 to 175230
 Background Range (CPM): 4394 to 6591
 Source Range +/- 20%
 Background Range +/- 20%

Performed By: _____

JMM

Date: _____

4/5/03

Reviewed By: _____

[Signature]

Date: _____

4/7/03

Initial 44-10 D Instrument Check In

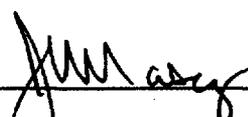
Meter Number: 117652	Detector Number: PR122613
Meter Model: 2221	Detector Model: 44-10
Cal. Due: 4/1/2004	Cal. Due: 4/1/2004

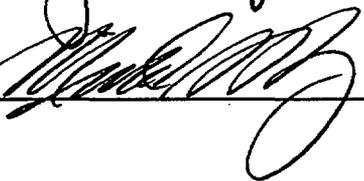
Source=Cs 137
S/N-4054-02

Threshold = 10mV
High Voltage = 1200V

Source GCPM	BKG CPM
134929	5443
134724	5476
135007	5495
135621	5317
135311	5458
135739	5410
135221	5403
135216	5457
134847	5331
134568	5389

Average Bkg. (CPM):	5418	
Average Source (GCPM):	135118	
Average Net Source (NCPM):	129700	
Source Range (GCPM):	108095	to 162142
Background Range (CPM):	4334	to 6501
Source Range +/- 20%		
Background Range +/- 20%		

Performed By:  Date: 4/5/03

Reviewed By:  Date: 4/7/03

Initial 44-10 E Instrument Check In

Meter Number: 117634
 Meter Model: 2221
 Cal. Due: 4/1/2004

Detector Number: PR118986
 Detector Model: 44-10
 Cal. Due: 4/1/2004

Source=Cs 137
 S/N-4054-02

Threshold = 10mV
 High Voltage = 1000V

Source GCPM	BKG CPM
139891	5484
140502	5238
140522	5349
139748	5186
140562	5485
141236	5314
141288	5539
141016	5049
140205	5392
140133	5110

Average Bkg. (CPM): 5315
 Average Source (GCPM): 140510
 Average Net Source (NCPM): 135196
 Source Range (GCPM): 112408 to 168612
 Background Range (CPM): 4252 to 6378
 Source Range +/- 20%
 Background Range +/- 20%

Performed By: *JMM* Date: 4/5/03

Reviewed By: *[Signature]* Date: 4/7/03

Initial 44-10 F Instrument Check In

Meter Number: 105934
Meter Model: 2221
Cal. Due: 4/1/2004

Detector Number: PR122628
Detector Model: 44-10
Cal. Due: 4/1/2004

Source=Cs 137
S/N-4054-02

Threshold = 10mV
High Voltage = 900V

Source GCPM	BKG CPM
141240	5199
140742	5381
143372	5214
143729	5407
143413	5066
143394	5293
143679	5169
143269	5293
143576	5317
143702	5293

Average Bkg. (CPM): 5263
Average Source (GCPM): 143012
Average Net Source (NCPM): 137748
Source Range (GCPM): 114409 to 171614
Background Range (CPM): 4211 to 6316

Source Range +/- 20%
Background Range +/- 20%

Performed By: *JMM* Date: 4/5/03

Reviewed By: *[Signature]* Date: 4/7/03

Initial 44-10 G Instrument Check In

Meter Number: 127217
 Meter Model: 2221
 Cal. Due: 5/6/2003

Detector Number: PR154615
 Detector Model: 44-10
 Cal. Due: 4/1/2004

Source=Cs 137
 S/N-4054-02

Threshold = 10mV
 High Voltage = 1050V

Source GCPM	BKG CPM
144708	5247
144713	5328
144991	5536
144434	5196
144733	5559
144865	5375
147546	5214
147775	5323
149591	5053
147774	5385

Average Bkg. (CPM): 5322
 Average Source (GCPM): 146113
 Average Net Source (NCPM): 140791
 Source Range (GCPM): 116890 to 175336
 Background Range (CPM): 4257 to 6386
 Source Range +/- 20%
 Background Range +/- 20%

Performed By: *J. Mary* Date: 4/5/03

Reviewed By: *[Signature]* Date: 4/7/03

Initial 44-10 H Instrument Check In

Meter Number: 154196
Meter Model: 2221
Cal. Due: 9/12/2003

Detector Number: PR122612
Detector Model: 44-10
Cal. Due: 4/1/2004

Source=Cs 137
S/N-4054-02

Threshold = 10mV
High Voltage = 900V

Source GCPM	BKG CPM
129217	5354
129351	5433
128991	5493
129534	5419
129035	5436
129555	5577
129554	5401
129713	5442
129388	5105
129514	5390

Average Bkg. (CPM): 5405
Average Source (GCPM): 129385
Average Net Source (NCPM): 123980
Source Range (GCPM): 103508 to 155262
Background Range (CPM): 4324 to 6486

Source Range +/- 20%
Background Range +/- 20%

Performed By: _____

Date: _____

Reviewed By: _____

Date: _____

SCALER/RATEMETER ELECTRONIC CALIBRATION CERTIFICATE

Customer: SAIC Order No.: SAIC0718021
 Fig.: Ludlum Model: 2360 Serial No.: 168050
 Cal. Interval: 1 yr. Meterface: 202-855
 T. 70 °F RH 68 % Alt 660 ASL

Instrument Received: Within Toler. +-10% 10-20% Out of Tol. Requiring Repair Other -See comments

Mechanical ck. Meter Zeroed Background Subtract Input Sens. Linearity
 F/S Resp. ck. Reset ck. Window Operation Geotropism
 Audio ck. Alarm Setting ck. Batt. Ck.

Calibrated in accordance with SAIC HP-30 and manufactures calibration instructions.

Instrument Volt Set 635 V Input Sens. comments mV Det. Oper. 635 V at comments mV
 HV readout (2 points) Ref./Inst. 500 / 521 V Ref./Inst. 2000 / 1960 V

COMMENTS: For input sensitivities see detector calibration form

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT "AS FOUND READING"	INSTRUMENT "AS LEFT READING"
<input checked="" type="checkbox"/> 1000	400 K cpm	400 K cpm	400 K cpm
<input checked="" type="checkbox"/> 1000	100 K cpm	100 K cpm	100 K cpm
X 100	40 K cpm	40 K cpm	40 K cpm
X 100	10 K cpm	10 K cpm	10 K cpm
X 10	4 K cpm	40 K cpm	4 K cpm
X 10	1 K cpm	1 K cpm	1 K cpm
X 1	400 cpm	400 cpm	400 cpm
X 1	100 cpm	100 cpm	100 cpm

*Uncertainty within ± 10% C.F. within ± 20%

ALL Ranges(s) Calibrated Electronically

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Reading	400 K cpm	40034 (0)	40029 (0)
	40 K cpm	4004 (0)	4003 (0)
	4 K cpm	401 (0)	401 (0)
	400 cpm	40 (0)	40 (0)
	40 cpm	4 (0)	4 (0)

Reference Instruments and/or Sources;

Multimeter S/N AA00153723

Oscilloscope S/N _____

m 500 S/N

Other

154177

Calibrated By: Del. J. France

Date: 7/18/02

Reviewed By: A. Thomas DeWitt

Date: 7/23/02

Calibration Due Date: 7/18/03

FUSRAP Detector Calibration Form

Customer: SAIC

Section 1: General Information

Date: 7/18/02 Location: Holtwick Technician: B. French

Manufacturer: Ludlum Model: 43-89 "N"

Serial #: 179856 Last Calibrated: 6/29/01

Reason for re-calibration: X Due for Calibration _____ Repair _____ Other (Enter in remarks)

Equipment used for Calibration:

Type	Identification	Date due for calibration
Model 2360	168050	7/18/03

Sources:

Isotope:	Identification:	Current Activity:	Assay Activity	Date of Assay:
Th-230	SAIC-0053	20300	20300	11/16/00
SrY-90	SAIC-0054	16059	16700	11/15/00

Section 2: As Found / As Left Data

Physical Condition SAT/UNSAT

As Found BKG. Alpha	As Found BKG. Beta	As Left BKG. Alpha	As Left BKG. Beta
5- 10 MIN. BKG. COUNTS	5- 1 MIN. BKG. COUNTS	5- 10 MIN. BKG. COUNTS	5- 1 MIN. BKG. COUNTS
1. 0.4	1. 141	1. 0.3	1. 153
2. 0.7 Avg. 0.36	2. 134 Avg. 139	2. 0.1 Avg. 0.34	2. 188 Avg. 167
3. 0.3	3. 134	3. 0.3	3. 164
4. 0	4. 146	4. 0.5	4. 186
5. 0.4	5. 141	5. 0.5	5. 146

As Found Source Alpha	As Found Source Beta	As Left Source Alpha	As Left Source Beta
5- 1 MIN. Source Counts	5- .1 MIN. Source Counts	5- 1 MIN. Source Counts	5- 1 MIN. Source Counts
1. 3374	1. 4084	1. 3470	1. 4386
2. 3124	2. 4124	2. 3380	2. 4434
3. 3222 Avg. 3276	3. 4197 Avg. 4107	3. 3474 Avg. 3430	3. 4411 Avg. 4404
4. 3313	4. 4115	4. 3364	4. 4379
5. 3346	5. 4016	5. 3463	5. 4408
Calculated Eff.: 16.14%%	Calculated Eff.: 24.71%%	Calculated Eff.: 16.90%%	Calculated Eff.: 25.38%%

Section 3:

HV SET: 635V Remarks: H.V. SET W/PROBE ATTACHED

Alpha Threshold: 120mV

Beta Threshold: 3.5mV

Beta Window: 30mV

Date Calibrated: 7/18/02 Date Calibration Due: 7/18/03

Performed by: [Signature] Date: 7/18/02

Reviewed by: [Signature] Date: 7/23/02

Designer and Manufacturer
of
Scientific and Industrial
Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. 915-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER SAIC ORDER NO. 286250

Ludlum Measurements, Inc. Model 2929 Serial No. 180850

Mfg. Model Serial No.

Cal. Date 6-Dec-02 Cal Due Date 6-Dec-03 Cal. Interval 1 Year Meterface 202-014

Check mark applies to applicable instr. and/or detector IAW mfg. spec. T. 76 °F RH 23 % Alt 710.8 mm Hg

New Instrument Instrument Received Within Toler. +10% 10-20% Out of Tol. Requiring Repair Other-See comments

Mechanical ck. Window Operation

Audio ck.

Meter Zeroed Alpha Sensitivity 175 mV Beta Sensitivity 4 mV Beta Window 50 mV

Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

Instrument Volt Set 900 V = 3.63 on High Voltage dial. High Voltage set with detector connected.

HV Readout (2 points) Ref./Inst. 500 / 500 V Ref./Inst. 2008 / 2000 V

COMMENTS:

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

Alpha Channel
Digital Readout

REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
400K cpm		400357
40K cpm		40039
4K cpm		4005
400 cpm		400
40 cpm		40

Beta/Gamma Channel
Digital Readout

REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
400K cpm		400296
40K cpm		40029
4K cpm		4002
400 cpm		400
40 cpm		40

*Uncertainty within ± 10% C.F. within ± 20%

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of ANSI/NCCL Z540-1-1994 and ANSI N323-1978. State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources:

137 Gamma S/N 1162 G112 M565 5105 T1008 T879 E552 E551 Neutron Am-241 Be S/N T-304

Alpha S/N Beta S/N Other

m 500 S/N 141244 Oscilloscope S/N Multimeter S/N 68160950

Calibrated By: Dave Nittler

SAICE FUSRAP Detector Calibration Form

Customer: SAIC

Section 1: General Information

Date: 2/19/03	Location: Holtwick	Technician: B. French
Manufacturer: Ludlum	Model: 43-10-1	
Serial #: 194703	Last Calibrated: NEW	
Reason for re-calibration: Due for Calibration _____ Repair x Other (Enter in remarks)		

Equipment used for Calibration:

Type	Identification	Date due for calibration
Model 2929	180850	12/6/03

Sources:

Isotope:	Identification:	Current Activity:	Assay Activity	Date of Assay:
Th-230	SAIC-0053	20300	20300	11/16/00
SrY-90	SAIC-0054	15833	16700	11/15/00

Section 2: As Found / As Left Data

Physical Condition SAT/UNSAT

As Found BKG. Alpha	As Found BKG. Beta	As Left BKG. Alpha	As Left BKG. Beta
5- <u>N/A</u> MIN. BKG. COUNTS	5- <u>N/A</u> MIN. BKG. COUNTS	5- <u>10</u> MIN. BKG. COUNTS	5- <u>1</u> MIN. BKG. COUNTS
1. <u>N/A</u>	1. <u>N/A</u>	1. <u>0</u>	1. <u>42</u>
2. <u>N/A</u> Avg. <u>N/A</u>	2. <u>N/A</u> Avg. <u>N/A</u>	2. <u>0.2</u> Avg. <u>0.12</u>	2. <u>41</u> Avg. <u>41</u>
3. <u>N/A</u>	3. <u>N/A</u>	3. <u>0.2</u>	3. <u>40</u>
4. <u>N/A</u>	4. <u>N/A</u>	4. <u>0.1</u>	4. <u>39</u>
5. <u>N/A</u>	5. <u>N/A</u>	5. <u>0.1</u>	5. <u>41</u>
As Found Source Alpha	As Found Source Beta	As Left Source Alpha	As Left Source Beta
5- <u>N/A</u> MIN. Source Counts	5- <u>N/A</u> MIN. Source Counts	5- <u>1</u> MIN. Source Counts	5- <u>1</u> MIN. Source Counts
1. <u>N/A</u>	1. <u>N/A</u>	1. <u>6925</u>	1. <u>6894</u>
2. <u>N/A</u>	2. <u>N/A</u>	2. <u>7122</u>	2. <u>6969</u>
3. <u>N/A</u> Avg. <u>N/A</u>	3. <u>N/A</u> Avg. <u>N/A</u>	3. <u>6968</u> Avg. <u>6977</u>	3. <u>6936</u> Avg. <u>6905</u>
4. <u>N/A</u>	4. <u>N/A</u>	4. <u>6970</u>	4. <u>6836</u>
5. <u>N/A</u>	5. <u>N/A</u>	5. <u>6900</u>	5. <u>6889</u>
Calculated Eff.: <u>N/A</u> %	Calculated Eff.: <u>N/A</u> %	Calculated Eff.: <u>34.37</u> %	Calculated Eff.: <u>43.35</u> %

Section 3:

HV SET: <u>675V</u>	Remarks: <u>- NEW INSTRUMENT RECEIVED.</u>
Alpha Threshold: <u>175mV</u>	
Beta Threshold: <u>4mV</u>	
Beta Window: <u>50mV</u>	
Date Calibrated: <u>2/19/03</u>	Date Calibration Due: <u>2/19/04</u>

Daily Check-In of Gamma Scan Instruments

APRIL YR: 2003 44-10 "B" Source #: 4054-02
 #: 117336 Detector #: PR112840 Source Type: Cs-137
 #: 2221 Model #: 44-10 HV: 1100 V
 Je: 4-1-04 Cal. Due: 4-1-04 Threshold: 10 mV

MSD
4/16/03

TIME	BKG RANGE		SOURCE RANGE		BAT CHECK	HV CHECK	INITIALS	INITIALS	CONFIRM
	INTL BKG CPM	POST BKG CPM	INTL SOURCE CPM	POST SOURCE CPM			INTL CHECK	POST CHECK	Y/N
0850	4703	6235	143095	138929	SAT	SAT	JCM	JCM	Y/N
0647	5396	4713	138292	137592	SAT	SAT	JCM	JCM	Y/N
0648	4675	4557	138708	140781	SAT	SAT	JCM	JCM	Y/N
0651	5568	5022	138626	140353	SAT	SAT	JCM	JCM	Y/N
0706	5724	5324	138478	138551	SAT	SAT	R	R	Y/N
0650	5459	4817	139749	137793	SAT	SAT	R	JCM	Y/N
0700	5336	5329	138379	137663	SAT	SAT	P.L.	P.L.	Y/N
0639	5319	5019	139252	139783	SAT	SAT	R	R	Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N

ved By: J. Old

Date: 4/16/03

Daily Check-In of Gamma Scan Instruments

: APRIL YR: 2003 44-10 "C" Source #: 4054-02
 #: 154232 Detector #: PR150642 Source Type: Cs-137
 #: 2221 Model #: 44-10 HV: 750 V
 ue: 4-2-04 Cal. Due: 4-1-04 Threshold: 10 mV

TIME	BKG RANGE	4108 - 6161	SOURCE RANGE	116690-175035	BAT CHECK	HV CHECK	INITIALS	INITIALS	CONFIRM
	INTL BKG CPM	POST BKG CPM	INTL SOURCE CPM	POST SOURCE CPM			INTL CHECK	POST CHECK	Y/N
0908	4429	4915	139637	141436	SAT	SAT	JAM	JAM	Y/N
0653	4933	4323	140823	143544	SAT	SAT	JAM	JAM	Y/N
0655	4782	4278	143218	144106	SAT	SAT	JAM	JAM	Y/N
0653	4456	5179 4378	142208	142562	SAT	SAT	JAM	JAM	Y/N
0700	4909	4385	142261	142343	SAT	SAT	JAM	JAM	Y/N
0652	5214	4527	144764	142071	SAT	SAT	JAM	JAM	Y/N
0710	4881	4121	143911	141759	SAT	SAT	D.L.	D.L.	Y/N
0641	4412	⊙	141450	⊙	SAT	SAT	J		Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N

read
ved By: Edy J. Olla

Date: 4/16/03

Daily Check-In of Gamma Scan Instruments

APRIL YR: 2003 44-10 "D" Source #: 4054-02
 #: 117652 Detector #: PR122613 Source Type: Cs-137
 #: 2221 Model #: 44-10 HV: 1200 V
 Date: 4-1-04 Cal. Due: 4-1-04 Threshold: 10 mV

MRP
4/10/03

TIME	BKG RANGE 4334 - 6501		SOURCE RANGE 108095-162142		BAT CHECK	HV CHECK	INITIALS	INITIALS	CONFIRM
	INTL BKG CPM	POST BKG CPM	INTL SOURCE CPM	POST SOURCE CPM			INTL CHECK	POST CHECK	Y/N
0907	4685	5392	131481	133089	SAT	SAT	JAM	JAM	Y/N
0650	5380	5051	133278	134219	SAT	SAT	JAM	JAM	Y/N
0643	5093	4495	132765	132818	SAT	SAT	JAM	JAM	Y/N
0655	4903	4645	132458	131331	SAT	SAT	JAM	JAM	Y/N
0700	5185	4703	131983	134737	SAT	SAT	JAM	JAM	Y/N
0653	5602	4729	133133	132758	SAT	SAT	JAM	JAM	Y/N
0712	5109	4690	133281	135677	SAT	SAT	P.L.	P.L.	Y/N
0642	4893	⊙	133817	⊙	SAT	SAT	R		Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N

Used By: John J. Allen

Date: 4/10/03

Daily Check-In of Gamma Scan Instruments

: APRIL YR: 2003 Source #: 44-10 "E" Source #: 4054-02
 #: 117634 Detector #: PR118986 Source Type: Cs-137
 #: 2221 Model #: 44-10 HV: 1000 V
 ue: 4-1-04 Cal. Due: 4-1-04 Threshold: 10 mV

MR
4/7/03

TIME	BKG RANGE		SOURCE RANGE		BAT CHECK	HV CHECK	INITIALS		CONFIRM
	INTL BKG CPM	POST BKG CPM	INTL SOURCE CPM	POST SOURCE CPM			INTL CHECK	POST CHECK	
0850	4436	5191	136128	136462	SAT	SAT	JAM	JAM	Y/N
0650	5652	4678	136890	137207	SAT	SAT	JAM	JAM	Y/N
0644	5108	4617	138559	138882	SAT	SAT	JAM	JAM	Y/N
0654	5179	4657	137423	137447	SAT	SAT	JAM	JAM	Y/N
0703	5227	4385 4675	138456	138174	SAT	SAT	JAM	JAM	Y/N
0653	5518	4740	138417	136815	SAT	SAT	JAM	JAM	Y/N
0714	5137	5181	138975	140772	SAT	SAT	D.L.	D.L.	Y/N
0642	4873	⓪	137073	⓪	SAT	SAT	R		Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N

MR

bed
ved By: Pol J All

Date: 4/16/03

Daily Check-In of Gamma Scan Instruments

: APRIL YR: 2003 44-10 "F" Source #: 4054-02
 #: 105934 Detector #: PR122628 Source Type: Cs-137
 #: 2221 Model #: 44-10 HV: 900 V
 ue: 4-1-04 Cal. Due: 4-1-04 Threshold: 10 mV

MP
4/10/03

TIME	BKG RANGE	4211 - 6316	SOURCE RANGE	114409-171614	BAT CHECK	HV CHECK	INITIALS	INITIALS	CONFIRM
	INTL BKG CPM	POST BKG CPM	INTL SOURCE CPM	POST SOURCE CPM			INTL CHECK	POST CHECK	Y/N
0909	4763	4865	136875	141669	SAT	SAT	JAM	JAM	Y/N
0642	5384	5090	138470	138682	SAT	SAT	JAM	JAM	Y/N
0655	5275	4955	139509	138993	SAT	SAT	JAM	JAM	Y/N
0652	5366	5286	138905	140393	SAT	SAT	JAM	JAM	Y/N
0707	5397	4987	139224	138638	SAT	SAT	R	R	Y/N
0650	5628	5355	138491	139357	SAT	SAT	R	JAM	Y/N
0707	5616	5482	140399	143467	SAT	SAT	D.L.	D.L.	Y/N
0641	4850	0	139809	0	SAT	SAT	R		Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N

Used
ved By: Paul J. Allen

Date: 4/10/03

Daily Check-In of Gamma Scan Instruments

: APRIL YR: 2003 Source #: 44-10 "G" Source #: 4054-02
 #: 127217 Detector #: PR154615 Source Type: Cs-137
 #: 2221 Model #: 44-10 HV: 1050 V
 ue: 5-6-03 Cal. Due: 4-1-04 Threshold: 10 mV

MS 4/1/03

TIME	BKG RANGE 4257 - 6386		SOURCE RANGE 116890-175336		BAT CHECK	HV CHECK	INITIALS	INITIALS	CONFIRM Y/N
	INTL BKG CPM	POST BKG CPM	INTL SOURCE CPM	POST SOURCE CPM			INTL CHECK	POST CHECK	
0910	4872	5392	148790	150830	SAT	SAT	JCM	JY	Y/N
0654	5426	4867	148549	150017	SAT	SAT	JCM	JY	Y/N
0656	5361								Y/N
0656	5361	5259	150061	150575	SAT	SAT	JCM	JCM	Y/N
0652	5288	5390	150614	153289	SAT	SAT	JCM	JY	Y/N
0707	5814	5010	151010	150560	SAT	SAT	R	R	Y/N
0651	5638	4884	151379	153028	SAT	SAT	JCM	JCM	Y/N
0702	5665	4901	149988	148977	SAT	SAT	D.L.	JCM	Y/N
0640	4994	5149	150620	151250	SAT	SAT	R	R	Y/N
0647	5018	5125	150135	151241	SAT	SAT	R	JCM	Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N

red By: Ray J. Allen

Date: 4/1/03

Daily Check-in of Gamma Scan Instruments

APRIL YR: 2003 44-10 "H" Source #: 4054-02
 #: 154196 Detector #: PR122612 Source Type: Cs-137
 #: 2221 Model #: 44-10 HV: 900 V
 Je: 9-12-03 Cal. Due: 4-1-04 Threshold: 10 mV

MD
4/17/03

TIME	BKG RANGE	4324 - 6486	SOURCE RANGE	103508-155262	BAT CHECK	HV CHECK	INITIALS	INITIALS	CONFIRM
	INTL BKG CPM	POST BKG CPM	INTL SOURCE CPM	POST SOURCE CPM			INTL CHECK	POST CHECK	Y/N
0855	4637	5023	127604	125619	SAT	SAT	JCM	NY	Y/N
0649	5326	4631	126637	128797	SAT	SAT	JCM	NY	Y/N
0658	4984	4337	126411	128225	SAT	SAT	JCM	JCM	Y/N
0652	5652	4597	127240	131225	SAT	SAT	JCM	NY	Y/N
0708	5205	4551	126182	128898	SAT	SAT	R	NY	Y/N
0652	6170	4343	127684	126253	SAT	SAT	JCM	JCM	Y/N
0704	5335	4725	128053	127049	SAT	SAT	D.L.	JCM	Y/N
0640	4773	5368	128211	129120	SAT	SAT	R	R	Y/N
0647	4876	5035	127589	128214	SAT	SAT	R	JCM	Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N
									Y/N

red By: Andy J. Allen

Date: 4/17/03

Certificate of Calibration

Voltage Plateau Form



Environmental Restoration Group, Inc.
12809 Arroyo De Vista NE
Albuquerque, NM 87111
(505) 298-4224

Detector Mfg.: Ludlum Model: 44-10 Serial No.: PA122612
Counter Mfg.: Ludlum Model: 2221 Serial No.: 149938

Temp.: 70 °F Rel. Humidity 18 % Bar. Pressure 30.1 in. of Hg

Counter Threshold Setting: 10 mV Geometry / Distance to source: 6-inches

Source: Th230 @ 13,500 dpm sn: 4098-03 Tc99 @ 18,100 dpm sn: 4099-03
 Cs137 @ 8.5 µCi sn: 4054-02 Other: _____

Count Time: 1 minute(s)

High Voltage	Gross Source Counts	Background Counts
700	51281	
800	75637	
900	83689	
1000	91020	
1100	93454	
1200	94529	12916
1300	95111	
1400	117421	

Recommended Operating Voltage: 1200 volts

Calibrated By: Charles P. Furr

Calibration Date: 4/1/03

Reviewed By: Kimberly R. Baker

Calibration Due: 4/1/04

Date: 4/1/03

ATTACHMENT 2
CONTAMINATION SURVEY RECORD

Westinghouse FFCF Radiological Survey Form

Survey Desc.: Special--Black Can Per: C. Horton		Log Number				0435 S 30417 WEC					
Surveyed by:		Date:	4/17/03	Time:	13:03	Smear Area	~ 100 cm ²	Batch #:	1454		Reviewed By:
Instrument	Serial Number	Calibration Due	Probe	Probe Area (cm ²)	Alpha Bkgd	Alpha Efficiency	Alpha MDA	Beta Bkgd	Beta Eff.	Beta MDA	
Tennelec LB	4	9/3/03	GFPC	2 in. dia.	0.8	26.38%	5.95	2.7	45.15%	8.6	
ASP-2	527	8/17/03	HT-270	GM-Tube	N/A	N/A	N/A	N/A	N/A	N/A	
Lud 2224	125609	9/8/03	43-89	100	6.0	20.00%	70.53		0.00%	0.00	
Ludlum 3	171199	9/8/03	44-9	15	N/A	N/A	N/A	44.0	15.00%	223.82	

#	Description	Loose Alpha		Loose Beta		Fixed Alpha		Fixed Beta		βy Dose Rate		Limit Exceeded
		Net CPM	DPM / 100 cm ²	Net CPM	DPM / 100cm ²	Gross CPM	DPM / 100cm ²	Gross CPM	DPM / 100cm ²	Contact uRad/hr	3 Ft. uRad/hr	
1	Pc #1 Inside of can	4.13	15.6	13.73	30.4	40.0	170.0	1000.0	42488.9	40.0		42 φβ
2	Pc #1 Inside of can	13.06	49.5	29.41	65.1	40.0	170.0	1000.0	42488.9	40.0		42 φβ
3	Pc #1 Outside of can	3.18	12.1	1.87	4.1	6.0	ND	142	4355.6	19.0		4 φβ
4	Pc #1 Outside of can	10.14	38.4	10.84	24.0	6.0	ND	142	4355.6	19.0		4 φβ
5	Pc #2 insid of can	46.86	177.6	72.38	160.3	30.0	120.0	2684	117333.3	30.0		117 φβ
6	Pc #2 Inside of can	16.09	61.0	20.95	46.4	30.0	120.0	2684	117333.3	30.0		117 φβ
7	Pc #2 Outside of can	9.15	34.7	7.99	17.7	6.0	ND	120	3377.8	20.0		3 φβ
8	Pc #2 Outside of can	21.13	80.1	14.20	31.5	6.0	ND	120	3377.8	20.0		3 φβ
9	Pc #3 Inside of can	10.15	38.5	9.84	21.8	12.0	30.0	686	28533.3	35.0		28 φβ
10	Pc #3 Outside of can	10.16	38.5	7.84	17.4	12.0	30.0	120	3377.8	22.0		3 φβ
11	Bottom of can inside	59.52	225.6	144.49	320.0	48.0	210.0	880	37155.6	105.0		37 φβ
12	Bottom of can inside	45.93	174.1	56.52	125.2	48.0	210.0	880	37155.6	105.0		37 φβ
13	Bottom of can outside (Rim)	10.13	38.4	13.84	30.7	22.0	80.0	4472	196800.0	240.0		196 φβ
14	Bottom of can outside (Rim)	14.14	53.6	11.24	24.9	22.0	80.0	4472	196800.0	240.0		196 φβ

Limit Exceeded: α indicates loose alpha
 β indicates loose beta, and Δ indicates fixed readings