FINAL DRAFT: REVISION 3

FINAL STATUS SURVEY PLAN

COLONIE FUSRAP SITE

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U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT OFFICE

FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM

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LIST OF ABBREVIATIONS AND ACRONYMS

AEC .... Atomic Energy Commission
ALARA .... As Low As Reasonably Achievable
BRA .... Baseline Risk Assessment
CISS .... Colonie Interim Storage Site
CFR .... Code of Federal Regulations
m^3 .... cubic meters
CMB .... Chemical Management Building
COC .... Contaminants of concern
Conrail .... Consolidated Rail Corporation
cpm .... counts per minute
CQC .... Contractor Quality Control
CQCP .... Construction Quality Control Plan
CSXT .... Consolidated Rail Corporation
yd^3 .... cubic yards
DCGL .... Derived Concentration Guideline Level
$DCGL_{EMC}$ .... Derived Concentration Guideline Level Elevated Measurement Comparison
DNAPL .... Dense Non-Aqueous Phase Liquid
DOD .... Department of Defense
DOE .... Department of Energy
DQO .... Data Quality Objective
EE/CA .... Engineering Evaluation and Cost Analysis
EPA .... Environmental Protection Agency
FID .... Flame Ionization Detector
FIDLER .... Field Instrument for Detecting Low Energy Radioactivity
FSSP .... Final Status Survey Plan
FUSRAP .... Formerly Utilized Site Remedial Action Program
GPS .... Global Positioning System
HASP .... Health and Safety and Emergency Response Plan
HAZWOPER .. Hazardous Waste Operations and Response
HPGe .... High Purity Germanium
IT .... The IT Corp, Inc
LBGR .... Lower Bound of the Gray Region
LCYD .... Loose Cubic Yard
LDR .... Land Disposal Restrictions
LNAPL .... Light Non-Aqueous Phase Liquid
MARSSIM ...... Multi-Agency Radiation Survey and Site Investigation Manual
MDC .... Minimum Detectable Concentration
MDL .... Minimum Detectable Level
mg/L .... milligrams per liter
Mg/Kg .... Milligrams per Kilogram
NiMo .... Niagara Mohawk Power Corp.
NL .... National Lead Industries
NRC .... Nuclear Regulatory Commission
NYSDEC .... New York State Department of Environmental Conservation
ORNL .... Oak Ridge National Laboratory
OSHA .... Occupational Safety and Health Administration
PARCC .... Precision, Accuracy, Representativeness, Completeness, Comparability
PCB .... Polychlorinated Biphenyl

pCi/gm .... pico Curies/gram
pCi .... picoCuries
PCE .... tetrachloroethene *(also known as perchloroethene)*
PID .... Photoionization Detector
PPE .... Personnel Protective Equipment
QC .... Quality Control
RCRA .... Resource Conservation Recovery Act
RESRAD........ Residual Radioactivity calculation model
RPD.............. Relative Percent Difference
SAP .... Sampling and Analysis Plan
m^2 .... square meters
SOP.............. Standard Operating Procedure
SPDES .... State Pollution Discharge Elimination System
TCE .... trichloroethene
TCLP .... Toxicity Characteristic Leaching Procedure
TERC............ Total Environmental Restoration Contract
Th .... Thorium
U.................... Uranium
USACE .... United States Army Corps of Engineers
USEPA .... United States Environmental Protection Agency
VOC.............. Volatile Organic Compound
VPs............... Vicinity Properties
WAC .... Waste Acceptance Criteria
XRF .... X-Ray Fluorescence Spectroscopy
1,2-DCE......... 1,2-dichloroethene

1.0 INTRODUCTION

The U.S. Army Corps of Engineers (USACE) is actively remediating soil contamination at the former National Lead Industries (NL) site (herein referred to as the "Colonie Site") and three adjacent vicinity properties (VPs), hereafter referred to as the Colonie Site. The Colonie FUSRAP Site is located in the Town of Colonie, Albany County, New York. This remedial effort falls under the USACE's Formerly Utilized Sites Remedial Action Program (FUSRAP), which was established to identify, investigate, and clean up or control sites previously used by the Atomic Energy Commission (AEC) and its predecessor, the Manhattan Engineer District.

The IT Corp ("IT") has assumed the ICF Kaiser Engineers, Inc. (ICF Kaiser) obligations under the USACE Total Environmental Restoration Contract (TERC) No. DACA 31-95-D-0083, Task Order No. 24/40, and is the remedial action contractor for the Colonie Site. The goal of this remedial effort is to complete the Colonie Site's remedial objectives as described in Action Memorandum for soil removal at the Colonie Site ("Action Memorandum") (U.S. Army Corps of Engineers, 2001). Our previously published Site Operations Work Plan (IT Corp., February 2002 or most recent version) provides a description of the remedial efforts, site history and background information.

The general site location is shown in Figure 1. The site conditions as of December 2001 are shown in Figure 2. The Site Operations Work Plan contains all necessary information relative to the site history, site background, and the site's ongoing remedial activities. Significant documents, reports and other submittals have been made concerning the work completed over the period since mobilization in 1998. This Final Status Survey Plan (FSSP) does not include this information, as the Operations Work Plan should be consulted directly for that information.

Colonie Site remediation will be conducted in accordance with USACE's December 2001 Final Soil Removal Action Memorandum and the supporting June 2001 Technical Memorandum. The selected remedial alternative is generally described as "Alternative 2B: large scale excavation and off-site disposal" from the 1995 Department of Energy's (DOE) Engineering Evaluation and Cost Analysis Report (EE/CA). Radiological surveying to confirm that the residual site soils meet the radiological cleanup goals contained in the Action Memorandum will be conducted in accordance with the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) Environmental Protection Agency (EPA), Dec 1997. This FSSP details how the survey will be conducted and how the results will be evaluated. Testing requirements to determine the site's objectives with respect to chemical contaminants of concern (COC) are contained in the Sampling and Analysis Plan (SAP) IT Corp., February 2002 or most recent version) and are not addressed in this document. Sampling for chemical contaminants of concern will be conducted concurrent with these final status survey efforts.

The Niagara Mohawk substation vicinity property has been previously released from radiological controls as of this writing and as such, it will be not considered an "affected area" for this plan. Please see USACE's Final Draft Focused Site Investigation Report: Niagara Mohawk Power Station, Colonie NY, April 2000, as well as the New York State Department of Environmental Conservation (NYSDEC) correspondence accepting the report for details on the Niagara Mohawk site status.

2.0 HISTORICAL INFORMATION REVIEW

To support a remedial action decision, several site characterizations have been performed at the Colonie Site (excluding vicinity properties) during 1978 - 1997. A brief summary of previous efforts is presented below.

Atcor Survey (Atcor, 1978)

In 1978, Atcor conducted a radiological survey of the National Lead Industries (NL) building and equipment to assess plant operations being conducted at the time. High levels of beta-gamma radiation and external gamma radiation were found on essentially all floor areas that were surveyed.

Teledyne Isotopes Survey (Teledyne Isotopes, 1980)

The purpose of the 1980 Teledyne Isotopes survey was to determine the extent of surface soil contamination on the NL property and its vicinity resulting from stack emissions from the plant. Samples were collected from various quadrants surrounding the plant and from low-lying areas where contamination could have collected. Contamination was detected on all portions of the NL property that could be surveyed.

Teledyne Isotopes Survey (Teledyne Isotopes, 1981)

In 1981, Teledyne Isotopes conducted a second survey of the NL site to determine the extent of subsurface soil contamination. The survey identified three subsurface contaminated areas on the NL property. Daughter isotopes of Th-232 are identified in an area of the former Patroon Lake northwest of the building footprint.

Bechtel National Inc (BNI) Geological and Hydrogeological Investigation (1984)

This investigation consisted of stratigraphic characterization, field permeability tests and geotechnical analysis. Five stratigraphic units and the two groundwater systems were identified. The tests also set hydraulic conductivity values and established primary hydrogeologic characteristics such as groundwater flow direction and gradients.

Oak Ridge National Laboratory Survey (ORNL, 1988)

The ORNL survey determined that some radiological measurements of the adjacent Conrail property were in excess of Department of Energy's original cleanup criteria.

Characterization Report for the Colonie Site (BNI, 1992)

The Characterization Report summarized existing data from previous investigation efforts. The information presented in the Characterization Report was used in developing the Engineering Evaluation and Cost Analysis (EE/CA) alternatives.

Engineering Evaluation and Cost Analysis (DOE, 1995)

An EE/CA was performed to identify, develop, and evaluate remedial action alternatives for the site, based on the nature and extent of contamination documented in the remedial investigation report. The report also evaluated the potential environmental consequences of the various remedial action alternatives identified. Seven alternatives were evaluated, ranging from no action to complete excavation with offsite disposal. This document established the initial site residual contaminant guidelines for U-238 at 35 pi/gm and Th-232 at 15 pCi/gm. Additionally, this document allowed for the on-site internment of soils contaminated with U-238 between 35-100 pCi/gm.

Employee Exposure Risk Assessment (BNI, 1997)

A baseline risk assessment (BRA) was conducted which presented the findings of an assessment to determine the human health and ecological risks posed by the presence of radioactive and associated chemical contamination. The BRA concluded that radioactive and chemical contaminants at the Colonie Site could result in risks to human health and ecological resources. Major potential human radiation exposure pathways identified were direct external radiation and inhalation of particulates.

Action Memorandum for Soils Removal at Colonie Site and Supporting Technical Memorandum, (USACE, 2001)

Radiological and chemical risk assessments were conducted to support the decision making process for the Action Memorandum at the Colonie Site. These documents concluded that radioactive and chemical contaminants at the Colonie Site resulted in unacceptable risks to human health. Further, the document lowered the residual Th-232 contaminant concentration to 2.8 pCi/gm in excess of background. The U-238 concentration remained at 35 pCi/gm in excess of background and the allowance for on-site internment was removed.

3.0 FINAL STATUS SURVEY DESIGN

The final status survey design process begins with development of data quality objectives (DQOs). The DQOs are then used in conjunction with the radiological conditions at the site to calculate the number and locations of measurement and sampling points to demonstrate compliance with the release criterion. Survey techniques and analytical methodologies are selected to generate the required analytical data. Once the analytical data is received from the laboratory and validated, it is evaluated using statistical techniques to test against the hypothesis stated in section 3.1.2. Sampling, as discussed in this and subsequent sections, refers to the collection of information. "Sampling" includes scanning surfaces with radiological and X-Ray fluorescence equipment as well as the physical collection of media for on-site and off-site laboratory analysis.

3.1 DATA QUALITY OBJECTIVES

DQOs for the Colonie Site were developed in accordance with "Guidance for Planning for Data Collection in Support of Environmental Decision Making Using the Data Quality Objectives Process" (USEPA, 1994a), as directed by MARSSIM (USEPA, 1997). The following steps were used in the development of DQOs for the site.

3.1.1 Problem to be Resolved

The selected remedial alternative in the Action Memorandum for implementation at the Colonie Site includes excavation and offsite disposal of soils that contain (1) U-238 activity greater than 35 pCi/gm in excess of background and/or (2) Th-232 activity greater than 2.8 pCi/gm in excess of background. Demonstrating that chemical contaminants meet cleanup values in the Action Memorandum will be addressed in the individual FSS Unit Reports.

3.1.2 Decision to be Made

Following remediation of a given survey unit or area of the site, it must be determined if the site-specific cleanup guideline has been met, or if further remediation is warranted. Therefore, the decision to be made can be stated: "Do the Final Status Survey Unit soils contain less than 35 pCi/gm in excess of background U-238 AND contain less than 2.8 pCi/gm in excess of background Th-232." The null hypothesis (H_o) as required by MARSSIM is stated and tested in the negative form: "The median concentration in the survey unit exceeds that in the reference area by more than the $DCGL_W$."

3.1.3 Inputs to the Decision

Inputs to the decision include the type, quality, and quantity of data that will be sufficient to make decisions. The type refers to the radiological data needed for the survey unit soils. Quality refers to various aspects of the analytical data collected such as precision, accuracy, representativeness, comparability, and completeness (PARCC), required and achieved detection limits, and data validation documentation requirements. Validation that the resulting data meets the agreed-to PARCC values will ensure the 'quality' of the information and allow the results to be used in testing the site cleanup hypothesis. Quantity refers to the amount of data necessary to confirm compliance with the release criteria, and is determined as part of the design process. Data quality requirements are provided below.

3.1.3.1 Precision

Precision refers to the level of agreement among repeated measurements of the same parameter. The overall precision of a piece of data is a mixture of sampling and analytical factors. The analytical precision is much easier to control and quantify because the laboratory is a controlled, and therefore measurable environment. Sampling precision is unique to each site, making it much harder to control and quantify.

As described in Section 3.7, each physical soil sample obtained from an individual field survey unit is also subjected to a static count prior to obtaining the soil sample. Field instrument sampling precision will be checked by obtaining a minimum of ten replicate static measurements for every survey unit. Precision will be evaluated by calculating the relative percent difference (RPD) for each replicate pair. It is expected that the field instrument replicate pairs will generally have RPDs $\pm 2\delta$ %.

Laboratory sampling precision will be checked by obtaining a minimum of one replicate sample for every 20 physical soil samples collected in a given survey unit. Precision will be evaluated by calculating the RPD for each replicate pair. It is expected that the soil field replicate pairs will generally have RPDs $\leq$50%.

Laboratory precision will be evaluated by following the procedures outlined in the Sampling and Analysis Plan: Quality Control and Quality Assurance Sections. This generally involves the minimum analysis of one replicate sample or recount of previously sampled location for every sample batch. A sample batch is defined as a group of samples which behave similarly with respect to the sampling or testing procedures being employed. For quality control (QC) purposes, a group of twenty samples of similar physical media collected within one work week, or all such samples collected in a work week (if less than twenty), whichever occurs first, is considered a 'batch'. The RPD for each analytical parameter will be calculated and compared to a method-specific precision criteria derived from historical performance data. If these criteria are not met, a careful examination of the sampling techniques, sample media, and analytical procedure will be conducted to identify the cause of the high RPD and define the usability of the data.

3.1.3.2 Accuracy

Accuracy refers to the difference between a measured value for a parameter and the true value for the parameter. It is an indicator of the bias in the measurement system. Field instrument accuracy will be evaluated by comparing the static count measurement at each soil sample location with the laboratory result. The accuracy should be consistent with those from the correlation data. Laboratory accuracy will be evaluated by the analysis of one method blank per sample batch and one spiked sample per sample batch as applicable for radionuclides - see the Sampling and Analysis Plan for further details of the lab QC requirements. The accuracy of all analyses must be within historically derived, method-specific criteria.

3.1.3.3 Representativeness

Representativeness is a measure of the degree to which the measured results accurately reflect the medium being sampled and the overall situation at the site. It is a qualitative parameter which is addressed through the proper design of the sampling program in terms of sample location, number of samples, and actual material collected as a sample of the whole.

The final status survey unit sampling program has been designed in accordance with the guidance given in MARSSIM (USEPA, 1997), to ensure that the appropriate statistically derived number of samples are collected during final status surveys. Sampling protocols discussed in the SAP have been developed to assure that samples collected are representative of the media. Field handling protocols (e.g., storage, handling in the field, and shipping) have been designed to preserve the integrity of the collected samples. Proper field documentation and QC efforts outlined in the Contractor's Quality Control Plan (IT Corp, 2000 or most current version) will be used to establish that protocols have been followed and that sample identification and integrity have been maintained.

3.1.3.4 Comparability

Comparability expresses the confidence with which one data set can be compared to another. When comparing data, it is important to compare data collected under the same set of conditions. Seasonal trends, depth of sample collection, analytical protocol, method detection limits, and any other sampling/analytical variables must be taken into account when comparing data sets. This is accomplished via the SAP using established USACE methods for collecting the samples, using USEPA methods for chemical analyses, using other published and documented methods for physical and radiological analyses, and documenting the methods used.

3.1.3.5 Completeness

Completeness is a measure of the amount of information that must be collected during the final status survey to allow for successful achievement of the project objectives. The overall objective of the remediation at the site is to remove contaminants exceeding the cleanup criteria presented in USACE's Final Action Memorandum and supporting Technical Memorandum.

A certain amount and type of data must be collected for each final status survey unit to be valid. The statistically-derived number of samples has been calculated in accordance with MARSSIM (USEPA, 1997). Missing data may reduce the precision of estimates or introduce bias, thus lowering the confidence level of the conclusions. The completeness goal for each final status survey will be 95% (areal) for the field sampling and 95% (number) for the laboratory analyses. The importance of any lost or suspect data will be evaluated in terms of the sample location, analytical parameter, nature of the problem, decision to be made, and the consequence of an erroneous decision. Critical locations or parameters for which data are determined to be inadequate may be resampled.

3.1.3.6 Sensitivity

Sensitivity refers to the ability to detect a minimal amount of a substance, and is typically expressed as the method detection limit, practical quantitation limit, or reporting limit. Radiological analyses must indicate if the soil remaining at the site has met the cleanup criteria. Therefore, the required off-site analytical laboratory minimum detectable level (MDL) has been set at 1 pCi/gm of U-238 and 1 pCi/gm of Th-232. Field instrument scan minimum detectable concentration (MDC) has been set to 9 pCi/gm for U-238 and 1.8 pCi/gm for Th-232. The scan MDC calculation is provided in Appendix D.

The correlation between gamma radiation to soil activity levels is based on an historical correlation study conducted by TMI on behalf of the Department of Energy in 1993 and is supplemented by studies conducted by The IT Corp and Argonne National Laboratory (ANL). These correlation studies will continue to be supplemented with data from the FSS Units.

3.1.4 Boundaries of the Study

Spatial boundaries of the decision statement are limited to the radiological contaminants within the residual on-site soils following remediation. Collected data will represent current radiological site conditions as well as radiological site conditions as they are expected to exist over the next 1,000 years, including normal radioactive decay products.

3.1.5 Decision Rules

If the concentration of residual U-238 and Th-232 radioactivity in the soils of a given survey unit is below 35 pCi/gm in excess of background and 2.8 pCi/gm in excess of background respectively, the survey unit is clearly in full compliance with the release criterion. The MARSSIM process specifically includes the use of elevated measurements as a component of radiation surveys and site investigations. Elevated areas should be rare as remediation activities are being rigorously conducted. "Hotspot criteria" will be a multiple of the clean-up criteria.

As with previous versions of the FSSP prepared for the Colonie Site, the maximum value for "hot spots" or elevated measurements will remain at field instrument readings indicating contaminant concentrations exceeding the 0.05% exemption set within 10 CFR 40.13. This criteria equates to levels of 174 pCi/g for U238 and 54.5 pCi/g for Th 232. Any such "hot spots" identified (if any) during the cross-walk of the final excavation surface will be plotted on survey unit maps. This hot spot plot will be evaluated to identify areas which may require additional evaluation based on spatial distribution of the elevated measurements.

The fact that the Colonie Site manufactured lead and lead based products long before radioactive materials or components were introduced is generally accepted in the site history and characterizations. Accordingly, the radiological contamination is expected to be completely removed before the Action Memorandum specified metals clean-up goals are achieved. See the Site Operations Work Plan for a detailed discussion of the excavation efforts in support of the removal and sampling for chemically contaminated soils that are generally being encountered below the applicable site radiological criteria.

The correlation between daughter gamma radiation to soil activity levels is based on an historical correlation study conducted by TMI on behalf of the Department of Energy in 1993 and is supplemented by a study conducted by The IT Corp in 1999. These correlation studies will be supplemented with data from the FSS Units. Copies of both the TMI study and The IT Corp's correlation efforts are included in Appendix A.

3.1.6 Acceptable Decision Errors

DQO guidance indicates that the worst-case scenario should be assumed as the null hypothesis; the data is then required to prove that the worst-case scenario does not exist. The null hypothesis can be stated thus: "The median concentration in the survey unit exceeds that in the reference area by more than the $DCGL_W$". It is then incumbent on the data to show otherwise.

Site measurement data are used to estimate the actual site conditions and decisions based on the measurement data could be in error (known as decision error). Statistical sampling designs in accordance with MARSSIMS attempts to control design error by defining the types of errors and incorporating them in the statistical sampling design process.

The possible types of decision errors include:

- Type I errors (α): Concluding that residual radiological contamination does not exceed the cleanup criteria when it actually exceeds the criteria.

- Type II errors (β): Concluding that residual radiological contamination exceeds the cleanup criteria when it actually is below the criteria.

Type I and Type II errors have distinctly separate consequences. Type I errors have human health consequences (the residual radiological risk at the Colonie Site could lead to excess human health problems), political consequences (local, state, and federal officials may face undue pressure if it is discovered that the site may not have been adequately cleaned up), and cost consequences (the cost of excavating selected portions of the site after remediation is complete would be significant).

Type II errors do not have residual risks but rather have cost and resource consequences (the manpower, equipment, and disposal costs associated with excavating and disposing of material that already meets the cleanup criteria is an unnecessary expense).

Several different scenarios were then evaluated for Type I and Type II errors. Based on the discussions above, Type I errors are the more significant errors due to human health and political consequences. The NYSDEC has determined that a Type I error value of no greater than 0.025 would be acceptable. The USACE project team has advised that based on the probability that lead-containing soils requiring remediation are likely to exist at depths below the anticipated levels of radiological contamination, a Type II error value of 0.1 was acceptable.

3.1.7 Sampling Design

Information presented in the previous characterization documents indicated the concentrations of U-238 and Th-232 in background measurements were low compared to the cleanup criteria, however; the Technical Memorandum and Action Memorandum has lowered the Thorium cleanup criteria to 2.8 pCi/g from 15 pCi/g, close to background. Therefore, MARSSIMS Manual Table 5.3 "Contaminant is Present in Background" was used to determine the number of final status survey samples needed in each survey unit.

The derived concentration guideline level (DCGL) is defined in MARSSIM as a radionuclide-specific concentration that could result in a member of the public dose at the allowed limit or meeting a specific allowed risk. For the Colonie Site, the DCGL is defined in the Action Memorandum as 35 pCi/gm in excess of background for U-238 and 2.8 pCi/gm in excess of background for Th-232. The lower bound of the gray region (LBGR) has been initially selected as half of the action levels. Therefore the delta-value, Δ, for the U-238 is 17.5 and for Th-232 is 1.4. The MARSSIM DQO process requires a subsequent review of the selected LBGR value as survey unit data becomes available.

Current site data representing seventy (70) individual soil samples/sample locations was used to determine the standard deviation for U-238 and Th-232 analyses of site soils. Table 1 shows the site data used to calculate the standard deviation. This data is a combination of samples from initial FSS efforts in 2000 and the more recent work associated with the time sensitive replacement of the stormwater culvert that transects the site. Table 2 presents the statistical information for the data in Table 1. The standard deviations were determined to be 5.35 for U-238 and 0.25 for Th-232. As the post-excavation surfaces will likely contain some low level of residual activity, the distance between the DCGL and the LBGR was selected as the initial best estimate. This is a conservative assumption since the lead cleanup criteria is generally resulting in a deeper and larger excavation than would be required solely for radiological contaminants of concern.

The delta over sigma value for U-238 is 3.3 (17.5/5.35) and for Th-232 the value is 5.6 (1.4/0.25). Since the calculated delta over sigma value for Th-232 exceed the highest value contained in Table 5.3 of the MARSSIMs Manual, the maximum value of 4 is utilized. MARSSIMS Manual Table 5.3 yields a total of 9 samples (N/2) required from each final status survey unit (FSSU) for U-238 and for Th-232 to satisfy the MARSSIM process and 9 samples are required in the reference area. Based on requirements of the NYSDEC with respect to sampling for chemical COCs, the actual number of samples obtained from a survey unit will be rounded upwards to the nearest whole number divisible by three, i.e. 8 samples would actually result in a minimum of 9 samples being obtained. In this case, the 9 samples are divisible by three and no rounding is required. The predicted measurement error will be reevaluated based on the sampling results as the MARSSIM process proceeds through the FSS process and through continued use of the Wilcoxon Rank Sum Test for evaluating DCGL compliance.

3.2 SURVEY UNIT LAYOUT

3.2.1 Classification

MARSSIM (USEPA, 1997) defines three classes of survey units: 1, 2, and 3. The Colonie Site has only Class 1 areas based on the Characterization Report. Class 1 MARSSIMS units are areas that have, or had prior to remediation, a potential for radioactive contamination or known contamination that exceed the DCGLs. Examples include site areas subjected to remediation, leak or spill locations, and former burial or disposal areas. Class 1 areas can be up to 2,000 sq. meters in area.

All areas within the site boundaries will be considered "affected" and Class 1. All Colonie FUSRAP Site Final Status Survey Units will be as close as feasible to 1,999 square meters in size. Smaller units and/or oddly shaped units may be required due to limitations associated with the site physical conditions, infrastructure, and property lines.

3.2.2 Delineation

As each successive unit is defined in the field, based on various physical and scheduling parameters, the individual unit will be subjected to civil surveying effort and a FSS Unit map produced. Each successive FSS Unit map will be added to previous FSS Unit mapping efforts to provide a site wide updated final status survey map. Figures 3 and 4 provide examples of the FSS Unit location and topographic survey/sample location maps that will be prepared for each Survey Unit. IT Corp will follow the same general concept of survey area lay-out such as minimum dimensions and surface area per unit for all Final Status Survey Units designated. However, each individual area will be defined as the work progresses based on physical site constraints, such as power poles and drainage culverts.

All areas of the site will eventually be subjected to a final status survey. As each unit is laid-out, the area lay-out/survey unit dimensions will be shown in an updated final status survey figure. In general, the use of triangular sample grids, as recommended in MARSSIM, will be followed. However, exceptions will be allowed to work around specific site physical constraints.

3.3 PHYSICAL SAMPLE LOCATIONS

The physical sample locations within each survey unit will be laid out using a triangular grid. The distance between survey locations (L) will be determined as detailed in MARSSIM section 5.5.2.5, knowing the actual area of the survey unit and the number of samples. The distance between rows of survey points will be calculated. For example, with a 2,000 sq. meter area and 9 samples, the distance will be the square root of the product of the area divided by 0.866 times the number of samples. The layout of the final status survey sample locations will be determined utilizing a random starting point as per MARSSIM, and laid out in a triangular pattern with each sample location being "L" distance away from the previous location. Therefore, the exact sample locations will be dependent on the random starting locations. If the location of the 9 samples do not all fall within the boundaries of a sampling unit then additional randomly selected locations within the sample unit will be determined such that 9 samples are collected within each survey unit. Appendix B contains an example calculation showing how FSS samples are located per MARSSIMS section 5.5.2.5.

3.4 FIELD INSTRUMENT SURVEY METHODOLOGY

Following excavation from a particular survey unit, a field scan of the survey unit will be conducted using a thin window low energy X-Ray detector - thin window Field Instrument for Detecting Low Energy Radioactivity (FIDLER). If the field scan indicates selected areas with elevated radioactivity (> DCGL), those areas will be further excavated and the resulting fresh surface soil field scanned. Details are provided below.

Field Scanning:

Surface soil scans will provide 100% coverage of the survey units. This is accomplished using a cross-walk approach where the survey unit is walked in a north-south direction followed by a complete walk in the east-west direction. This process minimizes the probability of an area of significant size being missed in the cross-walk survey. Additional biased field scanning will be conducted in other areas if deemed appropriate.

Field scanning will be performed using a FIDLER gamma scintillation detector with a single channel scaler/rate meter. The FIDLER shall be combined with a Global Positioning System (GPS) and a data logging instrument which marries the FIDLER reading with the GPS position data every two (2) seconds. Appendix B contains an example of the field survey data in table form that will be generated for each FSS field survey. This particular data is associated with a cross-walk conducted between Culvert Stations 1+00 and Station 1+50 during the culvert replacement work.

The resultant radiological walkover data and GPS location data will be downloaded into the ArcView plotting program to provide a graphic description of the cross-walk survey efforts. Figure 5 is an example of a representative cross-walk data plot and shows that all FIDLER readings are below the conservative correlation value of 13,001 cpm (green dots). Readings between 13, 001 and 33,400 cpm are yellow dots (indicating levels greater than 35 pCi/gm in excess of background and less than 167 pCi/gm) and readings over 33,401 cpm are plotted in red (indicating levels greater than 167 pCi/gm). These levels correspond directly with limits on the various waste disposal sites currently authorized by USACE for disposal of Colonie materials. For additional information and details on the correlation studies please see Appendix A.

The walkover data and the data plots will be evaluated by IT Corp staff and presented to the USACE staff in accordance with the USACE CQC plan for the site.

Based on these evaluations the following activities will occur:

> The data is deemed acceptable and physical sampling for off-site analytical will be conducted; or
>
> The data indicates small areas of elevated activity less than the "hot spot" criteria in magnitude; or
>
> The data indicate elevated measurements/hotspots above the specified levels and additional excavation is required. The survey unit requires additional remediation.

Sample Collection:

Surface soils samples will be collected at the specified 9 locations in each respective survey unit. Each FSS sampling event will be discussed and scheduled in advance of the actual sampling at the weekly project progress meeting to allow USACE and/or others to make necessary arrangements to observe and/or to identify the desire for spilt samples. At each physical sample location, a field scan using the appropriate field instrument (FIDLER, 2 by 2 or both) will be performed immediately prior to sample collection so that the current correlation between field scans and laboratory analytical data can be updated. This field scan will consist of a one (1) minute duration count reading at each of the 9 physical soil sample locations.

Samples will generally be described as right circular cones of approximately 6 inch diameter by 6 inch deep plug from each location. Samples will be placed in a clean aluminum tray and homogenized to the extent practicable. Once the sample has been mixed, an approximate 500 gram sample will be collected. Each sample will be identified with a unique sample ID number in accordance with IT's Sampling and Analysis Plan (SAP, February 2002 or most recent version). Full details on sample numbering, documentation, custody, and shipping can be found in the SAP. Quality control measures associated with FSSP efforts are conducted as described in the IT Corp's revised Contractor Quality Control Plan (CQCP, February 2002 or most recent version).

3.5 SAMPLE ANALYSES

The final status survey soil samples will be subjected to a series of analyses. In-situ field tests will be obtained at each sample location prior to sample acquisition. A one minute static count using the FIDLER will be obtained and compared to the most recent correlation between field readings and radioactivity. A second in-situ field analysis will be obtained for inorganic contaminants of concern using the Niton field X-Ray fluorescence instrument. Procedures for obtaining field X-Ray Fluorescence Spectroscopy (XRF) data are detailed in the Site Operations Plan (February 2002 or most recent version). The soil samples are then physically collected as noted above and as per the procedures detailed in the Sampling and Analysis Plan. All FSS samples will be analyzed for radioactive contaminants of concern using the on-site High Purity Germanium (HPGe) detector.

The final confirmatory analysis will be completed by shipping the samples to a USACE certified laboratory. The off-site analysis will provide confirmation of radiological concentrations via alpha spectroscopy for both Isotopic Uranium and Thorium. The laboratory will report the isotope(s) detected, minimum detectable activity, measurement error and detected activity (in pCi/gm) at a minimum. Additional off-site analysis will be completed for total metals to provide confirmation of total lead, total copper and total arsenic levels in the samples. Where appropriate, TCL volatile analysis will also be conducted per the site Operations Work Plan and the Sampling and Analysis Plan. Each of the FSS samples will be archived on-site for future use as USACE sees fit.

3.6 QA/QC

Over-all quality control will be provided as described in the Contractor's Quality Control Plan (February 2002 or most recent version) governing site operations. Analytical laboratories will follow the QC requirements specified in the SAP. QA/QC for on-site analysis will be provided via daily pre and post instrument calibration efforts. In addition, replicate, matrix spike, and matrix spike duplicate samples will be collected as described in the SAP at a rate of one per 20 samples. A minimum of one blind replicate sample will be analyzed from each survey unit. USACE's quality assurance laboratory will also receive a minimum of one split sample from each survey unit. Additional split samples will be obtained as directed at the time of sampling based on USACE's direction. All of IT's replicates will be analyzed by the off-site analytical lab for the same radiological parameters as the primary survey samples.

3.7 DATA INTERPRETATION

Interpretation of the analytical data will be conducted per IT Corp's SAP and QAPP as well as in accordance with MARSSIM Chapter 8. The following methods will be employed, although the data itself may indicate that alternate tests are more appropriate. The reader is directed to the SAP for a full and complete discussion of the data quality reviews that will occur in advance of any data assessment with respect to radiological clean-up criteria.

Data Assessment: The first step in the assessment will be data verification to verify that field work was conducted as planned. A review of all field documentation will be conducted to determine if the correct sampling methods were performed, instrumentation and equipment operated properly, deviations from the planned methods were documented, and the deviations will result in data that meets the objectives of the sampling.

Preliminary Data Review: All of the values will be compared with the DCGL. If all values from one survey unit are below the DCGL, the survey unit has clearly met the cleanup criteria. If all values from a survey unit are above the DCGL, the survey unit has clearly not met the cleanup criteria.

Assuming a range of values bracketing the DCGL are obtained from a survey unit, the mean, standard deviation, and median will be calculated for the data from each survey unit. The following checks will be performed:

- If the mean > DCGL, the survey unit has not met the cleanup criteria.
- The standard deviation will be compared to that used during sample design to ensure that an adequate number of samples were collected.
- The mean will be compared with the median. If there appear to be large differences, the skewness of the data set will be further examined.

- The data may be displayed on a map of each individual survey unit (posting plot). The display may indicate one or more areas of the survey unit that are above the DCGL.
- The laboratory data will be plotted with a quartile plot or histogram to examine the potential for outliers or trends in data.
- The laboratory data set will be tested using the Wilcoxon Rank Sum test as described in MARSSIM to determine if a survey unit can be considered clean.

Elevated Measurement Comparison: If required for data assessment purposes, the Derived Concentration Guideline Level for Elevated Measurement Comparison (DCGLEMC) will be calculated in one of the following manners:

Elevated measurements will not exceed the 0.05% exemption set within 10 CFR 40.13 (i.e. 174 pCi/g U238 and 54.5 pCi/g Th 232) OR DCGLEMC = (area factor) x (DCGL) with the appropriate area factor from the RESRAD run.

The area factor is the magnitude by which the concentration within a small area of elevated activity can exceed the DCGL while maintaining compliance with the release criteria. Outdoor area factors were calculated using the Residual Radioactivity Calculation Method (RESRAD) 5.82 (USDOE, 1993). The RESRAD model outputs are included in Appendix C. All exposure pathways were calculated assuming a concentration of 35 pCi/g U-238 and 2.8 pCi/g Th-232. The area of contamination was set at 2000 m2, which set the area factor equal to one. Area factors for the other sizes were determined by utilizing all RESRAD defaults and changing only the area of the contamination zone. The area factor was then computed by taking the ratio of the dose per unit concentration generated by RESRAD (2000 m2) to that generated for the other areas listed. These area factors are listed as follows:

Area Factors for U-238 and Th-232 As Applicable to the Colonie Site

Area Factors for U-238 and Th-232 at the DCGL Value									
Area: (m2)	1	5	10	50	100	500	1000	1500	2000
Area Factor	23.46	7.92	5.28	3.29	2.87	1.65	1.12	1.01	1.00

Each measurement from the survey unit will be compared with the DCGL. Values above the DCGL will be further investigated and compared to the $DCGL_{EMC}$, as appropriate. The actual size of the affected area will be determined by returning to the suspect sample point and using the FIDLER detector to define the elevated measurement boundary. The area factor can then be determined based on the actual area, the $DCGL_{EMC}$ calculated, and the comparison made between the measured activity level and the $DCGL_{EMC}$.

For example, if field scanning determines an actual area of 100 m^2 with elevated activity, the combined area factor would be 2.87 and the $DCGL_{EMC}$ would be 100.5 pCi/g U-238 (2.87 x 35) and 8.0 pCi/g Th-232 (2.87 x 2.8). If the elevated area sample concentrations exceed the $DCGL_{EMC}$, it requires further investigation and remediation as appropriate. If the concentrations are less than the $DCGL_{EMC}$, then the Wilcoxon Rank Sum Test will be used to determine if the total number of elevated areas within a survey unit are within the statistical allowance of the test. Survey units passing this test will not require additional excavation, however; if it fails this test then further remediation is required, followed by resampling of the re-excavated areas. The Wilcoxon Rank Sum Test is performed as outlined in the following six steps by MARSSIM:

Step 1

Obtain the adjusted reference area measurements, Zi, by adding the DCGLW to each reference area measurement, Xi. Zi = Xi + DCGLW.

Step 2

The m adjusted reference measurements, ZI, from the reference area and the n measurements, YI, from the survey unit are pooled and ranked in order of increasing size from 1 to N, where N = m + n.

Step 3

If several measurements are tied (i.e., have the same value), they are all assigned the average rank of that group of tied measurements.

Step 4

If there are *t* less than (<) the decision level (L_c) values, they are all given the average of the ranks from 1 to *t*. Therefore, they are all assigned the rank $t(t+1)/2t = (t+1)/2$, which is the average of the first *t* integers. If there is more than one detection limit, all observations below the largest detection limit should be treated as < values.

Step 5

Sum the ranks of the adjusted measurements from the reference area, Wr. Note that since the sum of the first N integers is N(N+1)/2, one can equivalently sum the ranks of the measurements from the survey unit, Ws, and compute Wr = N(N+1)/2 - Ws.

Step 6

Compare Wr with the critical value given in MARSSIM Table I.4, Critical Values for the WRS Test, for the appropriate values of n and m. If Wr is greater than the tabulated value, reject the Null Hypothesis that the survey unit exceeds the release criterion.

Draw Conclusions: Possible conclusions which can be drawn during data interpretation are as follows:

1. The sum of the reference area ranks is greater than the critical value (the null hypothesis is rejected) and the survey unit has met the release criteria.

2. The sum of the reference area ranks is less than the critical value and the survey unit has not met the cleanup criteria. Additional remediation is required, followed by a new final status survey.

Prepare Report: Results of each successive final status surveys will be compiled into separate Final Status Survey Reports for the individual unit. These reports will detail the survey unit location and physical dimension/size, cross-walk field scan data maps, field scan data files, physical sampling locations, in-situ field data, on-site analytical data, off-site analytical data, data assessment, data validation, data review, statistical tests performed, and conclusions drawn from each survey unit. Each successive FSS unit map will be added to the previous FSS unit mapping to maintain a global perspective on the progress of the final status surveying efforts. This base map will also include any other relevant updates to the site conditions based on other remedial activities.

4.0 REFERENCES

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USEPA, 1997. Multi-Agency Radiation Survey And Site Investigation Manual (MARSSIM), EPA402-R-97-016 (NUREG-1575). DOD, DOE, NRC, USEPA, December 1997.

U.S. Army Corps of Engineers (USACE), 2001. Final Technical Memorandum in Support of a Proposed Action Memorandum, Colonie FUSRAP Site, June 2001.

U.S. Army Corps of Engineers (USACE), 2001. Action Memorandum Revising Department of Energy (DOE) Action Memorandum dated February 14, 1997 Soil Removal at the Colonie FUSRAP Site, December 2001.

TABLE 1
Sample Data Summary
Colonie FUSRAP

SAMPLE ID	ISOTOPIC THORIUM RESULTS	ISOTOPIC URANIUM RESULTS
Culvert 0+25	0.514	2.01
Culvert 0+75	0.335	0.808
Culvert 1+25	0.547	0.546
Culvert 1+25R	0.329	2.40
Culvert 1+75	0.362	24.4
Culvert 2+25	0.415	0.304
Culvert 2+75	0.595	0.256
Channel 0-25	0.134	0.309
Channel 0-75	0.367	0.429
Channel 1-25	0.132	0.851
CFS-SWK-01	0.491	3.10
CFS-SWK-01D	0.424	3.35
CFS-SWK-02	0.442	5.04
CFS-SWK-03	0.409	1.51
CFS-SWK-04	0.471	4.22
CFS-SWK-05	0.336	3.32
CFS-SWK-2A	0.328	0.50
CFS-SWK-4A	0.278	0.481
NHW-1	0.216	0.323
NHW-2	0.138	0.353
NHW-3	0.384	0.387
NHW-4	0.314	1.82
NHW-5	0.261	0.425
CFS-01-01	1.09	6.05
CFS-01-02	0.768	1.45
CFS-01-03	0.879	1.58
CFS-01-04	1.05	1.69
CFS-01-05	0.856	3.10
CFS-01-06	0.615	1.93
CFS-01-07	0.546	1.65
CFS-01-08	0.761	2.22
CFS-01-09	0.867	1.80
CFS-01-10	1.08	2.29
CFS-01-11	0.547	1.94
CFS-01-12	0.517	5.79
CFS-01-13	0.477	2.00
CFS-01-14	0.542	8.74
CFS-01-15	0.300	2.05
CFS-01-16	0.9398	0.5648
CFS-01-17	0.7448	0.8911
CFS-01-18	0.7236	2.65
CFS-01-19	0.8263	1.285
CFS-01-20	0.8201	1.219
CFS-01-21	0.5365	4.426
CFS-01-22	0.4918	1.087
CFS-01-23	0.7101	0.9625
CFS-01-24	0.8314	1.897
CFS-01-25	0.6719	24.29
CFS-01-26	0.8506	1.933

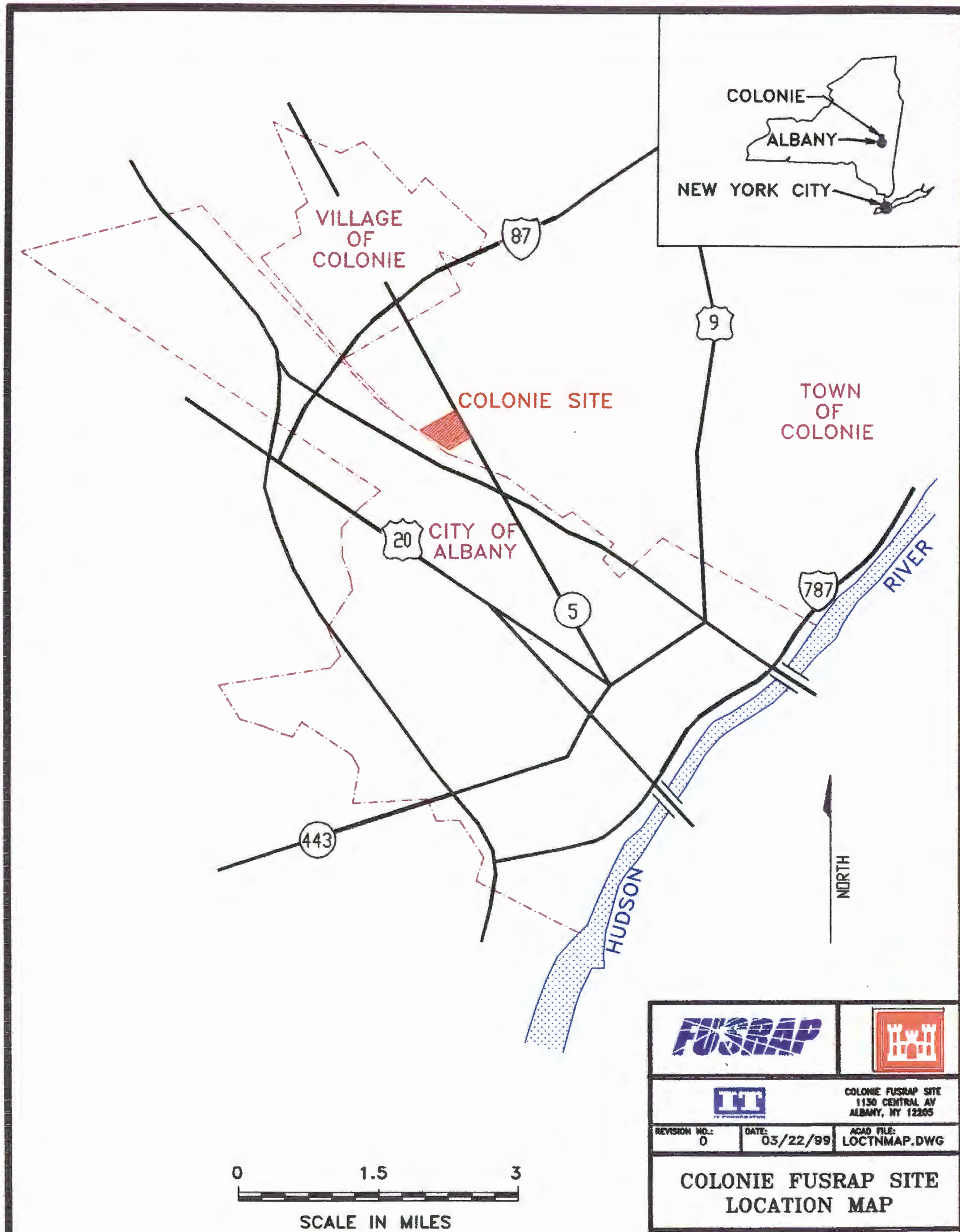
SAMPLE ID	ISOTOPIC THORIUM RESULTS	ISOTOPIC URANIUM RESULTS
CFS-01-27	0.6777	2.44
CFS-01-28	0.6834	1.138
CFS-01-29	0.888	1.303
CFS-01-30	0.8389	1.383
CFS-01-31	0.4061	22.95
HDWL-1	0.216	0.32
HDWL-2	0.182	0.30
HDWL-3	0.384	0.39
HDWL-4	0.314	1.82
HDWL-5	0.261	0.43
HDWL-1A	0.424	1.97
HDWL-2A	0.312	6.58
HDWL-3A	0.174	1.18
HDWL-4A	0.511	2.24
HDWL-5A	0.295	23.2
CSK-1	0.340	4.41
CSK-2	0.392	5.5
CSK-3	0.412	5.04
CSK-4	0.197	4.42
CSK-5	0.128	1.18
CSK-6	0.158	5.66

Notes:

All laboratory data reports associated with the above samples are on file at the Colonie FUSRAP site offices.
CSK: Central South Keyhole soil sample
HDWL: Culvert headwall soil sample, NHW: New Headwall Soil Sample
CFS: Colonie Site Final Status Survey Unit sample from Dec 1999's FSS Unit 1 efforts
SWK: Southwest Keyhoole soil sample
Channell: New stream channel soil sample
Station X+XX: New Culvert Alignment station soil sample (distance away from headwall entrance)
All Culvert related samples obtained over the period of August 2001 through October 2001
All FSS Unit 1 samples obtained over the period of December 1999 through January 2000
Samples with the suffix A indicate a resampling effort at a previously sampled location

TABLE 2
Descriptive Statistics for Table 1 Sample Data
Colonie FUSRAP

Statistical Values	ISOTOPIC THORIUM	ISOTOPIC URANIUM
	RESULTS	RESULTS
Total Sample Count	70	70
Median Value	0.457	1.820
Maximum Value	1.090	24.400
Minimum Value	0.128	0.256
Mode	0.547	3.100
Standard Deviation	0.254	5.353
95% UCL	0.002	0.040



FUSRAP

IT

COLONIE FUSRAP SITE
1130 CENTRAL AV
ALBANY, NY 12205

REVISION NO.: 0	DATE: 03/22/99	ACAD FILE: LOCTNMAP.DWG

COLONIE FUSRAP SITE LOCATION MAP

DET'D: AS	CLIENT: COLONIE FUSRAP	PROJECT NO.: 66724-007-65
CHK'D: LM	LOCATION: ALBANY, NY	FIGURE NO.: 1

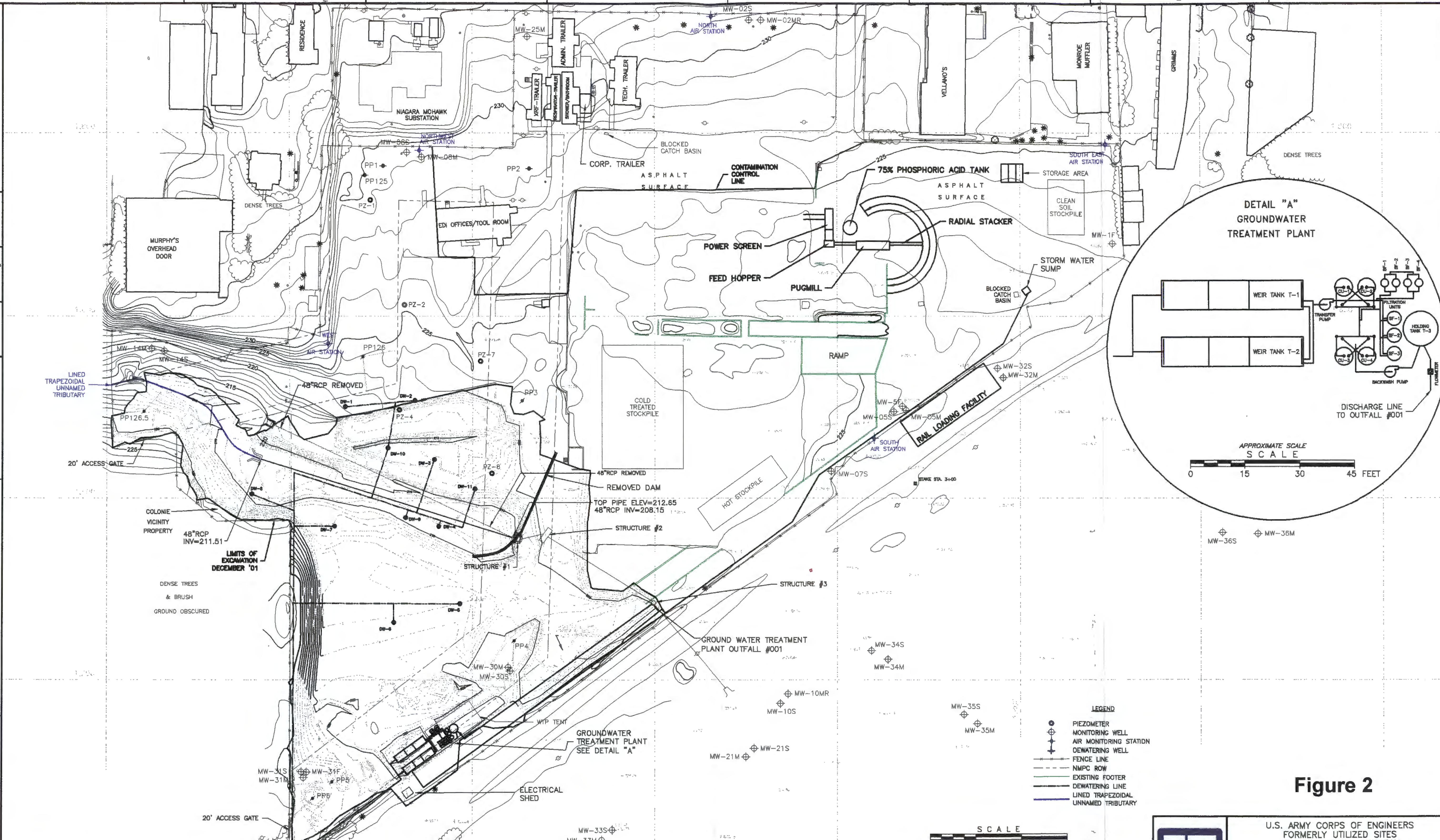


Figure 2

REFERENCE:

BASE MAP SOURCES:

EDWARD W. BOUTELLE & SON
CIVIL ENGINEERS AND SURVEYORS

BECHTEL NATIONAL INC.

GENERAL NOTES:

1. THIS SURVEY IS BASED ON PHOTOGRAMMETRIC MAPPING PREPARED BY LOCKWOOD MAPPING, INC., PHOTOS DATED MAY 13, 1998.
2. FIELD EDIT BASED ON SITE WORK CONDUCTED MAY 1998 – DECEMBER 2001.
3. NO UNDERGROUND UTILITY INFORMATION IS INCLUDED ON THIS DRAWING. REFERENCE BECTEL DRW #E01-04.
4. SITE ELEVATIONS AND COORDINATE GRID ARE BASED ON SITE MONUMENTATION AND INFORMATION PROVIDED BY ICF KAISER ENGINEERS, INC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE

IT CORPORATION

U.S. ARMY CORPS OF ENGINEERS
FORMERLY UTILIZED SITES
REMEDIAL ACTION PROGRAM

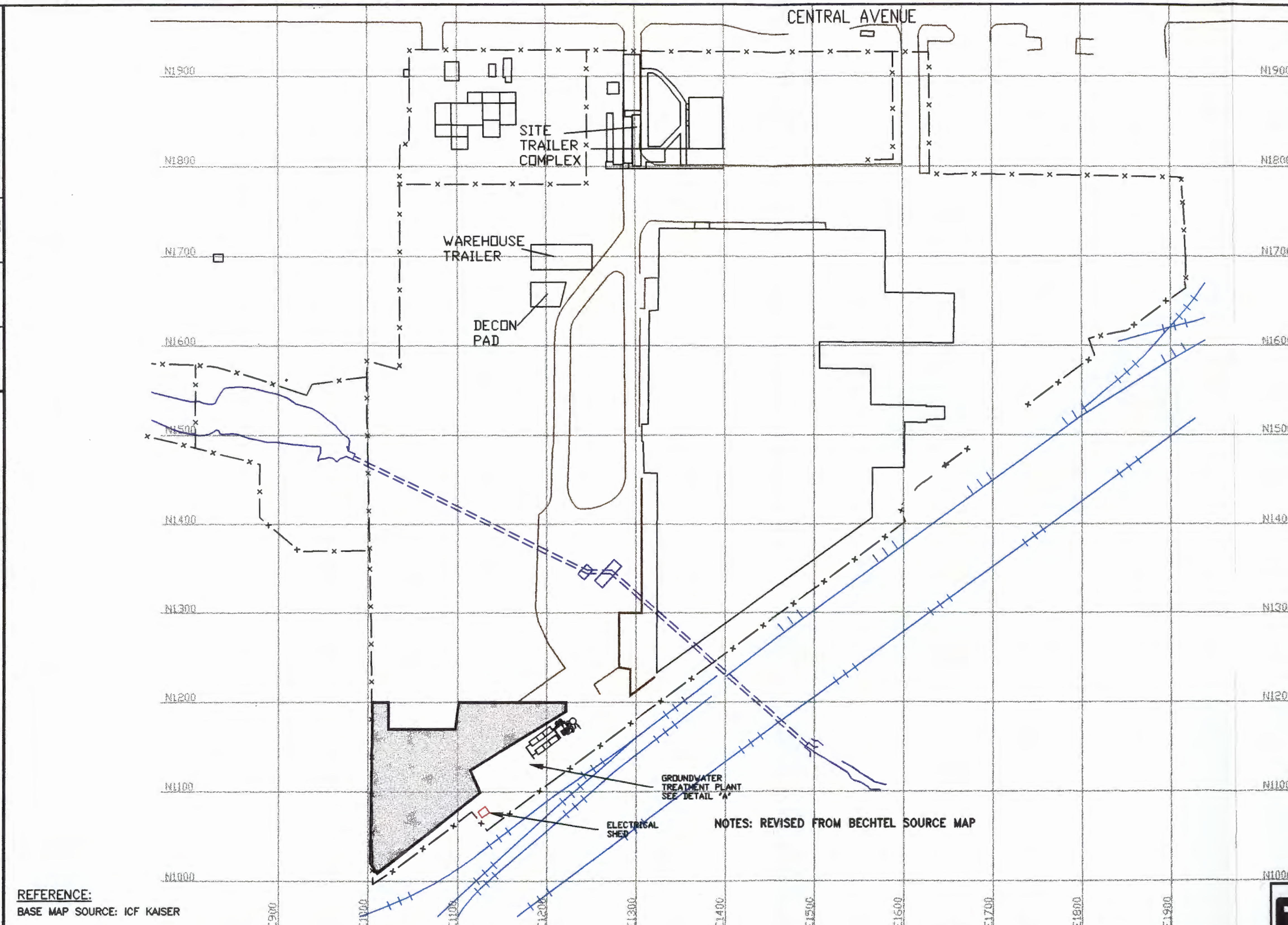
EXISTING CONDITIONS–DECEMBER 2001
COLONIE FUSRAP SITE
1130 CENTRAL AVENUE
ALBANY, NY 12205

DESIGNED BY	KSD	01/21/02	CHECKED BY
DRAWN BY	SSH	01/21/02	APPROVED BY

SCALE:	DRAWING NO.	SHEET NO.	REVISION NO.
1" = 50'	66724-B3	4-7	

IMAGE	X-REF	OFFICE	DRAWING NUMBER
---	1.dwg	ALB	66724-B3

IMAGE	X-REF	OFFICE	DRAWING NUMBER
---	---	ALB	6724FSS4



LEGEND

- COLONIE SITE BOUNDARY
- EXISTING FENCE
- RAILROAD TRACKS
- SURFACE HYDROLOGY
- UTILITY POLE

FINAL STATUS SURVEY

1 UNIT 1

FSS1 UNIT 1 – 19,258sq ft.
FSS1 UNIT 1 – 1,786 sq m

"EXAMPLE" **Figure 3**

REFERENCE:

BASE MAP SOURCE: ICF KAISER

APPROXIMATE SCALE

SCALE

0 120 240 FEET

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
4	02/09/00	SSH			ADJUSTED FSSI PERIMETER
3	12/17/99	SSH			REVISION 3 – DECEMBER 17, 1999
2	12/02/99	SSH			REVISION 2 – DECEMBER 2, 1999
1	10/22/99	SSH			REVISION 1 – OCTOBER 22, 1999

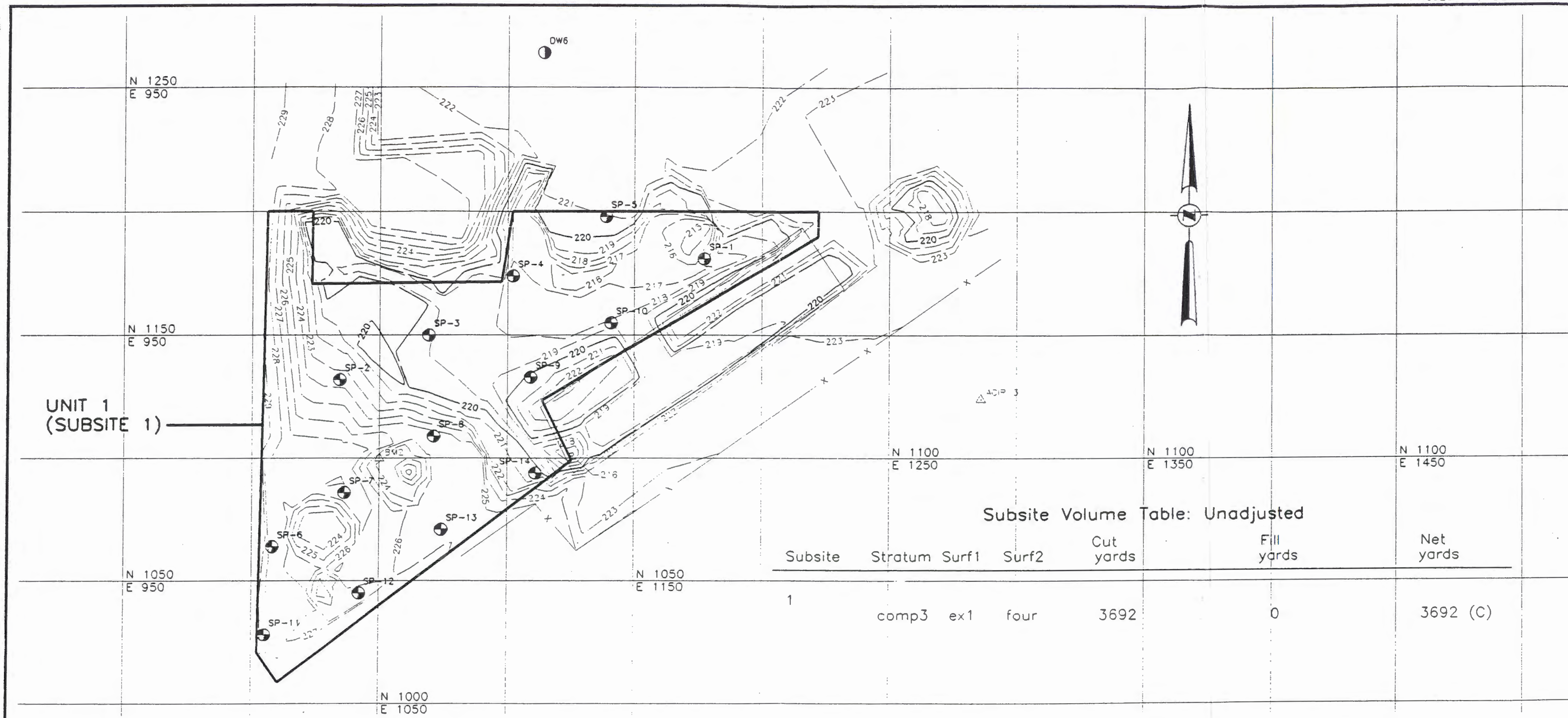
IT CORPORATION

U.S. ARMY CORPS OF ENGINEERS
FORMERLY UTILIZED SITES
REMEDIAL ACTION PROGRAM

FINAL STATUS SURVEY MAP
COLONIE FUSRAP SITE
1130 CENTRAL AVENUE
ALBANY, NY 12205

DESIGNED BY	KSD	10/22/99	CHECKED BY	
DRAWN BY	SSH	10/22/99	APPROVED BY	
SCALE: 1" = 120'	DRAWING NO. 6724FSS1		SHEET NO. 1	REVISION NO. 4

PROJECT NUMBER: 9905377



Subsite Volume Table: Unadjusted

Subsite	Stratum	Surf1	Surf2	Cut yards	Fill yards	Net yards
1	comp3	ex1	four	3692	0	3692 (C)

"ONLY COPIES OF THIS MAP SIGNED IN RED INK AND EMBOSSED WITH THE SEAL OF AN OFFICER OF C.T. MALE ASSOCIATES, P.C. OR A DESIGNATED REPRESENTATIVE SHALL BE CONSIDERED TO BE A VALID TRUE COPY".

DATE		REVISIONS RECORD/DESCRIPTION	DRAFTED	CHECK	APPR.
	1				
	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				

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DRAFTED : BRIZZEE
CHECKED :
PROJ. NO : 99.5377
SCALE : 1" = 40'
DATE : FEB. 1, 2000

FINAL TOPOGRAPHIC SURVEY

FSS UNIT 1

EXAMPLE MAP

Figure 4

TOWN OF COLONIE — ALBANY COUNTY, NEW YORK

C.T. MALE ASSOCIATES, P.C.

50 CENTURY HILL DRIVE, P.O. BOX 727, LATHAM, NY 12110
518.786.7400 • FAX 518.786.7299

ARCHITECTURE & BUILDING SYSTEMS ENGINEERING • CIVIL ENGINEERING
ENVIRONMENTAL SERVICES • SURVEY & LAND INFORMATION SERVICES

SHEET 1 OF 1
DWG. NO. 00-114

CAD DWG. FILE NAME: TS4.DWG

Figure 5

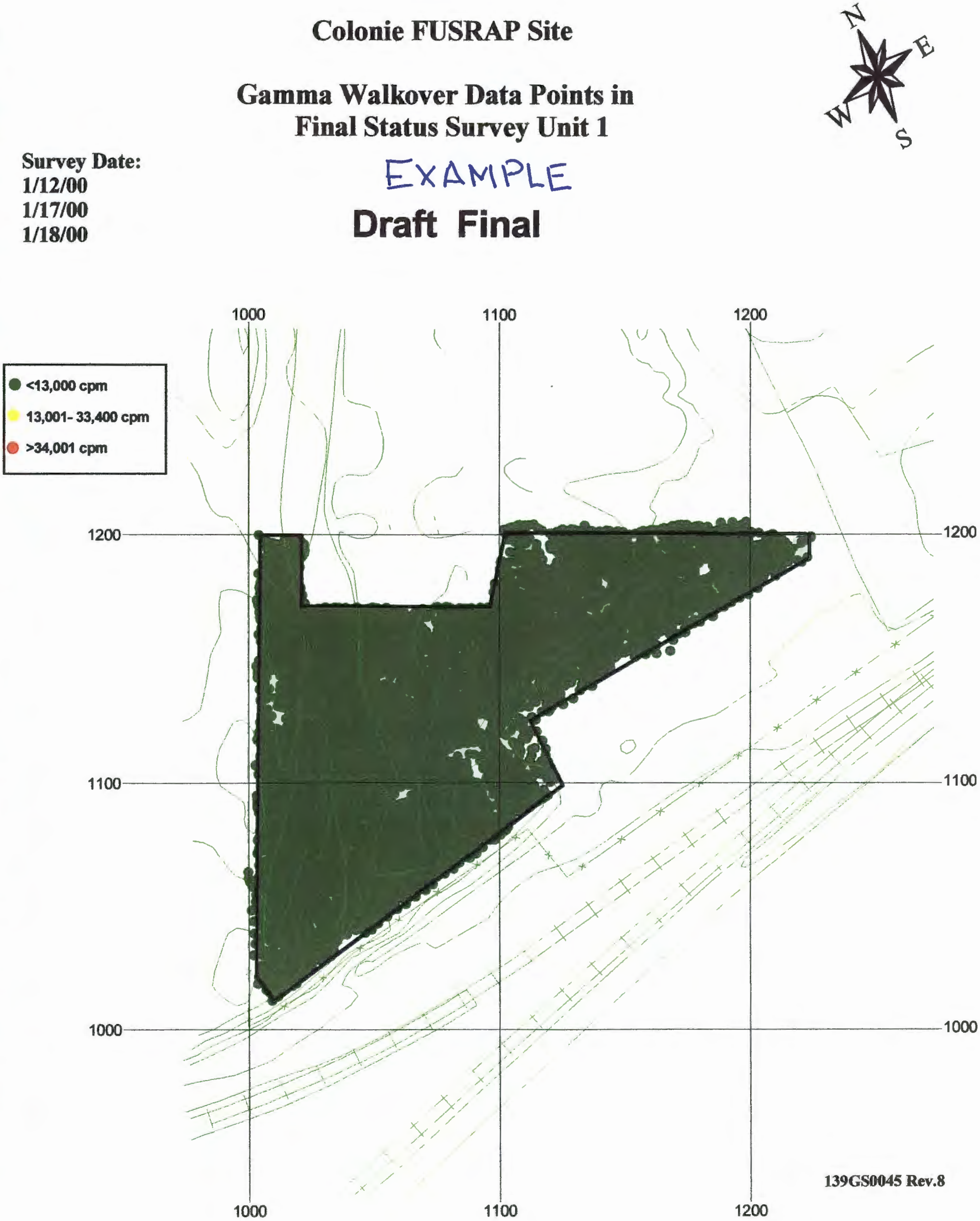
Colonie FUSRAP Site

Gamma Walkover Data Points in Final Status Survey Unit 1

Survey Date:
1/12/00
1/17/00
1/18/00

EXAMPLE

Draft Final



TMA 1993 Correlation Data

TMA/Eberline
Interoffice Memo

TO: M. Bradshaw, TMA/E PM

FROM: D. Beard, TMA/E NY Team Lead

DATE: June 3, 1993

SUBJECT: CISS U-238 to FIDLER Correlation

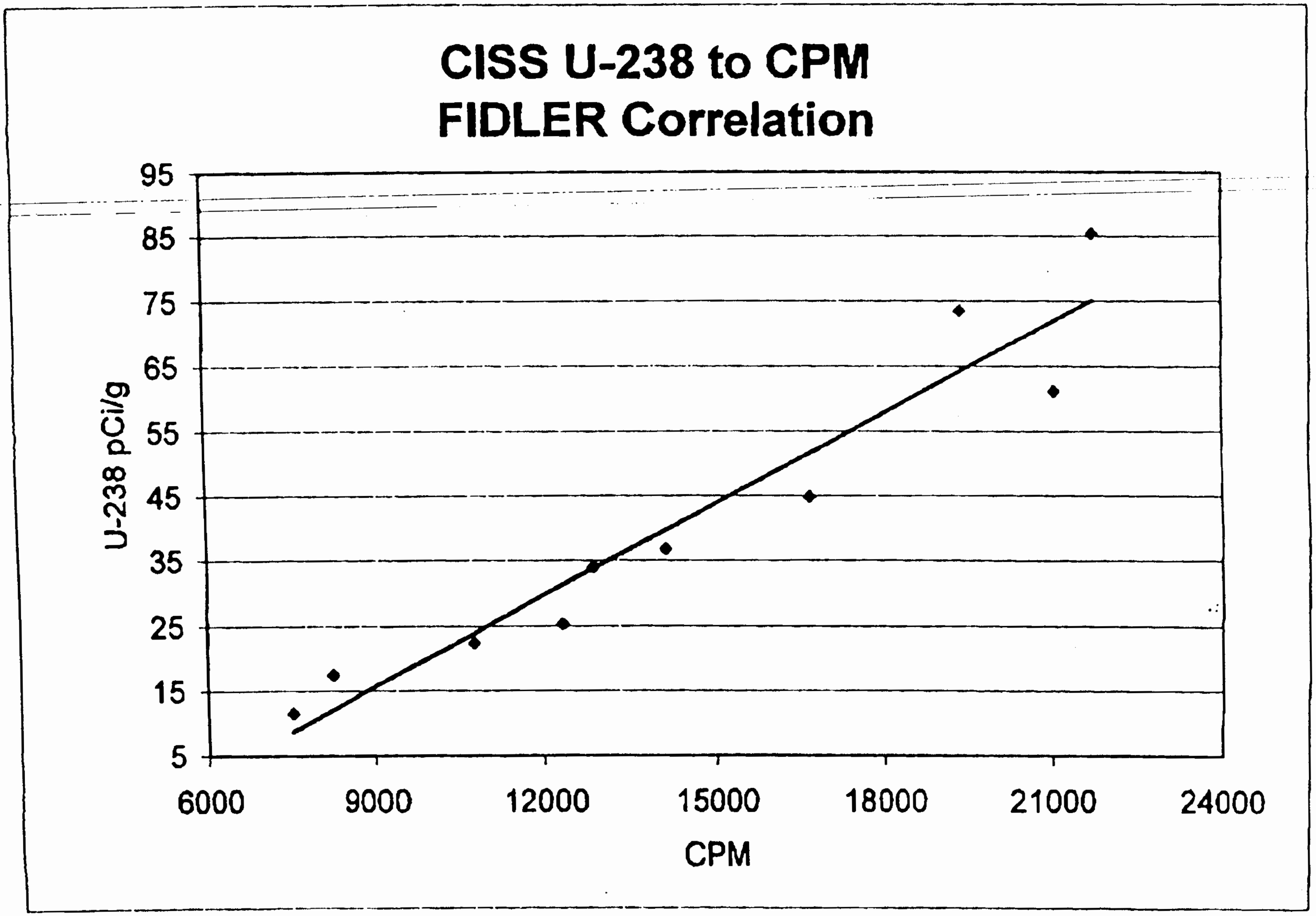
A gamma radiation correlation to Uranium-238 (U-238) concentrations in soil was conducted at the CISS on April 12, 1993 with a Bicron FIDLER. This study is being conducted, per your direction, to obtain a relative count rate (cpm) which would equate to approximately 35 pCi/g of U-238.

Ten soil sampling and gamma measurement locations were selected on the site. FIDLER gamma walk-over surveys were conducted in the West grounds to locate ten soil areas exhibiting gamma radiation ranges from 7,000 to 22,000 cpm. Five 1 minute counts were conducted with the FIDLER at each identified location, then averaged as reported in the Table below. FIDLER measurements were performed at 6" above grade surface and documented. One sample was collected from each measurement location to a depth of 6", encompassing an area of approximately 0.5 meters. The sample was homogenized in a 5-gallon bucket and one composite sample was collected from each bucket.

Samples were sent to the TMA/Eberline laboratory in Oak Ridge for analysis. A summary of analytical results is presented in the Table below. Also, see the attached CISS U-238 to CPM FIDLER Correlation graph.

Sample ID	FIDLER (cpm)	U-238 (pCi/g)
139-930412-01	7,520	11.5
139-930412-02	8,239	17.5
139-930412-03	10,750	22.4
139-930412-04	12,347	25.3
139-930412-05	12,881	33.9
139-930412-06	14,140	36.7
139-930412-07	16,702	44.8
139-930412-08	19,406	73.5
139-930412-09	21,043	61.1
139-930412-10	21,736	85.4

Sample results for locations 05 and 06 were 33.9 and 36.7 pCi/g of U-238, respectively, averaging 35.3 pCi/g. The corresponding FIDLER measurements for the same locations are 12,881 and 14,140 cpm, with an average of 13, 510 cpm. Based on the data presented and reviewed, it appears the FIDLER count rate of 13,500 would correspond to approximately 35 pCi/g U-238. Measurement error and analytical error were not considered for this correlation. Additional correlation studies may be required for U-238 and Th-232 in the future.



BNI/TMA 041293

ICF Kaiser 1999 Correlation Data

CCL99-2.076

ICF KAISER

1130 Central Avenue
Albany, NY 12205
518-482-0237, Fax: 518-482-0343

February 17, 1999

U.S. Army Corps of Engineers
New York District
Colonie FUSRAP Site
1130 Central Ave.
Colonie, NY 12205

Attention: Brad Eaton

Subject: *Field Instrumentation Correlation Study*
Colonie FUSRAP Site
Contract No. DACA31-95-D-0083, Task Order 24

Attached for your review is the correlation study performed by Environmental Dimensions, Inc. for ICF Kaiser Engineers, Inc. at the Colonie FUSRAP Site.

The purpose of the study was to correlate the counts per minute (cpm) of two filder instruments (#000277 & #29117) with the picocuries per gram (pCi/g) U238 in contaminated samples of soil.

The method for abstracting soil for the sample was derived from contacting Alan Justus of Argron National Laboratories. It was determined that the best geometry for counting the in-situ soil with the fidler was to hold the instrument at approximately 1.5 inches from the ground and recording ten consecutive measurements. The data was then averaged and a standard deviation calculated. The sample volume was determined to be 5 cm deep by 1 foot diameter. The entire volume was extracted and processed in accordance with EDi proceedure 5B.15, *Peperartion of Soil Samples for Gamma Spectrometry*. The sample was counted in the on-site HPGe System. The pCi/g / CPM correlation was plotted on a graph for each instrument.

Scott Brock
CQC Manager
Colonie FUSRAP Site

Cc. Randy Battaglia CENAN-PP-E
Debra Ford CENAB-EN-HT
John Abunaw NYSDEC

Location: North Lawn	Location: North Lawn
Fidler #000277	Fidler #29117
Offsite Bkg: 7700 cpm	Offsite Bkg: 9700 cpm
Cal Due: 11/4/99	Cal Due: 8/2/99
21613	25241
21313	25616
21706	25074
21786	25156
21492	25022
21472	24994
21556	25185
21495	24870
21671	24879
21571	25018
Avg: 21567.5 cpm	Avg: 25105.5 cpm
1 sig: 135.3 cpm	1 sig: 216.7 cpm
- 1 sig: 21432.2 cpm	- 1 sig: 24888.8 cpm
+ 1 sig: 21702.8 cpm	+ 1 sig: 25322.2 cpm

Date Measurements/Sample taken in field: 2/16/99
Date Sample prepped: 2/16/99
Date Sample Counted: 2/17/99
Measurements in pCi/g
Sample ID #139SS990012

132.2pCi/g - U-238
0.2 pCi/g - mda

Sampling Techniques:

Walkover of area to find elevated measurements.
Ten, one minute counts recorded for each Fidler. Fidler held at 1.5" above area to be sampled.
Sample depth: 0-5 cm
Sample Width: 12 in.
Sample Description: Vegetation (grass/sod), sandy soil

Location: N.Lawn(drvwy)	Location: N.Lawn(drvwy)	Date Measurements/Sample taken in field: 2/17/99
Fidler #000277	Fidler #29117	Date Sample prepped: 2/17/99
Offsite Bkg: 7700 cpm	Offsite Bkg: 9700 cpm	Date Sample Counted: 2/18/99
Cal Due: 11/4/99	Cal Due: 8/2/99	Measurements in pCi/g
12847	15490	Sample ID #139SS990015
12896	15284	
12749	15449	
12932	15320	
12575	15447	
12752	15423	
12648	15185	
12904	15510	
12871	15361	
12904	15284	
Avg:12807.8 cpm	Avg: 15375.3 cpm	39.4 pCi/g - U-238
1 sig: 121.8 cpm	1 sig: 105.6 cpm	0.1 pCi/g mda
- 1 sig: 12686.0 cpm	- 1 sig: 15269.7 cpm	
+ 1 sig: 12930.0 cpm	+ 1 sig: 15480.9 cpm	

Sampling Techniques:

Walkover of area to find elevated measurements. Ten, one minute counts recorded for each Fidler.Fidler held at 1.5" above area to be sampled.

Sample depth: 0-5 cm

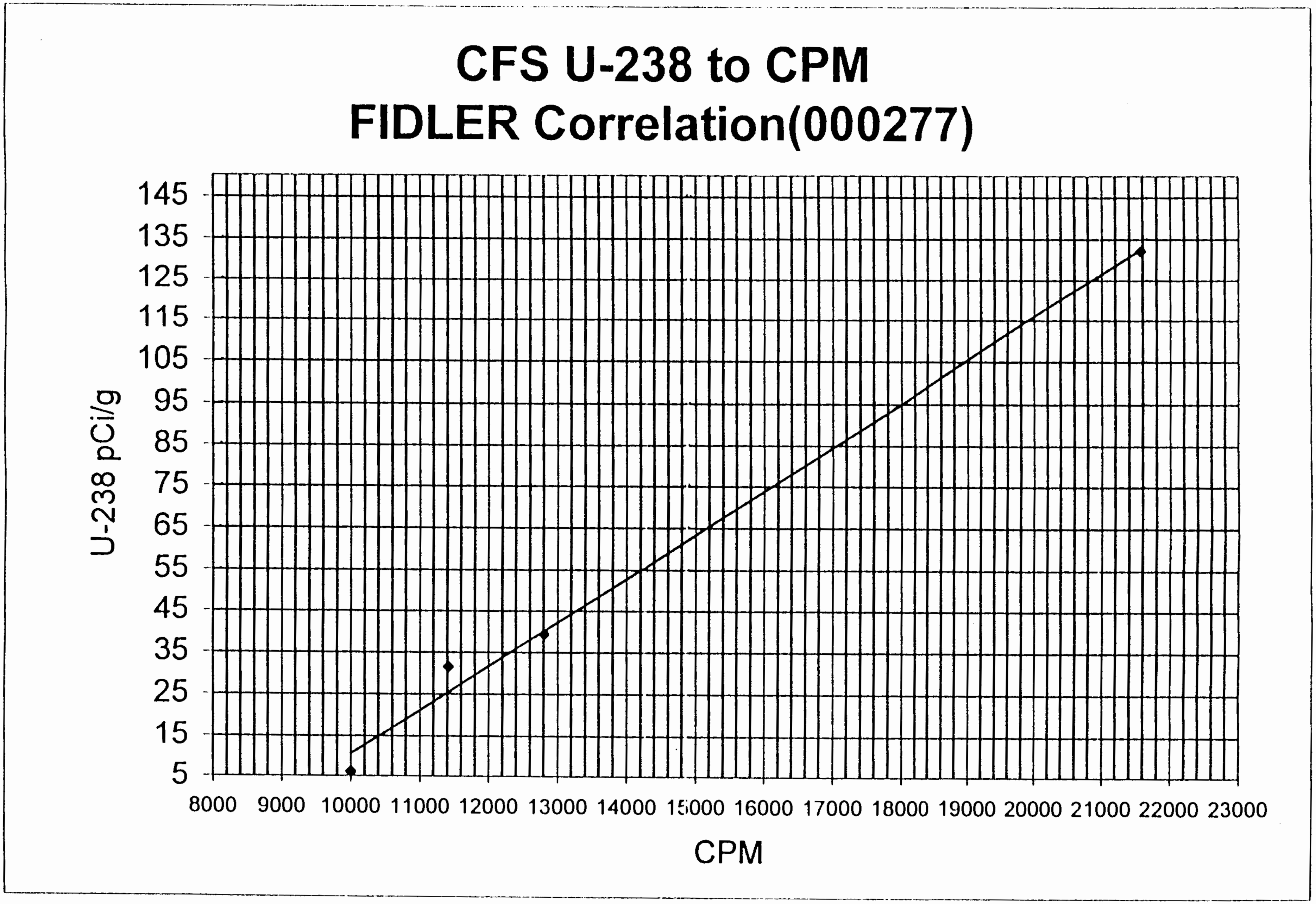
Sample Width: 12 in.

Sample Description: Vegetation (grass/sod), sandy soil

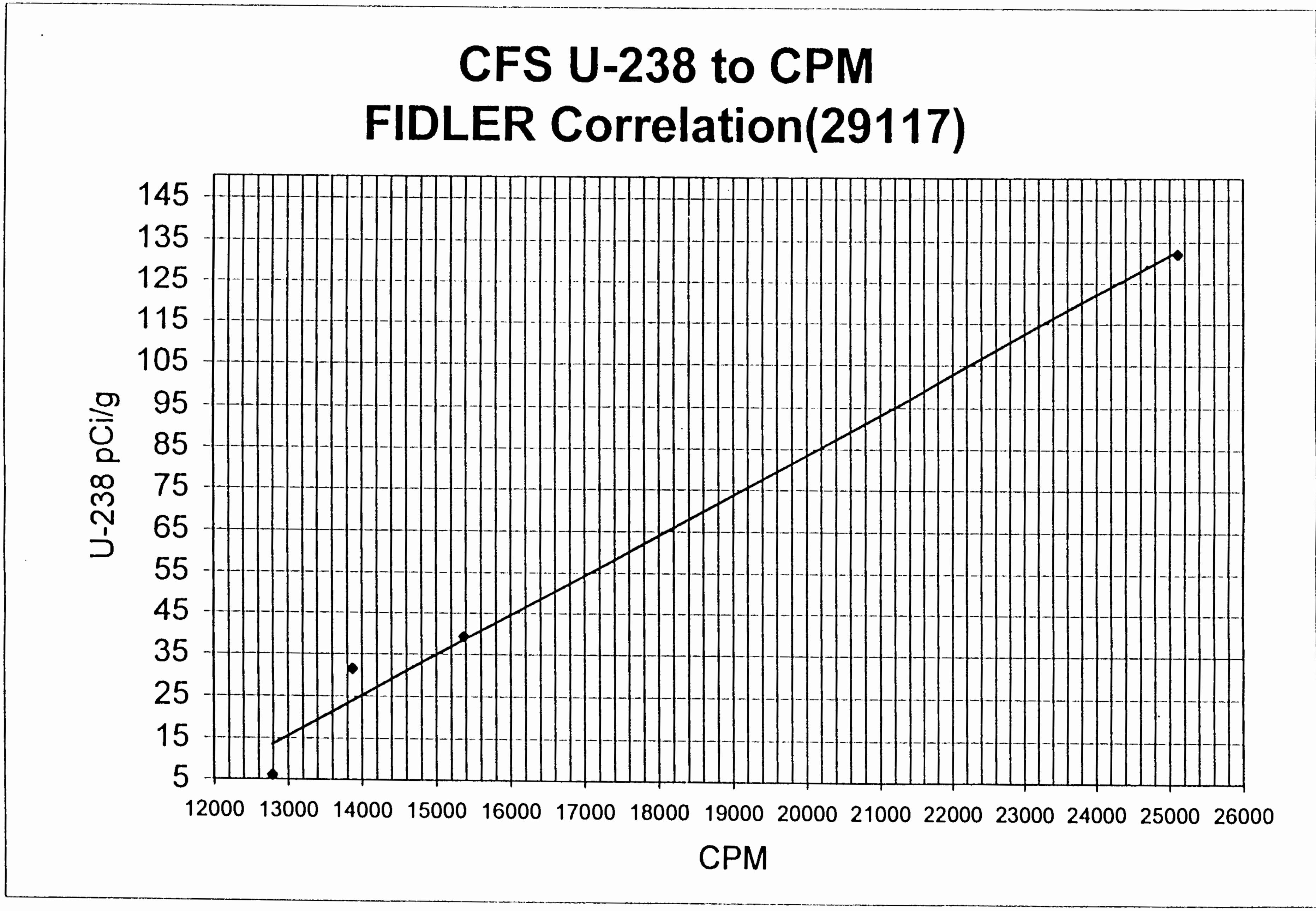
Location: N.Lawn(drvwy)	Location: N.Lawn(drvwy)	Date Measurements/Sample taken in field: 2/17/99
Fidler #000277	Fidler #29117	Date Sample prepped: 2/17/99
Offsite Bkg: 7700 cpm	Offsite Bkg: 9700 cpm	Date Sample Counted: 2/18/99
Cal Due: 11/4/99	Cal Due: 8/2/99	Measurements in pCi/g
11376	13806	Sample ID #139SS990016
11515	13865	
11271	13838	
11469	13816	
11483	13851	
11570	13913	
11392	13734	
11212	14181	
11426	13915	
11412	13801	
Avg:11412.6 cpm	Avg: 13872.0 cpm	31.5 pCi/g - U-238
1 sig: 108.3 cpm	1 sig: 121.21 cpm	0.1 pCi/g mda
- 1 sig: 11304.3 cpm	- 1 sig: 13750.8 cpm	
+ 1 sig: 11520.9cpm	+ 1 sig: 13993.2 cpm	

Sampling Techniques:

Walkover of area to find elevated measurements.
Ten, one minute counts recorded for each Fidler. Fidler held at 1.5" above area to be sampled.
Sample depth: 0-5 cm
Sample Width: 12 in.
Sample Description: Vegetation (grass/sod), sandy soil



CFS Graph1 21899 000277



CFS Graph2 21899 29117

Fidler counts per minute to picocurie per gram of U-238 concentrations in soil study conducted at Colonie 2/16/99-2/18/99:

A method of abstracting soil from the ground contaminated with Uranium 238 was derived from contacting Alan Justus, Argon National Laboratories, due to their knowledge in these correlation studies.

It was determined that the best geometry is counting the soil in-situ with the Fidler held at 1.5 inches from the ground and recording ten consecutive measurements in counts per minute. That data was then averaged and a standard deviation calculated. The sample volume was determined to be 5 cm deep by 1 foot diameter and the complete circle was extracted and processed per the EDi procedure 5B.15, Preparation of Soil Samples for Gamma Spectrometry. The samples were then counted in the on-site HPGe System and the picocurie per gram activity vs. counts per minute was plotted on a graph for each Fidler.

IT Corporation 2000 Correlation Data

IT Corporation
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Memo

FILE COPY

To: Kevin Dufek, Site Engineer
Tony Noce, Site Chemist
David Sendra, Radiation Safety Manager

From: Tony Sheeran, Project Manager

CC: Brad Eaton, USACE Project Engineer
J. Franz, Program Manager
E. Turney, Edi Lead Technician

Date: 10/09/00

Subject: USACE's Correlation Memorandum

Attached please find USACE's 06 Oct 00 Memorandum providing directions concerning the ongoing correlation efforts here at Colonie. Please review this memorandum with respect to your areas of responsibility and advise if anything beyond that listed below is required of us.

USACE has directed that:

- No further Alpha Spectrometry analysis for soil samples will be conducted unless the sample is associated with a Final Status Survey. One minute static counts are to be acquired at each final status survey physical sample location. Per the 5 Oct 00 meeting, IT Corp. is not to pursue any further Final Status Surveying efforts until so directed by USACE;

- Obtain in-situ correlation continuation study samples (from warm or hot materials) at a rate of one sample per every 5,000 cyds of excavated materials. For accounting purposes, we recently passed the 30,000th cubic yard mark, so take the next sample on or about the date the 35,000 cyd is excavated. If there is any correlation study related information that has been obtained but not submitted to USACE, please identify the data and summarize for submittal to USACE/Website posting as soon as possible.

As detailed in previous memorandums, IT Corp. has recommended that the correlation in counts per minute used to field screen materials at the 35 pCi/gm Uranium –238 level be changed to 13,000 cpm (14 April 00). Neither the Army's 06 Oct 00 memorandum nor any prior correspondence indicates a disagreement in that level and accordingly we will now use this level in all surveying efforts. For your information, attached are the formula sheet for the various instruments developed in late July by Tony Noce. All Gamma Spec comparisons show that at the 13,000 cpm level, activity is below the 35 pCi/gm level.

Please see me with any questions or to identify additional considerations with respect to correlation studies and or implementation of USACE's directives.

Attachment: as noted above

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT, CORPS OF ENGINEERS
WEST POINT AREA OFFICE
COLONIE FUSRAP SITE
COLONIE, NEW YORK 12205

COPY

CENAN-CO-W (200-1c) 6 October 2000

MEMORANDUM FOR: IT Corporation at Colonie FUSRAP Site
Dave Miller, Argonne National Laboratory

SUBJECT: Thorium and Uranium Correlation Study

1. Attached is the meeting summary from the 8/31/00 correlation meeting, prepared by IT.

2. I concur with statement 1 concerning alpha spectroscopy. Apply this technique to final status survey (FSS) samples only.

3. I concur that Baltimore District should contact NYS DEC concerning the recommendation to drop off site gamma spectroscopy analysis of FSS samples, instead accepting the results of onsite gamma spectroscopy of these samples.

4. I concur that a correlation study sample should be collected from in situ warm or hot material for every 5000 cy of such material. At our current excavation rate of 30,000 cy of total material in 9 months, this should translate into no more than one additional sample every 6 weeks.

5. I concur with comment 4 concerning the adequacy of mapping of the FSS data points. Mr. Miller of ANL has provided an additional comment that there should be a one minute gamma reading over the sample point prior to collection of the sample.

6. I concur with comment 5 that the 2X2 device coupled with our conservative excavation and treatment techniques eliminates the need for a further thorium-232 correlation study. Per the sampling and analysis plan, field instruments such as the 2X2 are not to be used to determine activity levels for soil disposal. ANL must still provide the Tonawanda correlation study to USACE for review.

7. IT should begin collecting the correlation samples as indicated in 4 above. ANL should provide the Tonawanda study to USACE as soon as possible.

8. Questions may be addressed to me at (518) 453-0803.

Attch

Bradley G. Eaton
Project Engineer

Cf:
Joe Forcina, USACE
Steve DeNardis, USACE

RECEIVED
OCT 06 2000
By

Correlation Studies – 08.31.00 Meeting Summary

In attendance:

- Brad Eaton, USACE *(called away shortly after the meeting began)*
- Hans Honerlah, USACE
- David Miller, ANL
- Tony Sheeran, IT *(called away twice during the meeting)*
- Tony Noce, IT

This meeting was held to discuss the correlation studies conducted to date for the Colonie FUSRAP Site. The focus of the discussion was provided by two memos from USACE to IT, the first dated 08.08.00 ("Thorium Correlation Study") and the second dated 08.11.00 ("FIDLER – Uranium238 Correlation Study"). The results of the meeting may be summarized as follows:

1. The only samples that require alpha spectroscopy analysis are the final status survey samples.
2. Hans Honerlah will check with the DEC on the possibility of dropping the off-Site gamma spectroscopy analysis of the final status survey samples. It should be noted that on-Site gamma spectroscopy would still be performed on these samples.
3. Hans Honerlah and David Miller believe that the correlation study should be on-going process, with a correlation study sample collected from *in situ* warm or hot material for every 20 stockpiles formed. This translates to approximately one sample every two to three weeks for the remainder of the project.
4. Mapping of the data points was discussed at some length and it was agreed that the mapping of the final status survey data points, which occurs as part of the final status survey process, would allow us demonstrate adequate coverage of the Site without performing any additional mapping tasks.
5. The 2x2 allows for the determination of the presence or absence of thorium-232, and our conservative approach to the excavation, characterization and treatment of soils containing thorium-232 eliminates the need for a thorium-232 correlation study *per se*.
6. The FIDLER response to thorium-232 provides us confidence that our current walkover process would detect the presence of thorium-232 at a level above the Site limit of 15 pCi/g. ANL has a study from Tonawanda confirming this that will be provided to both USACE and IT.

Action Items

ANL:

- Provide the FIDLER study referenced in the meeting to both USACE (Hans Honerlah) and IT (Tony Noce).

USACE:

- Hans Honerlah - Contact the NYSDEC regarding the analysis of final status survey samples by off-Site gamma spectroscopy. *(It was the consensus of the group that only on-Site gamma spectroscopy and off-Site alpha spectroscopy analysis be performed on these samples.)*
- Brad Eaton - Determine if the on-going correlation study sampling discussed in the meeting and referenced in #3 above will be implemented for the Site and provide confirmation to IT.

IT:

- If so directed by USACE, initiate the on-going correlation study sampling discussed in the meeting and referenced in #3 above.

Alpha Spectra FIDLER Correlation Data - Calculations

IT Project Number 866724
Colonie FUSRAP Site
Colonie, New York

Alpha Spectra FIDLER to On-Site Gamma Spectroscopy

$y = 157.81x + 7704.7$

$R^2 = 0.9606$

enter x = 17.5	enter x = 35	enter x = 100	
y = 10,466	y = 13,228	y = 23,486	
enter y = 12,000	enter y = 13,000	enter y = 18,000	enter y = 21,000
x = 27.2	x = 33.6	x = 65.2	x = 84.2

Alpha Spectra FIDLER to Off-Site Gamma Spectroscopy

$y = 121.56x + 9200.2$

$R^2 = 0.8815$

enter x = 17.5	enter x = 35	enter x = 100	
y = 11,328	y = 13,455	y = 21,356	
enter y = 12,000	enter y = 13,000	enter y = 18,000	enter y = 21,000
x = 23.0	x = 31.3	x = 72.4	x = 97.1

Alpha Spectra FIDLER to Off-Site LEPS Gamma Spectroscopy

$y = 109.83x + 9406.9$

$R^2 = 0.9364$

enter x = 17.5	enter x = 35	enter x = 100	
y = 11,329	y = 13,251	y = 20,390	
enter y = 12,000	enter y = 13,000	enter y = 18,000	enter y = 21,000
x = 23.6	x = 32.7	x = 78.2	x = 105.6

Alpha Spectra FIDLER to Off-Site Alpha Spectroscopy

$y = 86.019x + 9315.2$

$R^2 = 0.9271$

enter x = 17.5	enter x = 35	enter x = 100	
y = 10,821	y = 12,326	y = 17,917	
enter y = 12,000	enter y = 13,000	enter y = 18,000	enter y = 21,000
x = 31.2	x = 42.8	x = 101.0	x = 135.8

the group

IT Corporation
1130 Central Avenue
Albany, NY 12205
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Memo

To: Tony Sheeran, Project Manager
Kevin Dufek, Project Engineer

CC: Dave Sendra, Radiological Controls Supervisor
Ed Turney, EDi Project Lead
Scott Brock, CQC Manager
Sarah Hojnacki, Site Health and Safety Officer
File

From: Tony Noce, Project Chemist

Date: 07/13/00

Subject: Correlation Data Summary to Date
2x2 NaI Detector

Per USACE directive, a correlation study has been initiated for the Eberline SPA-3 2x2 sodium iodide detector specifically configured to detect thorium-232 (Th-232) being used at the Site. The purpose of this correlation study is to attempt to determine a correlation between a relative count rate (in cpm) and the Th-232 activity (in pCi/g). The range of particular interest is the break point between "cold" and "hot" (*i.e.*, 15 pCi/g). Towards this end, ten gamma measurement and soil sampling locations were selected on-Site. Samples collected from three of these locations were discarded and excluded from the study because the on-Site gamma spectroscopy results for Th-232 for these samples were less than 5 pCi/g (1.7, 4.6 and 2.1 pCi/g, respectively).

The soil sampling procedures used for the correlation may be summarized as follows:

- A single one (1) minute static count was taken at each location prior to sampling (*in-situ*). The sample was then collected and removed to an area of the Site more representative of background radiation than the area where the sampling was conducted and a second one (1) minute static count was taken *(ex-situ)*. The detector was placed 2" above ground surface while taking this measurement, and the average has been used for correlation purposes.
- Surface soil samples were collected at each location approximately 0–6" below ground surface using a stainless steel trowel.
- The sample material collected was homogenized using a limited cone and quarter technique.
- Aliquots of the homogenized sample material were placed in 1 quart paint cans and processed in accordance with EDi Sop 5B.15 prior to a split sample being submitted to ThermoNUtech of Oak Ridge, Tennessee for radiological analysis (*i.e.*, gamma spectroscopy, isotopic uranium and isotopic thorium).
- All non-dedicated reusable sampling equipment was decontaminated using a non-phosphate detergent wash and a distilled/deionized water rinse. Equipment stored for future use was allowed to air dry and then wrapped in aluminum foil (shiny-side out) or sealed in plastic bags.

The Correlation Data Summary for Th-232 is presented in the attached tables along with charts summarizing various correlations:

1. *In-Situ* 2x2 NaI Detector to On-Site Gamma Spectroscopy

2. *In-Situ* 2x2 NaI Detector to Off-Site Gamma Spectroscopy

3. *In-Situ* 2x2 NaI Detector to Off-Site Alpha Spectroscopy

4. *Ex-Situ* 2x2 NaI Detector to On-Site Gamma Spectroscopy

5. *Ex-Situ* 2x2 NaI Detector to Off-Site Gamma Spectroscopy

6. *Ex-Situ* 2x2 NaI Detector to Off-Site Alpha Spectroscopy

7. *In-Situ* 2x2 NaI Detector to *Ex-Situ* 2x2 NaI Detector

8. Off-Site Gamma Spectroscopy to Off-Site Alpha Spectroscopy

The four data sets using the *in-situ* cpm readings all exhibited extremely low correlation coefficients, with the highest of the four exhibiting a correlation coefficient of only 0.06. As a rule of thumb, if the correlation coefficient is less than 0.5 there is no correlation.

The correlation between the *Ex-Situ* 2x2 NaI Detector and On-Site Gamma Spectroscopy results, based on seven (7) samples, exhibits a 0.80 correlation coefficient. According to the equation derived for a linear trendline through the data, 15 pCi/g would be the equivalent of 2,300 cpm.

The correlation between the *Ex-Situ* 2x2 NaI Detector and Off-Site Gamma Spectroscopy results, based on seven (7) samples, exhibits a 0.91 correlation coefficient. According to the equation derived for a linear trendline through the data, 15 pCi/g would be the equivalent of 2,256 cpm and a cut off of 2,300 cpm would yield an expected Th-232 concentration of 19 pCi/g.

The correlation between the *Ex-Situ* 2x2 NaI Detector and Off-Site Alpha Spectroscopy results, based on seven (7) samples, exhibits a 0.83 correlation coefficient. According to the equation derived for a linear trendline through the data, 15 pCi/g would be the equivalent of 2,744 cpm and a cut off of 2,300 cpm would yield an expected Th-232 concentration of 4.8 pCi/g.

The correlation between the Off-Site Gamma Spectroscopy and Off-Site Alpha Spectroscopy results, also based on seven (7) samples, exhibits a 0.75 correlation coefficient. This lower coefficient may be due to the fact that the two samples that vary most widely tend to cancel each other out in the calculation of the correlation coefficient because one is high and one is low. Additional samples are required in order to determine a correlation between a relative count rate (in cpm) and the Th-232 activity (in pCi/g).

Recommendations

- For the time being, use of 2,300 counts per minute as the break point between "cold" and "hot" for gamma walkovers conducted in the field.
- The collection of an additional ten to twenty correlation study samples to further refine the correlation and continued refinement of this correlation as additional data are received in the course of the project.

2x2 NaI Detector Correlation Data Summary

IT Project Number 866724
Colonie FUSRAP Site
Colonie, New York

Sample ID	2x2 NaI Detector Static Counts		Thorium-232		
			EDi	ThermoNUtech	
	in-situ	*ex-situ*	Gamma Spec Result	Gamma Spec Result	Alpha Spec Result
	cpm	*cpm*	*pCi/g*	*pCi/g*	*pCi/g*
CSL-250	9,725	67	55.2	57.2	0.767
CSL-251	560	515	82.5	55.2	28.8
CSL-252	77	44	5.1	2.98	3.1
CSL-253	154	140	16.4	5.85	3.41
CSL-255	2,170	2,231	149.4	202	46.3
CSL-267	1,400	120	55.6	47.6	12.8
CSL-268	3,000	51	8.7	10.7	9.68

Notes:
pCi/g indicates picoCuries per gram
cpm indicates counts per minute

2x2 NaI Detector Correlation Data - Calculations

IT Project Number 866724
Colonie FUSRAP Site
Colonie, New York

In-Situ 2x2 NaI Detector to On-Site Gamma Spectroscopy

$y = 6.5869x + 2090$

$R^2 = 0.0099$

enter x = 7.5	enter x = 15	enter x = 50
y = 2,139	y = 2,189	y = 2,419
enter y = 2,140	enter y = 2,180	enter y = 2,400
x = 7.6	x = 13.7	x = 47.1

In-Situ 2x2 NaI Detector to Off-Site Gamma Spectroscopy

$y = 6.7521x + 2072.8$

$R^2 = 0.019$

enter x = 7.5	enter x = 15	enter x = 50
y = 2,123	y = 2,174	y = 2,410
enter y = 2,140	enter y = 2,180	enter y = 2,400
x = 10.0	x = 15.9	x = 48.5

In-Situ 2x2 NaI Detector to Off-Site Alpha Spectroscopy

$y = -50.041x + 3190.5$

$R^2 = 0.0611$

enter x = 7.5	enter x = 15	enter x = 50
y = 2,815	y = 2,440	y = 688
enter y = 2,140	enter y = 2,180	enter y = 2,400
x = 21.0	x = 20.2	x = 15.8

2x2 NaI Detector Correlation Data - Calculations

IT Project Number 866724
Colonie FUSRAP Site
Colonie, New York

Ex-Situ **2x2 NaI Detector to On-Site Gamma Spectroscopy**

$y = 13.973x - 291.81$

$R^2 = 0.7994$

enter x = 7.5	enter x = 15	enter x = 50
y = 2,195	y = 2,300	y = 2,789
enter y = 2,200	enter y = 2,300	enter y = 2,800
x = 7.9	x = 15.0	x = 50.8

Ex-Situ **2x2 NaI Detector to Off-Site Gamma Spectroscopy**

$y = 11.042x - 149.25$

$R^2 = 0.91$

enter x = 7.5	enter x = 15	enter x = 50
y = 2,173	y = 2,256	y = 2,642
enter y = 2,200	enter y = 2,300	enter y = 2,800
x = 10.0	x = 19.0	x = 64.3

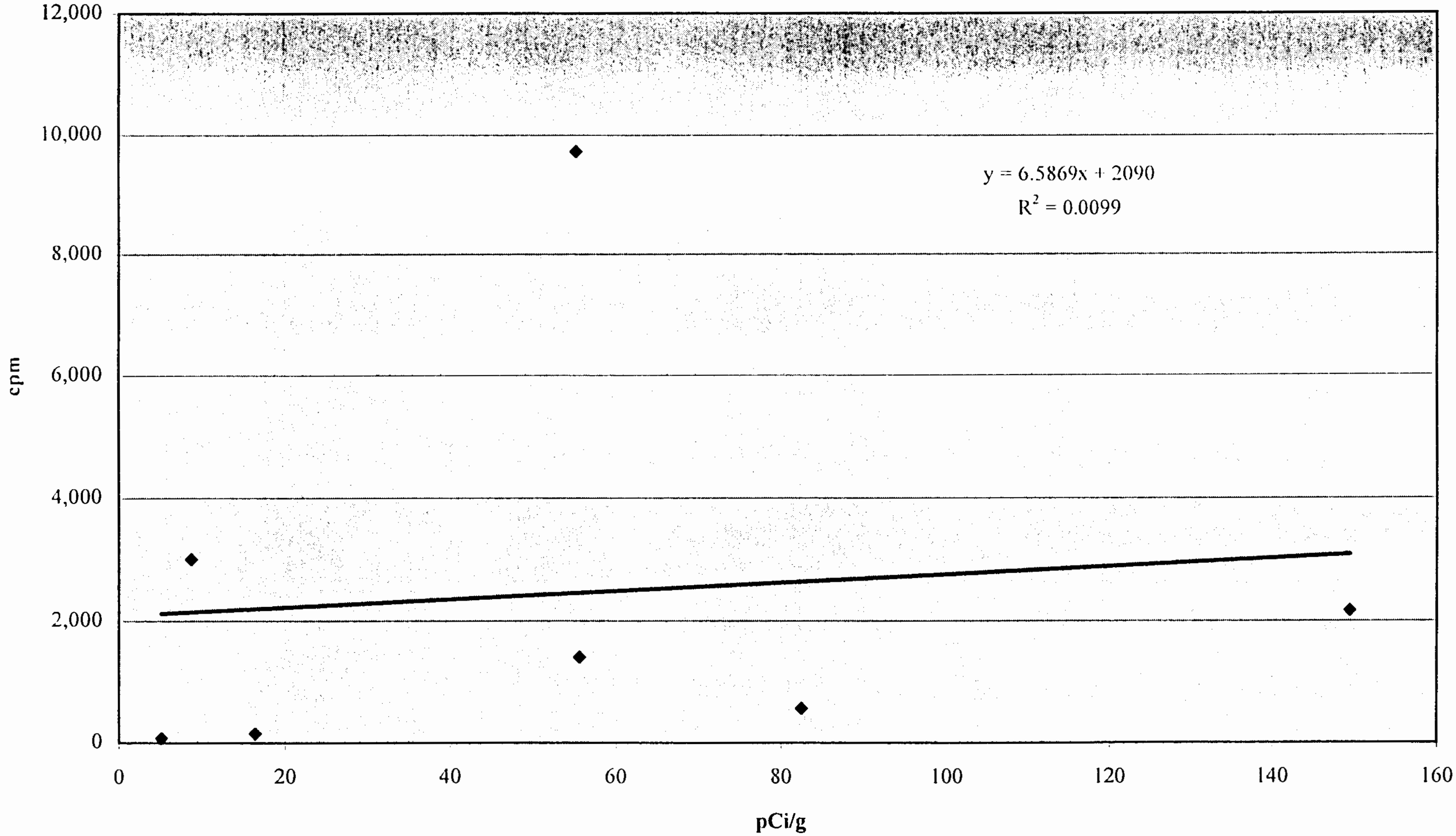
Ex-Situ **2x2 NaI Detector to Off-Site Alpha Spectroscopy**

$y = 43.624x - 200.9$

$R^2 = 0.8309$

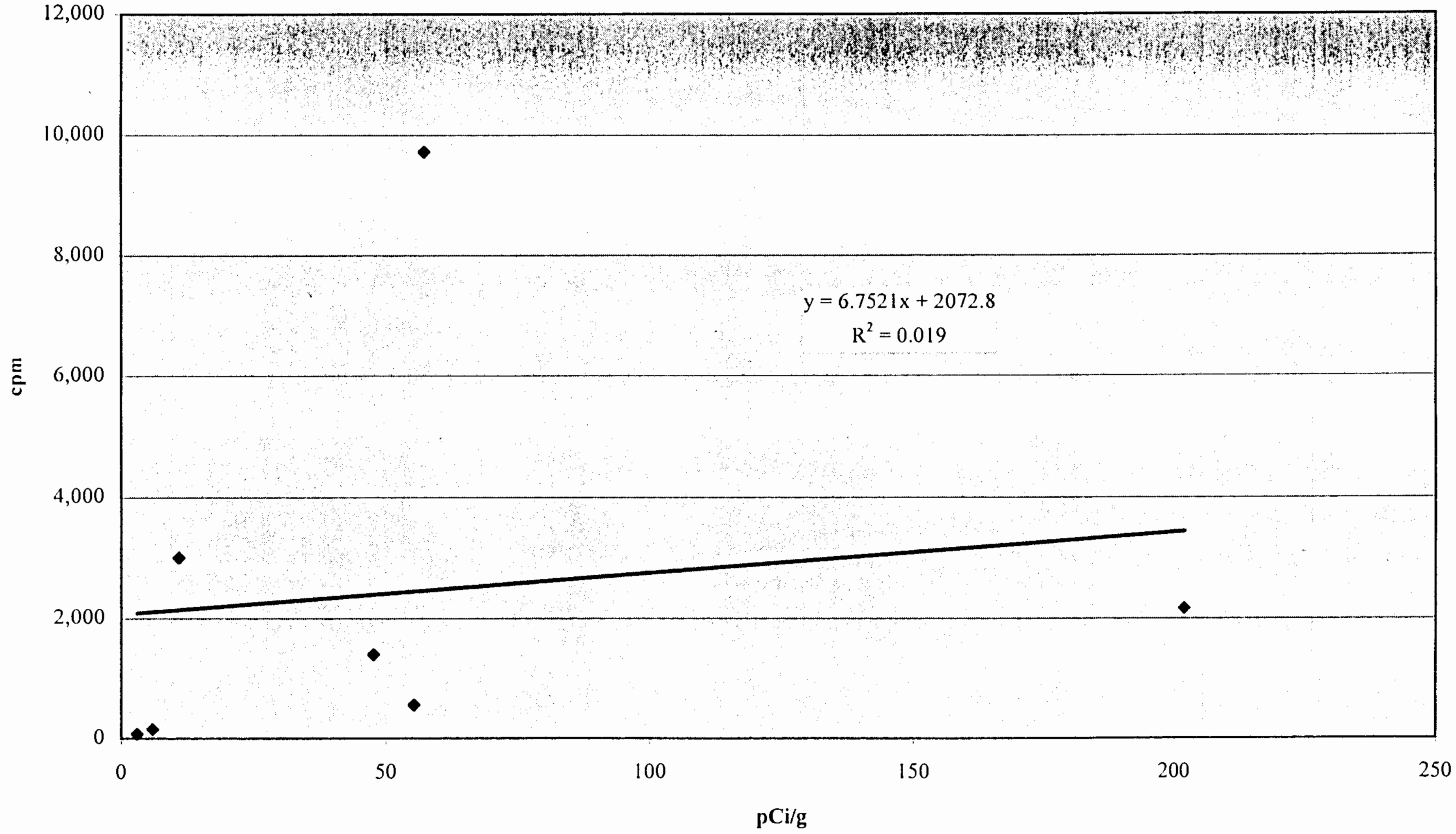
enter x = 7.5	enter x = 15	enter x = 50
y = 2,417	y = 2,744	y = 4,271
enter y = 2,200	enter y = 2,300	enter y = 2,800
x = 2.5	x = 4.8	x = 16.3

Th-232 Correlation - Chart 1
In-Situ 2x2 NaI Detector to On-Site Gamma Spectroscopy (cpm to pCi/g)

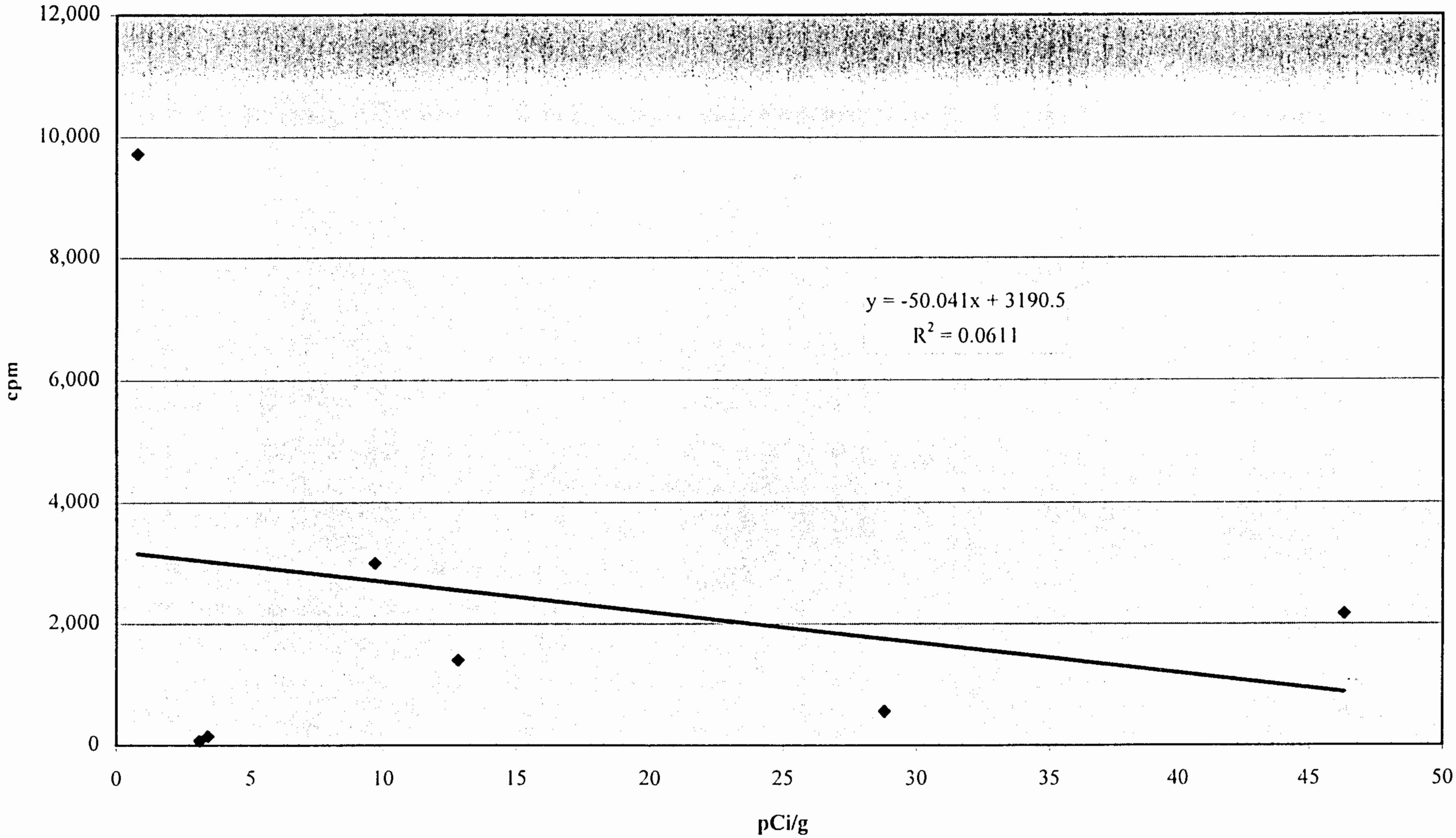


Th-232 Correlation - Chart 2

In-Situ 2x2 NaI Detector to Off-Site Gamma Spectroscopy (cpm to pCi/g)

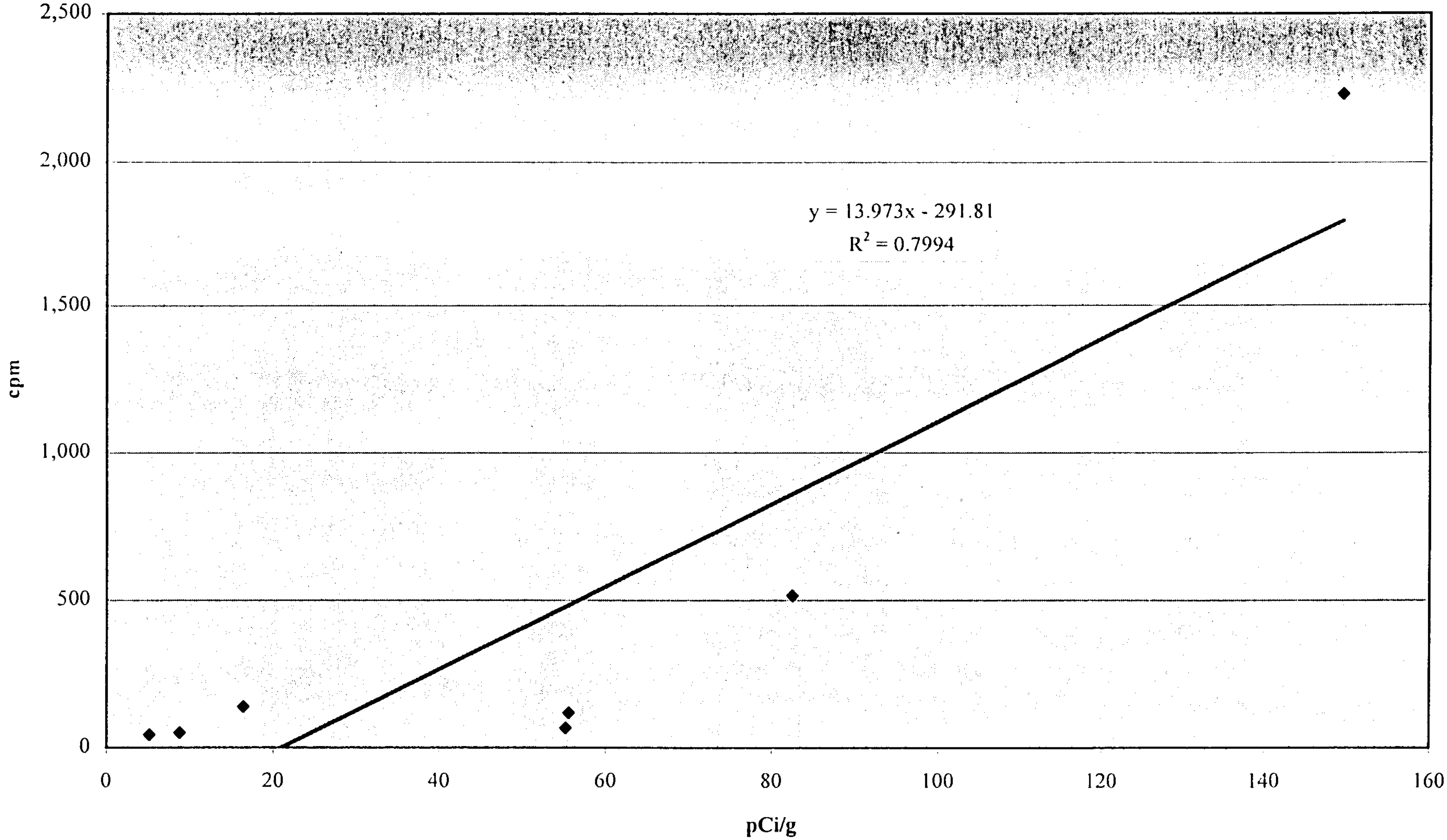


Th-232 Correlation - Chart 3
In-Situ 2x2 NaI to Off-Site Alpha Spectroscopy (cpm to pCi/g)

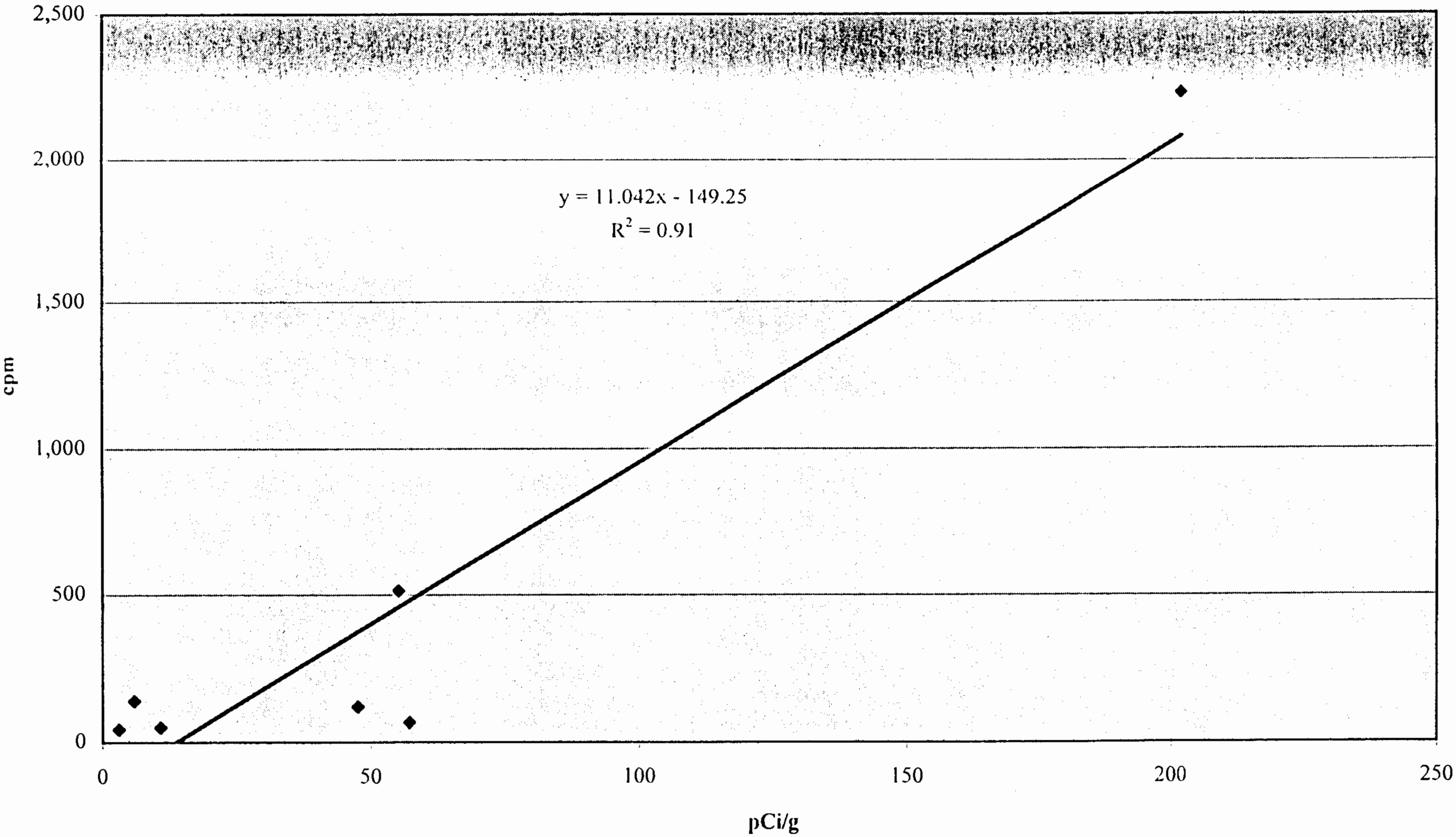


Th-232 Correlation - Chart 4

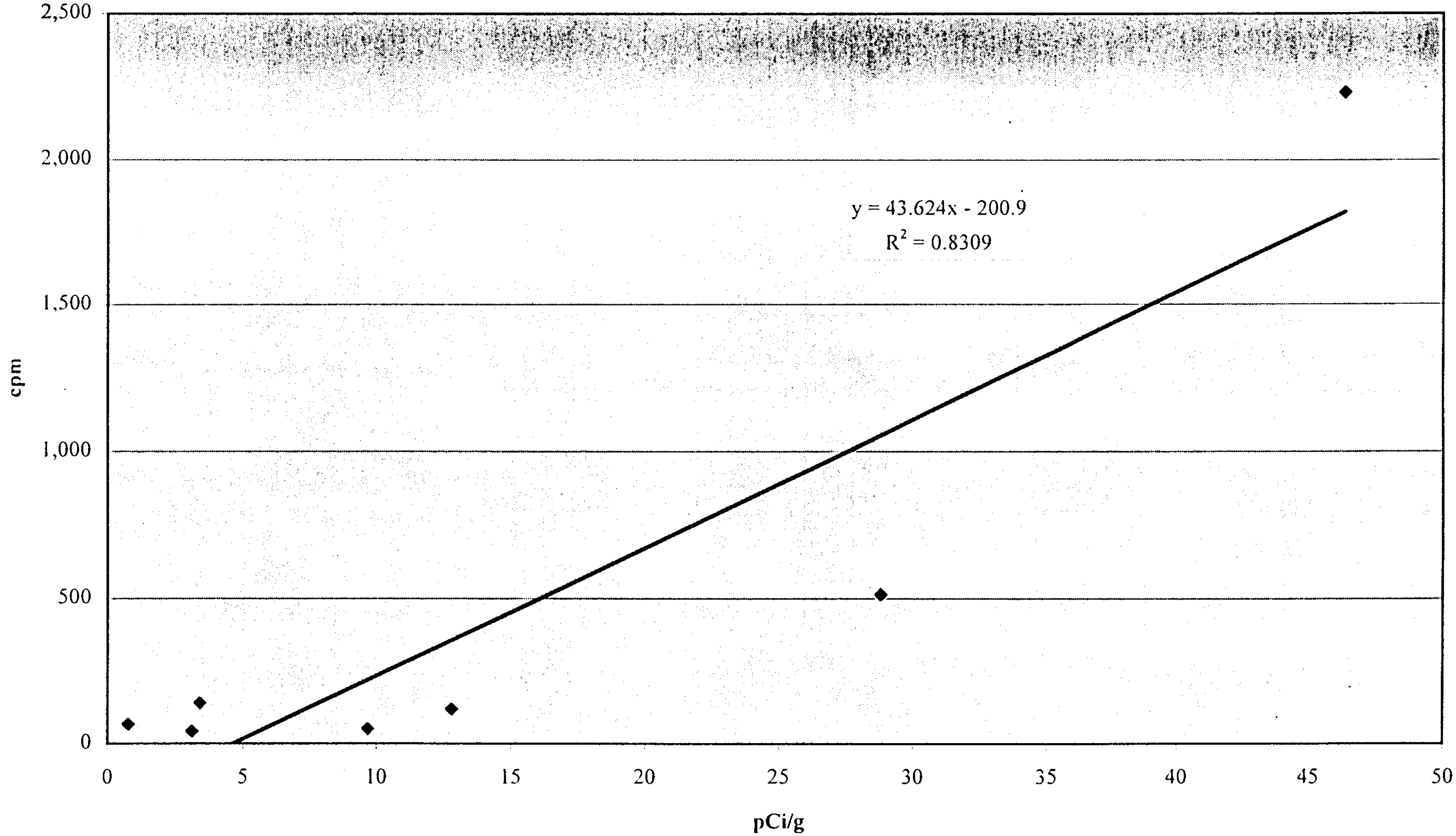
Ex-Situ 2x2 NaI to On-Site Gamma Spectroscopy (cpm to pCi/g)



Th-232 Correlation - Chart 5
Ex-Situ 2x2 NaI to Off-Site Gamma Spectroscopy (cpm to pCi/g)

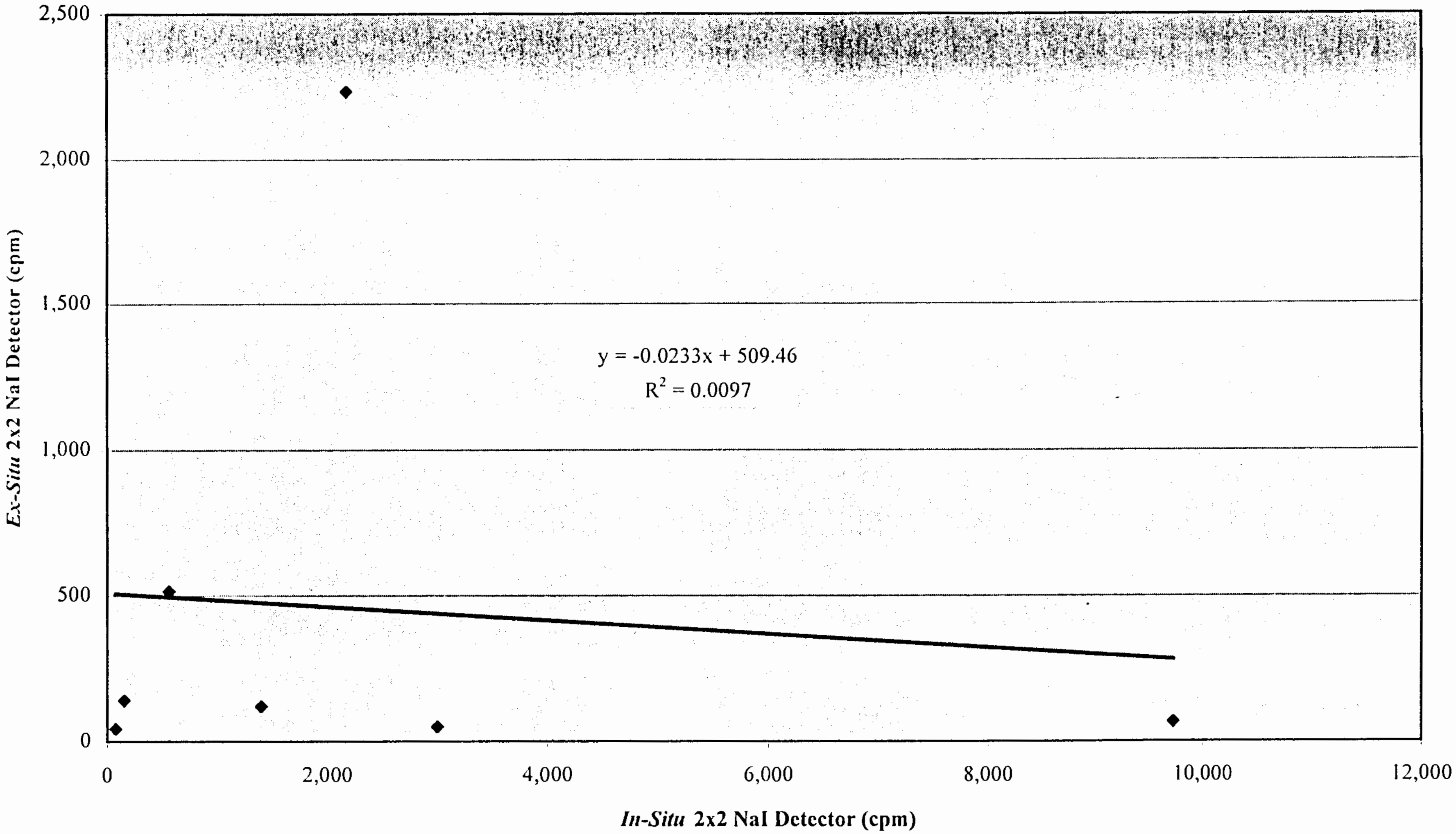


Th-232 Correlation - Chart 6
Ex-Situ 2x2 NaI Detector to Off-Site Alpha Spectroscopy (cpm to pCi/g)

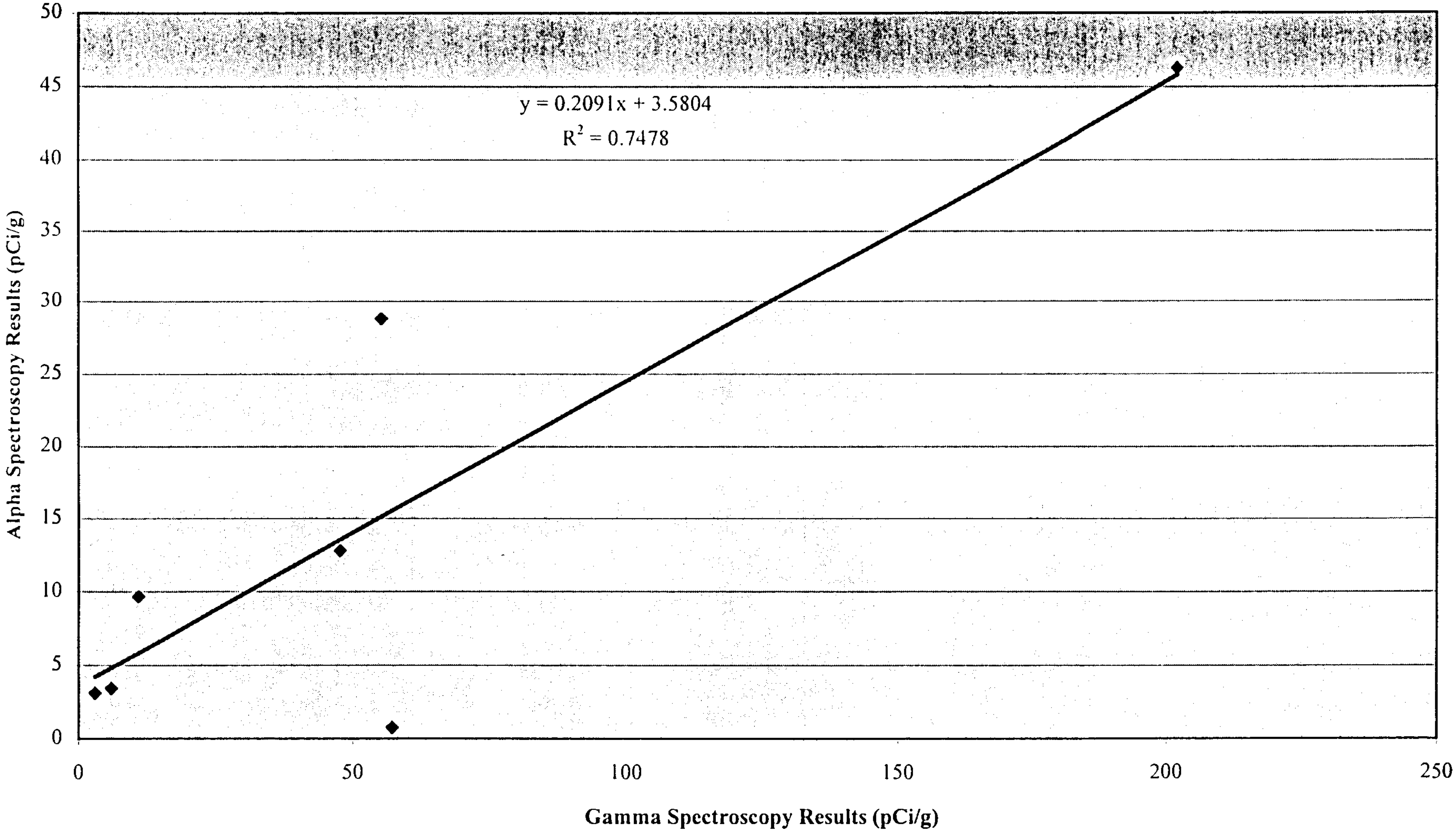


Th-232 Correlation - Chart 7

In-Situ 2x2 NaI Detector (cpm) to *Ex-Situ* 2x2 NaI Detector (cpm)



Th-232 Correlation - Chart 8
Off-Site Gamma Spectroscopy to Off-Site Alpha Spectroscopy



OCL2000-4, 02b

IT Corporation
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Albany, NY 12205
518/482-0237 Fax 518/482-0343

the group

Memo

FILE COPY

To: Brad Eaton, USACE Project Engineer

From: Tony Sheeran, IT Group Project Manager

CC: J. Forcina, USACE Project Management
R. Battaglia, USACE Project Management
D. Ford, USACE Balt. Technical Lead
H. Honerlah, USACE Balt. HP
T. Noce, IT Site Chemist ✓
D. Sendra, IT Site Radiation Control Manager ✓
J. Franz, IT Group Program Manager

Date: 04/14/00

Subject: Updated Correlation Study

The IT Corporation is pleased to submit the attached Correlation Study for the Colonie FUSRAP site. This study was conducted to update the correlation between radiological field instruments and laboratory analysis for site soils. Based on this work, we recommend increasing our FIDLER CPM level for the cut-off between soils meeting the site criteria for Uranium 238 from 12,500 to 13,000 cpm. We recommend increasing the 100 pCi/gm cut-off level from 18,500 to 21,000 cpm.

Once USACE has had a chance to review the attached data and recommendations, this information should be provided to project team's NYSDEC radiological staff for their information.

See me or Tony Noce with any questions concerning the study or the recommendations.

Attachment 4/14/00 Correlation study Memorandum A. Noce to A. Sheeran

OCL 2000-4, 026

the group

IT Corporation
1130 Central Avenue
Albany, NY 12205
518/482-0237 Fax 518/482-0343

Memo

To: Tony Sheeran, Project Manager
Kevin Dufek, Project Engineer

CC: Dave Sendra, Radiological Controls Supervisor
Ed Turney, EDi Project Lead *(includes distribution to other EDi staff)*
Scott Brock, CQC Manager
Sarah Hojnacki, Site Health and Safety Officer
File

From: Tony Noce, Project Chemist

Date: 04/14/00

Subject: Correlation Data Summary to Date

As you are aware, I have been working with RadCon, EDi, CQC and Health and Safety to review the available correlation data for both our radiological field screening instruments and the Niton field portable x-ray fluorescence unit. This memo summarizes the correlation data to date for a thin window Field Instrument for Detecting Low Energy Radioactivity (FIDLER); correlation for the Niton 722 will be addressed in a separate memorandum. In addition, an instrument with a 2x2 sodium iodide detector specifically configured to detect thorium-232 (Th-232) is scheduled to arrive on-Site in the near future. This instrument will also require a correlation study for use on-Site.

The primary goal of this review was to determine the correlation between a relative count rate in counts per minute (cpm) on the FIDLER and the uranium-238 (U-238) activity in picoCuries per gram (pCi/g). The two ranges of particular interest are the break point between "cold" and "warm" (*i.e.*, 35 pCi/g) and the break point between "warm" and "hot" (*i.e.*, 100 pCi/g). Towards this end, thirteen gamma measurement and soil sampling locations were selected on-Site. Samples collected from three of these locations were discarded and excluded from the study when it was discovered that the samples were collected in an obvious burial area. Several drum remnants were encountered, and the static gamma counts following sampling were actually higher than those prior to sample collection.

In addition to the ten acceptable data points collected specifically for correlation purposes, the data from the Final Status Survey Sampling event of March, 2000 in Unit 1 have been included. Data from the TMA/Eberline correlation study conducted in 1993 and documented in a TMA/Ederline Interoffice Memo from M. Bradshaw (TMA/E PM) to D. Beard (TMA/E NY Team Lead) and dated June 3, 1993 have also been included because the sampling methodology used was comparable to the sampling methodology used for the current correlation study.

The data from the Final Status Survey Sampling in Unit 1 conducted in December of 1999 have been excluded from consideration because the one minute static counts were not made prior to sample collection. Due to differences in sampling methodology, the *Field Instrumentation Correlation Study* data presented by ICF Kaiser to the USACE in a letter dated February 17, 1999 have also been excluded from this review.

The soil sampling procedures used for the correlation may be summarized as follows:

- Two separate one (1) minute static gamma counts were taken at each sample location using the FIDLER. The detector was placed 2" above ground surface while taking this measurement, and the average has been used for correlation purposes.
- Surface soil samples were collected at each location approximately 0–6" below ground surface using a stainless steel trowel.
- The sample material collected was homogenized using a limited cone and quarter technique..
- Aliquots of the homogenized sample material were placed in 1 quart paint cans and processed in accordance with EDi Sop 5B.15 prior to a split sample being submitted to ThermoNUtech of Oak Ridge, Tennessee for radiological analysis (*i.e.*, gamma spectroscopy, isotopic uranium and isotopic thorium).
- All non-dedicated reusable sampling equipment was decontaminated using a non-phosphate detergent wash and a distilled/deionized water rinse. Equipment stored for future use was allowed to air dry and then wrapped in aluminum foil (shiny-side out) or sealed in plastic bags.

A total of 36 samples representing 35 discrete sampling locations and one blind field duplicate were considered in the development of this correlation. Sixteen samples (15 discrete locations and one blind duplicate) from the March 2000 sampling in Final Status Survey Unit 1, ten samples from the current correlation study, and ten samples from the 1993 correlation study. One sample from the current correlation study was found to be anomalous and has been excluded as a probable statistical outlier; the data for this sample has been included in a footnote on the attached table. This leaves a total of 35 samples that were used to develop the current correlation values. Samples collected in the future will be added to this database in order to further refine the correlations outlined here.

The Correlation Data Summary for U-238 is presented on the attached table. In addition, a total of five charts summarizing various correlations are presented:

1. FIDLER to On-Site Gamma Spectroscopy
2. FIDLER to Off-Site Gamma Spectroscopy
3. FIDLER to Off-Site LEPS Gamma Spectroscopy
4. FIDLER to Off-Site Alpha Spectroscopy
5. On-Site Gamma Spectroscopy to Off-Site Alpha Spectroscopy

The first correlation, FIDLER to On-Site Gamma Spectroscopy, is based on a total of 25 samples and exhibits a 0.96 correlation coefficient. According to the equation derived for a linear trendline through the data, 35 pCi/g would be the equivalent of 13,228 cpm, while 100 pCi/g would be 23,486 cpm.

The second correlation, FIDLER to Off-Site Gamma Spectroscopy, is based on a total of 35 samples and exhibits a 0.88 correlation coefficient. According to the equation derived for a linear trendline through the data, 35 pCi/g would be the equivalent of 13,455 cpm, while 100 pCi/g would be 21,356 cpm.

The third correlation, FIDLER to Off-Site LEPS Gamma Spectroscopy, is based on a total of 25 samples and exhibits a 0.94 correlation coefficient. According to the equation derived for a linear trendline through the data, 35 pCi/g would be the equivalent of 13,251 cpm, while 100 pCi/g would be 20,390 cpm.

The fourth correlation, FIDLER to Off-Site Alpha Spectroscopy, is also based on a total of 25 samples and exhibits a 0.93 correlation coefficient. According to the equation derived for a linear trendline through the data, 35 pCi/g would be the equivalent of 12,326 cpm, while 100 pCi/g would be 17,917 cpm.

The fifth correlation compares 25 On-Site Gamma Spectroscopy to Off-Site Alpha Spectroscopy results and exhibits a 0.96 correlation coefficient. Although there is an apparent divergence between the absolute values of the results reported at the upper end, the agreement between the two sets of results is generally acceptable, and the correlation between the two sets of results is excellent.

After reviewing the results summarized above, I recommend the following:

- Use of 13,000 counts per minute as the break point between "cold" and "warm" for gamma walkovers.
- Use of 21,000 counts per minute as the break point between "warm" and "hot" for gamma walkovers.
- Assuming the preceding recommendations are accepted and implemented, the submission of all soil stabilization samples to a laboratory with a radioactive materials license unless we have on-Site gamma spectroscopy results demonstrating that the material meets the Site release criteria (*i.e.*, exhibits < 35 pCi/g U-238 and < 15 pCi/g Th-232).
- The collection of an additional six to ten correlation study samples in the 19,000 to 24,000 cpm range. These are necessary to further refine the correlation at the upper end.
- Continued refinement of this correlation as additional data are received in the course of the project.
- As mentioned previously, performance of a correlation study for the 2x2 sodium iodide detector specifically configured to detect Th-232 that is scheduled to arrive on-Site in the near future.

I would also like to recommend that we meet with the appropriate USACE staff once they have had the opportunity to review this memorandum in order to discuss the process and the appropriate follow-up activities required, including the 2x2 correlation study and the frequency with which they would like to see updates to this correlation based on our ongoing correlation work.

As always, please see me if you have any questions or comments.

Correlation Data Summary

IT Project Number 866724
Colonie FUSRAP Site
Colonie, New York

Sample ID	FIDLER Static Counts			Uranium-238			
				EDi	ThermoNUtech		
	#1 *cpm*	#2 *cpm*	average *cpm*	Gamma Spec Result *pCi/g*	Gamma Spec Result *pCi/g*	LEPS Result *pCi/g*	Alpha Spec Result *pCi/g*
CFS-01-16			8,697	6.3	1.03	0.479	0.565
CFS-01-17			8,625	8.7	0.973	1.42	0.891
CFS-01-18			8,312	11.6	< 2.06	2.85	2.65
CFS-01-19			8,938	10.9	2.600	1.06	1.29
CFS-01-20			8,624	8.0	3.34	0.130	1.22
CFS-01-21			8,028	10.8	5.560	5.73	4.43
CFS-01-22			8,270	8.0	1.45	1.0	1.09
CFS-01-23			8,947	10.5	0.832	0.724	0.963
CFS-01-24			9,900	9.2	2.87	0.65	1.90
CFS-01-25			11,108	25.7	28.6	17.6	24.3
CFS-01-26			9,846	8.6	2.93	0.53	1.93
CFS-01-27			10,258	8.7	1.13	3.12	2.44
CFS-01-28			10,199	9.4	1.66	1.02	1.14
CFS-01-29			9,049	8.0	1.71	1.07	1.30
CFS-01-30			9,773	11.0	1.43	1.23	1.38
CFS-01-31			10,917	31.0	19.6	19.4	23.0
CSL207	11,754	11,924	11,839	13.3	6.28	6.3	3.62
CSL208	10,369	10,698	10,534	11.2	2.05	6.11	5.56
CSL209	32,453	31,985	32,219	149.7	176.1	198.5	235.7
CSL210	17,673	17,519	17,596	68.2	76.88	63.36	118.7
CSL211	17,603	17,309	17,456	61.6	50.35	58.05	73.32
CSL213	13,247	12,990	13,119	49.4	39.73	38.27	54.66
CSL214	14,871	14,734	14,803	41.4	31.38	33.23	47.89
CSL215	22,222	22,198	22,210	93	153	146.8	189.6
CSL216	15,843	15,680	15,762	38.1	45.78	27.44	39.19
CSL217	28,903	28,718	*point excluded as an outlier*				
TMA1			7,520		11.5		
TMA2			8,239		17.5		
TMA3			10,750		22.4		
TMA4			12,347		25.3		
TMA5			12,881		33.9		
TMA6			14,140		36.7		
TMA7			16,702		44.8		
TMA8			19,406		73.5		
TMA9			21,043		61.1		
TMA10			21,736		85.4		

Notes:

CSL217	(excluded)	28,811	318.6	162.4	268.8	367.7

pCi/g indicates picoCuries per gram
cpm indicates counts per minute

Correlation Data - Calculations

IT Project Number 866724
Colonie FUSRAP Site
Colonie, New York

FIDLER to On-Site Gamma Spectroscopy

$y = 157.81x + 7704.7$
$R^2 = 0.9606$

enter x = 17.5	enter x = 35	enter x = 100	
y = 10,466	y = 13,228	y = 23,486	
enter y = 12,000	enter y = 13,000	enter y = 18,000	enter y = 21,000
x = 27.2	x = 33.6	x = 65.2	x = 84.2

FIDLER to Off-Site Gamma Spectroscopy

$y = 121.56x + 9200.2$
$R^2 = 0.8815$

enter x = 17.5	enter x = 35	enter x = 100	
y = 11,328	y = 13,455	y = 21,356	
enter y = 12,000	enter y = 13,000	enter y = 18,000	enter y = 21,000
x = 23.0	x = 31.3	x = 72.4	x = 97.1

FIDLER to Off-Site LEPS Gamma Spectroscopy

$y = 109.83x + 9406.9$
$R^2 = 0.9364$

enter x = 17.5	enter x = 35	enter x = 100	
y = 11,329	y = 13,251	y = 20,390	
enter y = 12,000	enter y = 13,000	enter y = 18,000	enter y = 21,000
x = 23.6	x = 32.7	x = 78.2	x = 105.6

FIDLER to Off-Site Alpha Spectroscopy

$y = 86.019x + 9315.2$
$R^2 = 0.9271$

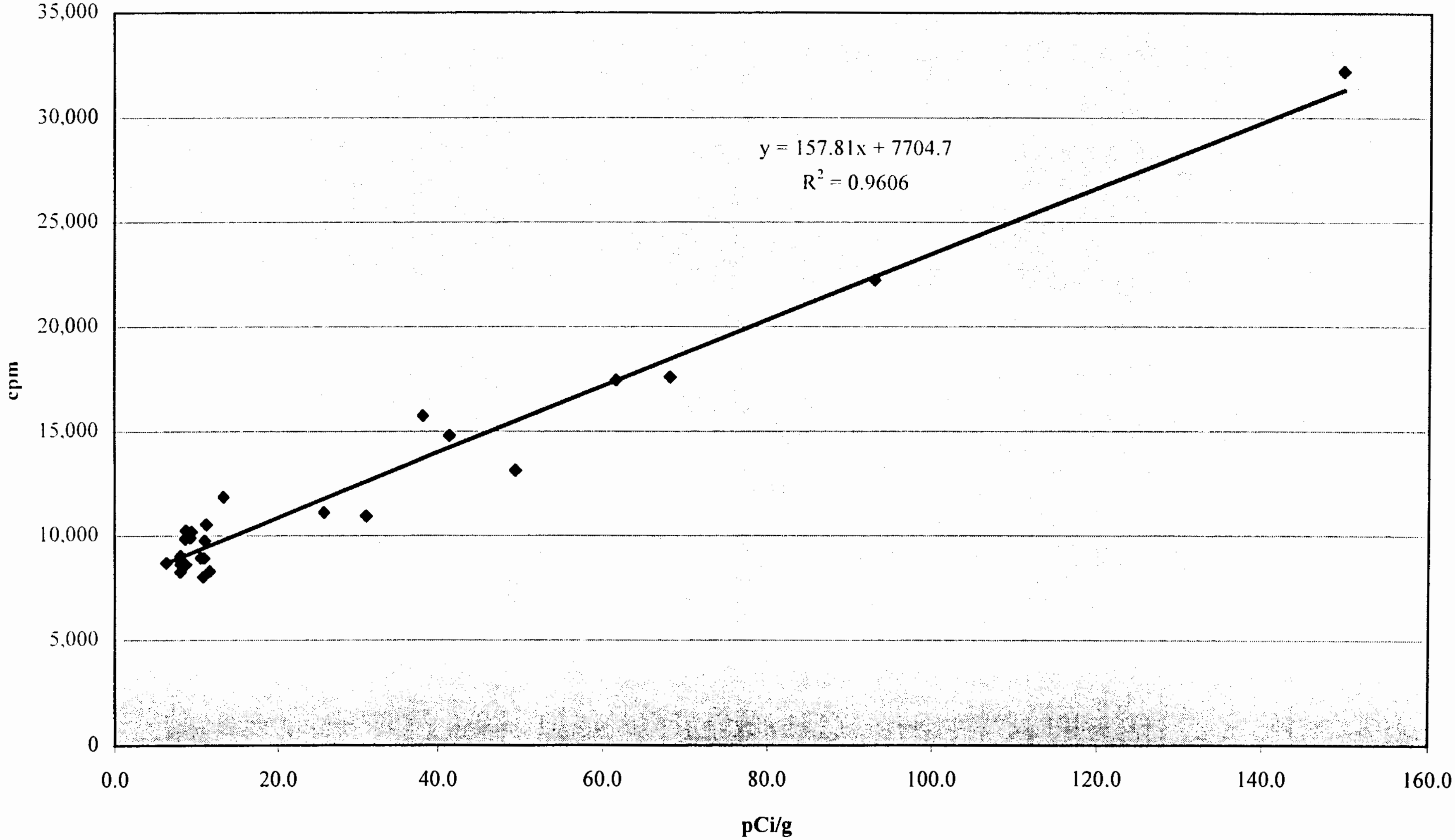
enter x = 17.5	enter x = 35	enter x = 100	
y = 10,821	y = 12,326	y = 17,917	
enter y = 12,000	enter y = 13,000	enter y = 18,000	enter y = 21,000
x = 31.2	x = 42.8	x = 101.0	x = 135.8

On-Site Gamma Spectroscopy to Off-Site Alpha Spectroscopy

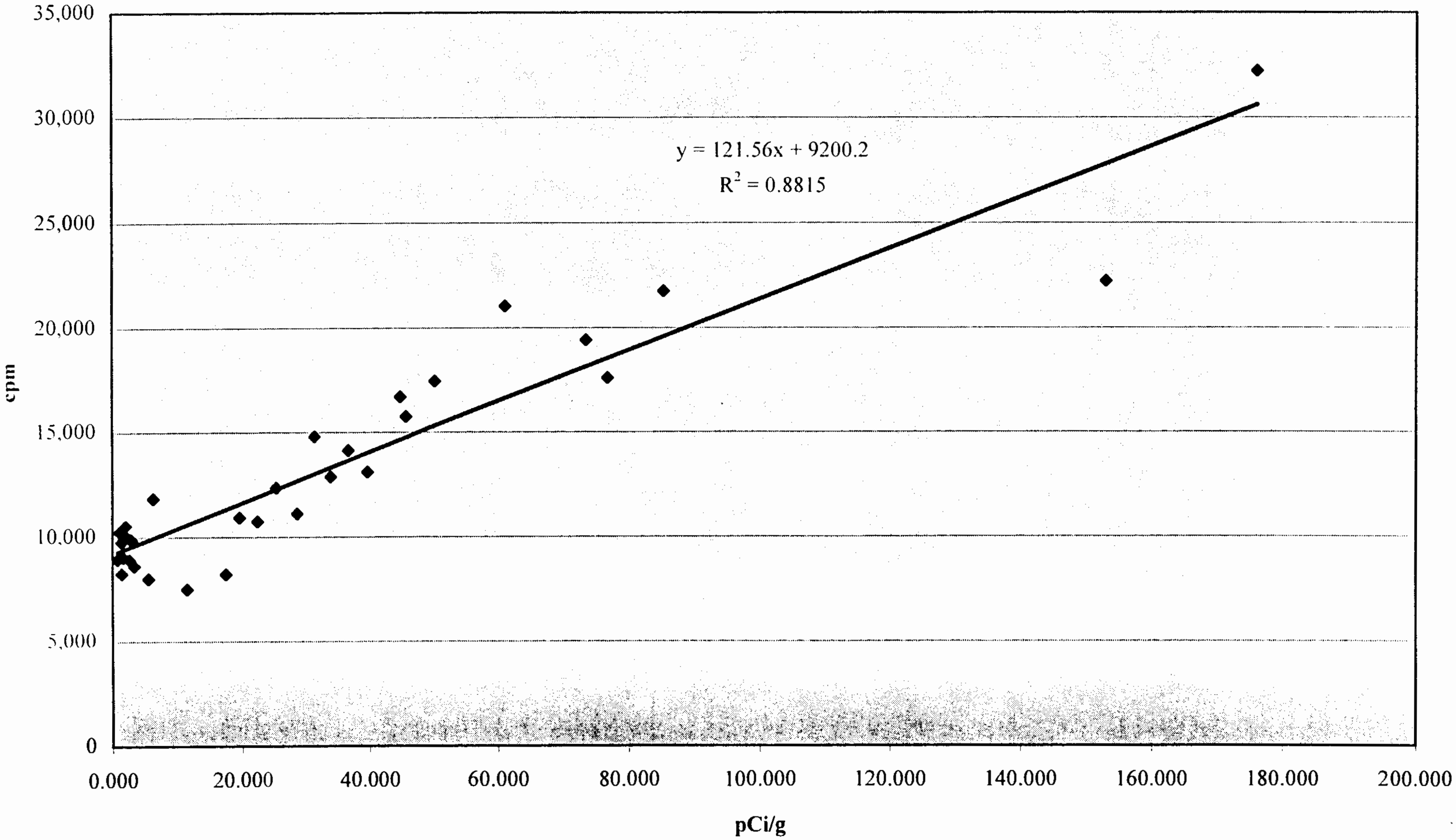
$y = 1.769x - 16.852$
$R^2 = 0.9633$

enter x = 17.5	enter x = 35	enter x = 100
y = 14.1	y = 45.1	y = 160.0

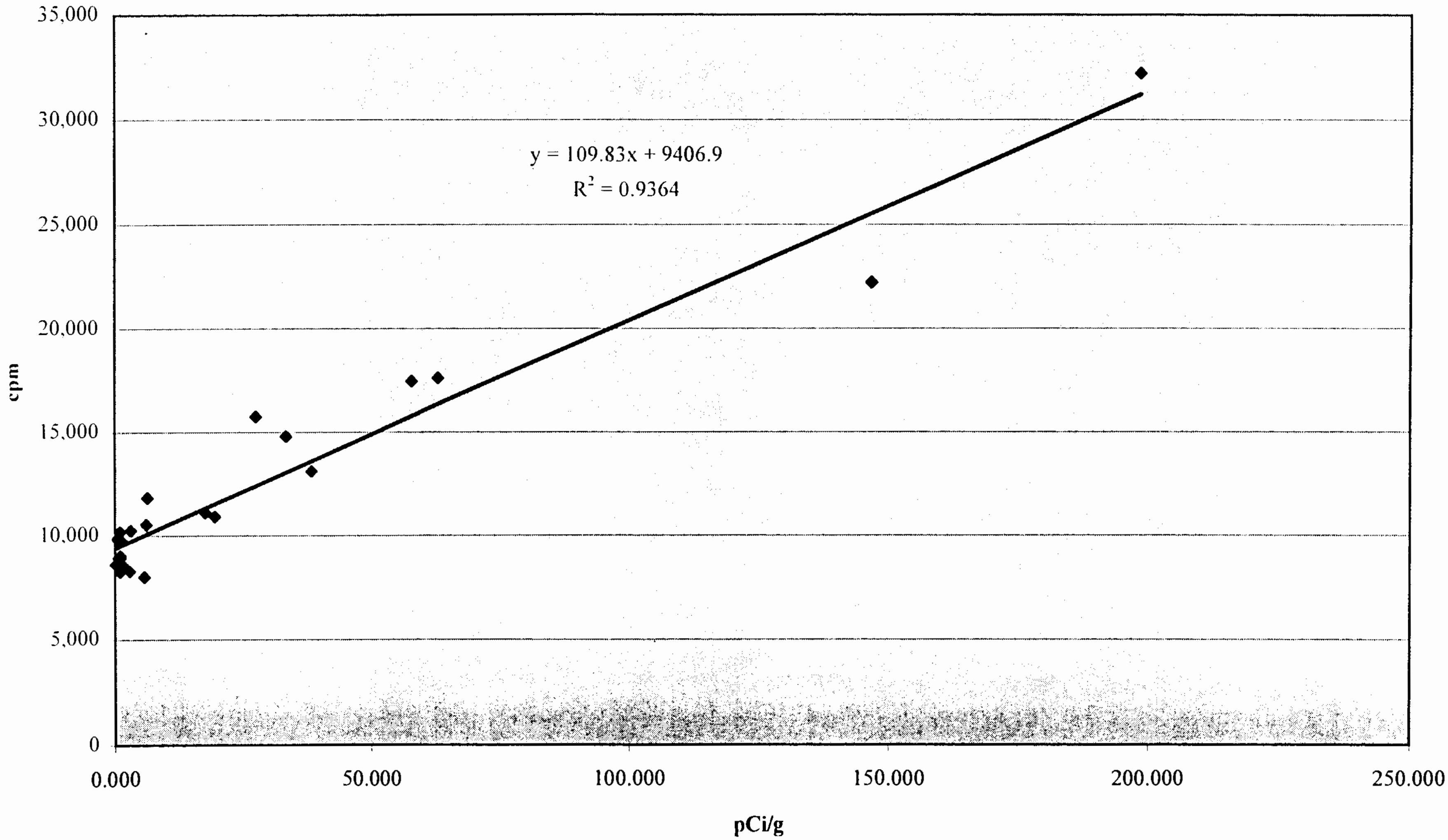
U-238 Correlation - Chart 1
FIDLER to On-Site Gamma Spectroscopy



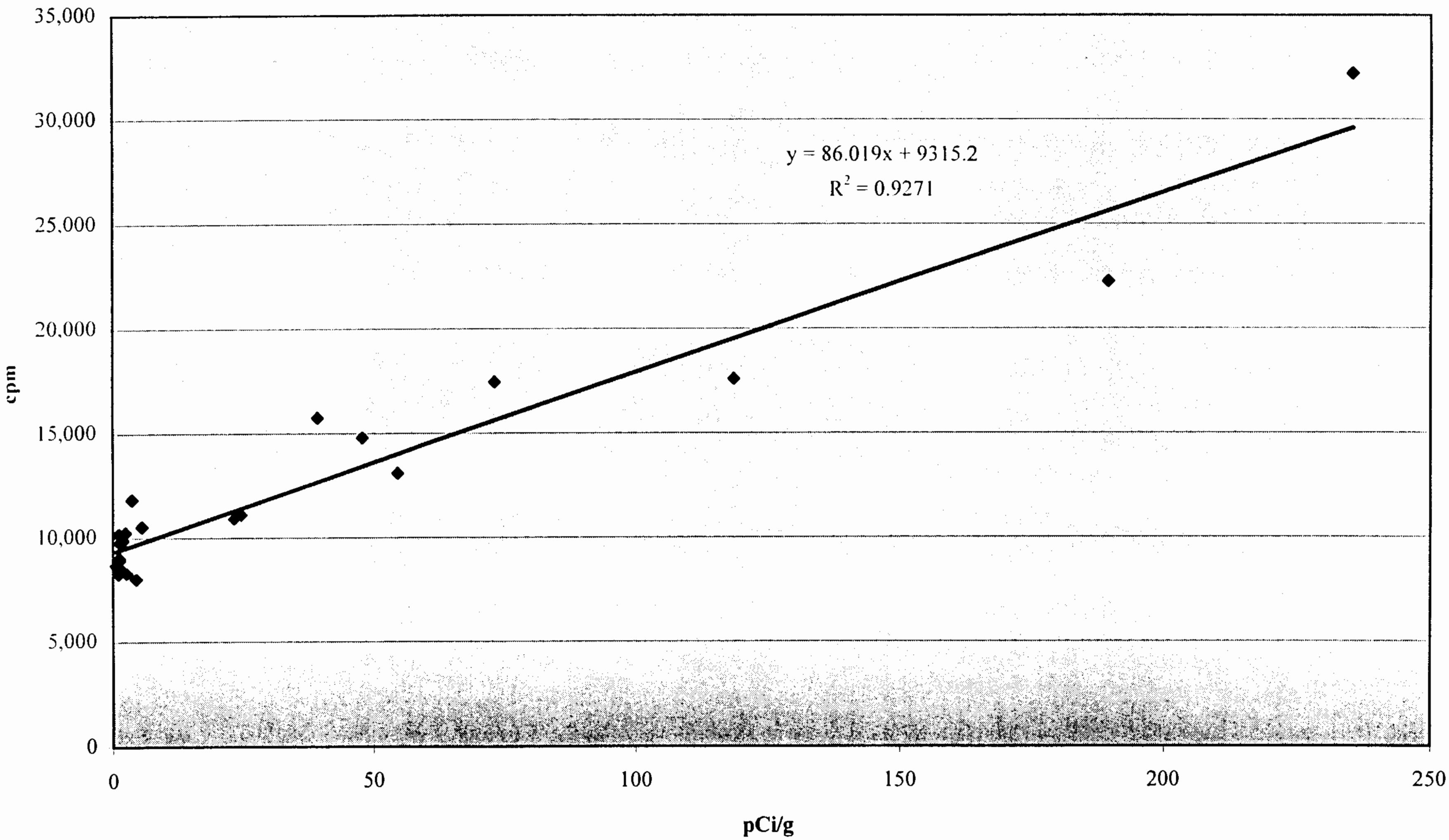
U-238 Correlation - Chart 2
FIDLER to Off-Site Gamma Spectroscopy



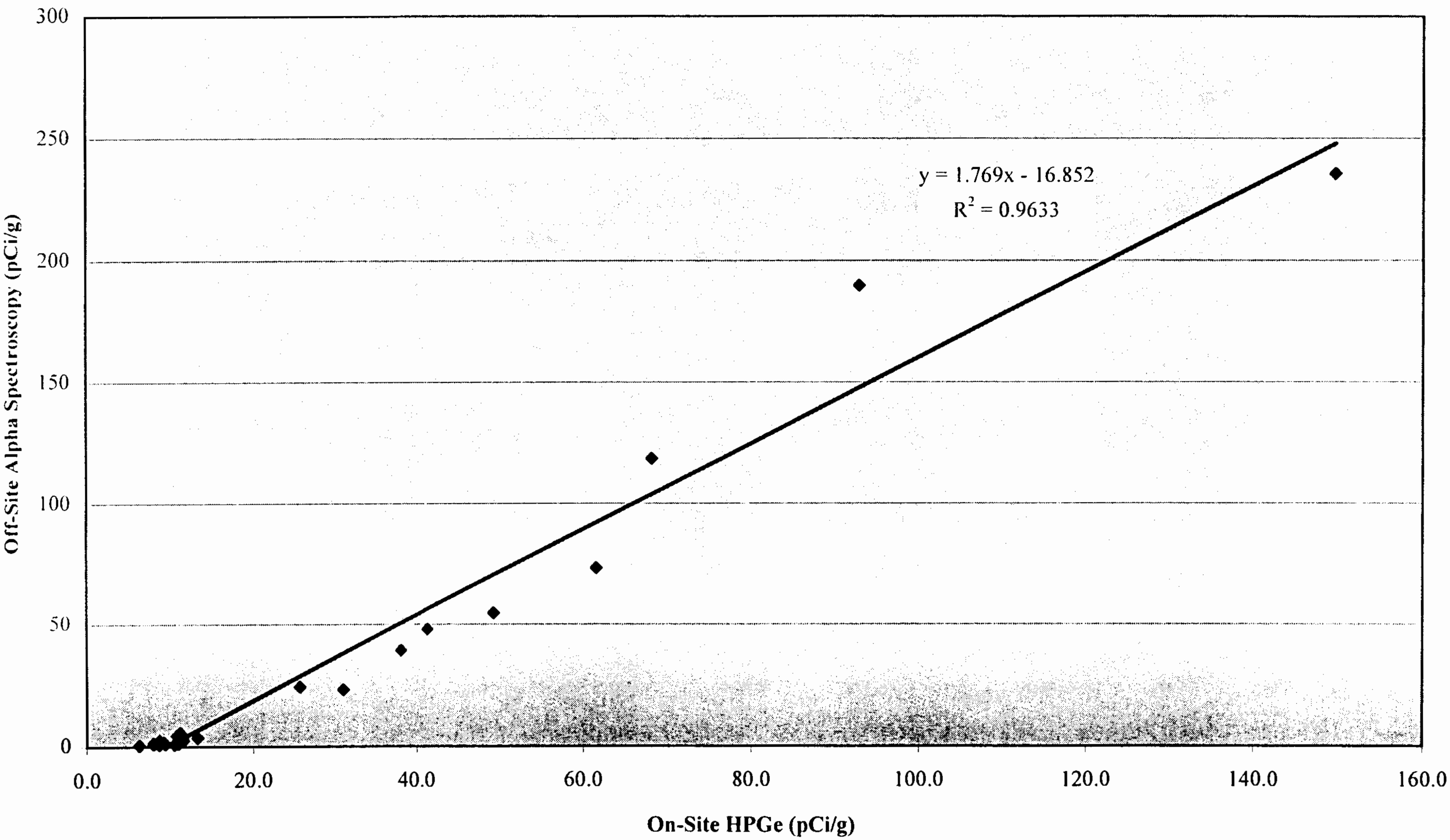
U-238 Correlation - Chart 3
FIDLER to Off-Site LEPS Gamma Spectroscopy (cpm to pCi/g)



U-238 Correlation - Chart 4
FIDLER to Off-Site Alpha Spectroscopy (cpm to pCi/g)



U-238 Correlation - Chart 5
On-Site Gamma Spectroscopy to Off-Site Alpha Spectroscopy



EXAMPLE FIELD SURVEY DATA TABLE

DATE	TIME	RAD DATA	X-COORDINATE	Y-COORDINATE
8/9/01	10:23:29AM	9215	1061.15801	1406.65872
8/9/01	10:23:29AM	8648	1061.15801	1406.65872
8/9/01	10:23:29AM	8364	1061.15801	1406.65872
8/9/01	10:23:29AM	8851	1060.88185	1407.08400
8/9/01	10:23:31AM	9411	1061.03775	1407.85743
8/9/01	10:23:33AM	9125	1061.82282	1410.69761
8/9/01	10:23:35AM	9161	1062.77859	1414.63801
8/9/01	10:23:37AM	7806	1063.14541	1418.15355
8/9/01	10:23:39AM	8594	1065.63018	1420.26941
8/9/01	10:23:41AM	8612	1065.38129	1422.39522
8/9/01	10:23:43AM	8527	1064.32084	1422.66370
8/9/01	10:23:45AM	9424	1065.12423	1422.75893
8/9/01	10:23:47AM	9444	1065.07620	1423.53750
8/9/01	10:23:49AM	7999	1065.24483	1419.04505
8/9/01	10:23:51AM	9050	1064.03636	1417.20504
8/9/01	10:23:53AM	7962	1063.82834	1413.30463
8/9/01	10:23:55AM	8514	1062.33132	1409.44826
8/9/01	10:23:57AM	8858	1061.10364	1406.00437
8/9/01	10:23:59AM	8536	1058.47615	1404.39464
8/9/01	10:24:01AM	8855	1058.04948	1405.36251
8/9/01	10:24:03AM	9050	1058.41001	1404.94602
8/9/01	10:24:05AM	9841	1058.93447	1408.82514
8/9/01	10:24:07AM	8826	1060.60063	1412.94868
8/9/01	10:24:09AM	8269	1061.44464	1417.61969
8/9/01	10:24:11AM	9096	1062.58444	1421.40980
8/9/01	10:24:13AM	9140	1063.84413	1422.54671
8/9/01	10:24:15AM	8370	1064.14240	1423.39674
8/9/01	10:24:17AM	8141	1063.53715	1423.97165
8/9/01	10:24:19AM	9030	1064.38563	1419.40522
8/9/01	10:24:21AM	8897	1062.35555	1416.77434
8/9/01	10:24:23AM	8357	1061.52400	1412.69922
8/9/01	10:24:25AM	8315	1060.68320	1408.84306
8/9/01	10:24:27AM	8973	1059.47727	1405.03797
8/9/01	10:24:29AM	8767	1059.31189	1403.86945

DATE	TIME	RAD DATA	X-COORDINATE	Y-COORDINATE
8/9/01	10:24:31AM	8558	1056.96193	1405.88388
8/9/01	10:24:33AM	8942	1057.00440	1406.08665
8/9/01	10:24:35AM	8640	1056.43490	1407.04696
8/9/01	10:24:37AM	9205	1057.53463	1410.37900
8/9/01	10:24:39AM	9032	1058.74397	1413.75939
8/9/01	10:24:41AM	8711	1059.79259	1416.60218
8/9/01	10:24:43AM	8463	1063.93564	1417.23132
8/9/01	10:24:45AM	8427	1063.85678	1420.82526
8/9/01	10:24:47AM	8933	1064.22945	1422.03052
8/9/01	10:24:49AM	9367	1064.71345	1421.68012
8/9/01	10:24:51AM	8715	1064.04464	1422.29213
8/9/01	10:24:53AM	8290	1063.20067	1423.06442
8/9/01	10:24:55AM	8257	1060.73002	1420.55539
8/9/01	10:24:57AM	8519	1060.73280	1418.02276
8/9/01	10:24:59AM	9203	1060.32293	1416.63903
8/9/01	10:25:01AM	8677	1059.54795	1414.18754
8/9/01	10:25:03AM	8952	1058.81941	1410.34197
8/9/01	10:25:05AM	8959	1057.42333	1406.20678
8/9/01	10:25:07AM	8480	1057.48779	1404.75525
8/9/01	10:25:09AM	8713	1055.88109	1404.09302
8/9/01	10:25:11AM	8975	1054.61244	1405.08447
8/9/01	10:25:13AM	8869	1054.88345	1407.57752
8/9/01	10:25:15AM	9782	1055.64223	1409.41051
8/9/01	10:25:17AM	8936	1056.53081	1412.31714
8/9/01	10:25:19AM	8741	1056.54164	1414.69143
8/9/01	10:25:21AM	8589	1057.71189	1418.39232
8/9/01	10:25:23AM	8406	1058.29610	1420.16401
8/9/01	10:25:25AM	8388	1060.51859	1422.97626
8/9/01	10:25:27AM	8223	1060.27321	1424.16823
8/9/01	10:25:29AM	8763	1059.14447	1424.82876
8/9/01	10:25:31AM	9156	1059.28474	1425.00894
8/9/01	10:25:33AM	9026	1059.51854	1425.30924
8/9/01	10:25:35AM	9834	1060.81419	1424.09525
8/9/01	10:25:37AM	9200	1060.68578	1422.65072

DATE	TIME	RAD DATA	X-COORDINATE	Y-COORDINATE
8/9/01	10:25:39AM	8880	1059.83607	1419.84699
8/9/01	10:25:41AM	8428	1059.74120	1418.64294
8/9/01	10:25:43AM	8870	1058.78748	1415.70534
8/9/01	10:25:45AM	9347	1057.49369	1412.23218
8/9/01	10:25:47AM	8433	1056.42579	1409.02947
8/9/01	10:25:49AM	8557	1055.63124	1405.69925
8/9/01	10:25:51AM	8763	1053.37745	1404.29110
8/9/01	10:25:53AM	9713	1053.85232	1406.32591
8/9/01	10:25:55AM	9509	1053.53003	1409.15971
8/9/01	10:25:57AM	9151	1055.98619	1410.04864
8/9/01	10:25:59AM	8640	1055.33747	1415.01477
8/9/01	10:26:01AM	8873	1057.21171	1418.78513
8/9/01	10:26:03AM	8387	1057.30774	1422.59007
8/9/01	10:26:05AM	8625	1058.01568	1423.51269
8/9/01	10:26:07AM	8887	1058.21500	1424.60244
8/9/01	10:26:09AM	9311	1058.77415	1424.86025
8/9/01	10:26:11AM	9482	1058.13271	1424.05803
8/9/01	10:26:13AM	9801	1057.52077	1423.02152
8/9/01	10:26:15AM	8744	1057.28107	1420.21800
8/9/01	10:26:17AM	8997	1057.14927	1418.33530
8/9/01	10:26:19AM	9016	1056.18902	1415.13168
8/9/01	10:26:21AM	9199	1055.55416	1410.55493
8/9/01	10:26:23AM	9203	1054.06511	1406.97615
8/9/01	10:26:25AM	9453	1053.43784	1405.84781
8/9/01	10:26:27AM	8925	1053.58158	1404.77136
8/9/01	10:26:29AM	8680	1053.58158	1404.77136
8/9/01	10:26:31AM	8618	1053.58158	1404.77136
8/9/01	10:26:33AM	8902	1056.96567	1418.55303
8/9/01	10:26:35AM	8691	1056.96567	1418.55303
8/9/01	10:26:37AM	9025	1056.56985	1421.11992
8/9/01	10:26:39AM	8584	1057.77452	1423.73571
8/9/01	10:26:41AM	8808	1056.64591	1424.77372
8/9/01	10:26:43AM	9681	1057.16387	1423.57774
8/9/01	10:26:45AM	8885	1057.43035	1423.52591

DATE	TIME	RAD DATA	X-COORDINATE	Y-COORDINATE
8/9/01	10:26:47AM	8727	1057.07509	1425.06732
8/9/01	10:26:49AM	8118	1056.78873	1422.78235
8/9/01	10:26:51AM	8824	1056.81329	1420.73504
8/9/01	10:26:53AM	9354	1056.81329	1420.73504
8/9/01	10:26:55AM	8530	1056.81329	1420.73504
8/9/01	10:26:57AM	8965	1053.12879	1404.95576
8/9/01	10:26:59AM	9106	1053.12879	1404.95576
8/9/01	10:27:01AM	8675	1053.12879	1404.95576
8/9/01	10:27:03AM	9026	1053.16268	1405.37218
8/9/01	10:27:05AM	8763	1053.16268	1405.37218
8/9/01	10:27:07AM	9918	1053.16268	1405.37218
8/9/01	10:27:17AM	8966	1058.27852	1425.25742
8/9/01	10:27:19AM	9298	1058.27852	1425.25742
8/9/01	10:27:21AM	9096	1058.27852	1425.25742
8/9/01	10:27:23AM	8370	1058.27852	1425.25742
8/9/01	10:27:25AM	8850	1058.27852	1425.25742
8/9/01	10:42:33AM	9567	1068.60921	1423.02146
8/9/01	10:42:35AM	9880	1068.71305	1422.95026
8/9/01	10:42:37AM	9698	1070.70437	1422.08544
8/9/01	10:42:39AM	8222	1074.21115	1421.47235
8/9/01	10:42:41AM	8776	1076.39096	1420.66205
8/9/01	10:42:43AM	8633	1079.16097	1419.89137
8/9/01	10:42:45AM	8493	1082.15097	1419.22527
8/9/01	10:42:47AM	8633	1084.42471	1418.14958
8/9/01	10:42:49AM	7875	1087.28218	1417.36585
8/9/01	10:42:51AM	8681	1090.09903	1416.36593
8/9/01	10:42:53AM	9192	1092.22671	1415.87432
8/9/01	10:42:55AM	9378	1094.74405	1414.81823
8/9/01	10:42:57AM	8514	1097.97013	1413.82249
8/9/01	10:42:59AM	8121	1100.99060	1413.06302
8/9/01	10:43:01AM	8255	1103.71061	1411.72508
8/9/01	10:43:03AM	9311	1106.44191	1411.26900
8/9/01	10:43:05AM	8246	1109.51065	1410.23389
8/9/01	10:43:07AM	8751	1109.35027	1409.35567

DATE	TIME	RAD DATA	X-COORDINATE	Y-COORDINATE
8/9/01	10:43:09AM	8793	1107.25482	1409.61815
8/9/01	10:43:11AM	8470	1106.13421	1408.84020
8/9/01	10:43:13AM	7434	1106.60458	1407.32279
8/9/01	10:43:15AM	8273	1106.54823	1408.26986
8/9/01	10:43:17AM	8936	1106.08922	1408.80037
8/9/01	10:43:19AM	8272	1106.29724	1408.70770
8/9/01	10:43:21AM	8241	1105.10459	1409.05645
8/9/01	10:43:23AM	8651	1105.55690	1409.02505
8/9/01	10:43:25AM	8362	1102.24338	1409.53235
8/9/01	10:43:27AM	8978	1100.43250	1410.56246
8/9/01	10:43:29AM	9252	1097.72922	1411.10322
8/9/01	10:43:31AM	8535	1095.86117	1411.71973
8/9/01	10:43:33AM	8491	1092.91381	1412.81598
8/9/01	10:43:35AM	8699	1090.89335	1413.89148
8/9/01	10:43:37AM	9146	1088.61419	1414.84981
8/9/01	10:43:39AM	9087	1086.20299	1415.71253
8/9/01	10:43:41AM	9148	1083.87363	1416.17147
8/9/01	10:43:43AM	9471	1081.51906	1416.82359
8/9/01	10:43:45AM	8807	1078.90017	1417.13783
8/9/01	10:43:47AM	8169	1075.73684	1418.39990
8/9/01	10:43:49AM	8295	1073.42650	1418.65522
8/9/01	10:43:51AM	8411	1070.46475	1419.96683
8/9/01	10:43:53AM	8746	1067.68922	1420.32045
8/9/01	10:43:55AM	9426	1066.12652	1420.76116
8/9/01	10:43:57AM	8526	1065.96677	1421.06952
8/9/01	10:43:59AM	8268	1066.51983	1421.85298
8/9/01	10:44:01AM	8398	1065.38183	1421.07155
8/9/01	10:44:03AM	8649	1064.21781	1421.20467
8/9/01	10:44:05AM	9492	1064.75601	1421.34003
8/9/01	10:44:07AM	9165	1068.46437	1420.95130
8/9/01	10:44:09AM	8468	1071.99126	1420.05960
8/9/01	10:44:11AM	8687	1076.05160	1419.06159
8/9/01	10:44:13AM	8246	1078.36678	1418.37616
8/9/01	10:44:15AM	8711	1081.71387	1417.87951

DATE	TIME	RAD DATA	X-COORDINATE	Y-COORDINATE
8/9/01	10:44:17AM	8648	1084.52275	1416.95025
8/9/01	10:44:19AM	8647	1087.52153	1415.88956
8/9/01	10:44:21AM	8093	1090.81385	1414.79563
8/9/01	10:44:23AM	8072	1093.22675	1413.92292
8/9/01	10:44:25AM	8181	1096.04133	1412.77666
8/9/01	10:44:27AM	8328	1097.99424	1412.19812
8/9/01	10:44:29AM	8812	1101.26508	1411.63469
8/9/01	10:44:31AM	8484	1103.27402	1411.70156
8/9/01	10:44:33AM	8610	1105.38823	1410.96944
8/9/01	10:44:35AM	8359	1107.30096	1409.79815
8/9/01	10:44:37AM	7574	1109.01563	1408.16542
8/9/01	10:44:39AM	8484	1106.78350	1408.15178
8/9/01	10:44:41AM	8897	1105.96776	1407.10414
8/9/01	10:44:43AM	9337	1105.45977	1406.23381
8/9/01	10:44:45AM	8993	1105.94424	1404.85529
8/9/01	10:44:47AM	8425	1105.36538	1405.49963
8/9/01	10:44:49AM	8128	1105.96545	1405.09474
8/9/01	10:44:51AM	8683	1106.30888	1404.62751
8/9/01	10:44:53AM	9277	1105.14522	1406.51030
8/9/01	10:44:55AM	8792	1105.58796	1406.73801
8/9/01	10:44:57AM	9405	1105.80069	1406.86892
8/9/01	10:44:59AM	9061	1104.53053	1407.06504
8/9/01	10:45:01AM	7660	1104.50076	1407.29898
8/9/01	10:45:03AM	8440	1103.27068	1407.62694
8/9/01	10:45:05AM	8928	1100.43607	1408.18234
8/9/01	10:45:07AM	8415	1097.20710	1409.41453
8/9/01	10:45:09AM	7957	1094.92381	1410.35518
8/9/01	10:45:11AM	8462	1091.40434	1411.55759
8/9/01	10:45:13AM	8367	1087.87352	1411.97903
8/9/01	10:45:15AM	8397	1084.21241	1413.35097
8/9/01	10:45:17AM	8449	1080.51399	1414.70375
8/9/01	10:45:19AM	8887	1077.16394	1415.66097
8/9/01	10:45:21AM	7766	1075.22838	1416.75832
8/9/01	10:45:23AM	8324	1071.31223	1417.55654

DATE	TIME	RAD DATA	X-COORDINATE	Y-COORDINATE
8/9/01	10:45:25AM	8427	1070.04435	1417.99112
8/9/01	10:45:27AM	9070	1066.99788	1418.68479
8/9/01	10:45:29AM	9487	1066.34919	1419.00374
8/9/01	10:45:31AM	9142	1065.77825	1419.39101
8/9/01	10:45:33AM	9118	1064.00267	1419.30409
8/9/01	10:45:35AM	8636	1067.47532	1418.86573
8/9/01	10:45:37AM	9368	1071.19406	1417.68469
8/9/01	10:45:39AM	9463	1074.77328	1417.09041
8/9/01	10:45:41AM	8195	1077.77557	1417.07662
8/9/01	10:45:43AM	7719	1081.06718	1415.34435
8/9/01	10:45:45AM	9474	1084.56193	1414.64078
8/9/01	10:45:47AM	8583	1087.68360	1413.50709
8/9/01	10:45:49AM	8330	1091.00889	1412.47357
8/9/01	10:45:51AM	8973	1094.42437	1411.61853
8/9/01	10:45:53AM	9131	1098.76997	1410.73933
8/9/01	10:45:55AM	8918	1101.33929	1409.75860
8/9/01	10:45:57AM	8440	1104.18515	1407.70059
8/9/01	10:45:59AM	7855	1105.40259	1406.98903
8/9/01	10:46:01AM	8932	1102.56575	1406.84293
8/9/01	10:46:03AM	9101	1102.98390	1405.39038
8/9/01	10:46:05AM	10188	1102.81819	1405.01332
8/9/01	10:46:07AM	10409	1101.62949	1405.88292
8/9/01	10:46:09AM	9882	1099.62013	1406.65618
8/9/01	10:46:11AM	9924	1097.78188	1407.11497
8/9/01	10:46:13AM	9437	1094.42602	1408.76276
8/9/01	10:46:15AM	9439	1091.60083	1409.46457
8/9/01	10:46:17AM	9764	1088.53204	1410.36832
8/9/01	10:46:19AM	8756	1085.76036	1410.95370
8/9/01	10:46:21AM	8982	1082.95935	1411.95205
8/9/01	10:46:23AM	8970	1080.19973	1412.93342
8/9/01	10:46:25AM	8515	1077.93623	1413.67280
8/9/01	10:46:27AM	8440	1076.57318	1414.72196
8/9/01	10:46:29AM	8111	1073.84982	1414.66501
8/9/01	10:46:31AM	8638	1071.53067	1415.02619

DATE	TIME	RAD DATA	X-COORDINATE	Y-COORDINATE
8/9/01	10:46:33AM	10226	1068.77852	1415.69034
8/9/01	10:46:35AM	9971	1066.12751	1416.51222
8/9/01	10:46:37AM	8827	1065.43014	1416.61058
8/9/01	10:46:39AM	8266	1064.96392	1417.72150
8/9/01	10:46:41AM	8436	1065.04531	1417.11385
8/9/01	10:46:43AM	8735	1065.16513	1417.17375
8/9/01	10:46:45AM	8364	1066.45969	1417.27066
8/9/01	10:46:47AM	9018	1070.08255	1416.65073
8/9/01	10:46:49AM	8987	1073.25408	1415.45111
8/9/01	10:46:51AM	9391	1076.84706	1414.95916
8/9/01	10:46:53AM	9457	1079.90134	1413.80622
8/9/01	10:46:55AM	8988	1082.78935	1413.10980
8/9/01	10:46:57AM	8630	1086.20568	1411.49533
8/9/01	10:46:59AM	8401	1089.57855	1410.88713
8/9/01	10:47:01AM	9641	1093.02447	1409.37220
8/9/01	10:47:03AM	9411	1096.79106	1408.32689
8/9/01	10:47:05AM	10620	1099.90153	1406.61084
8/9/01	10:47:07AM	10058	1103.06004	1406.60235
8/9/01	10:47:09AM	9414	1105.99134	1405.50827
8/9/01	10:47:11AM	9747	1103.95278	1405.28009
8/9/01	10:47:13AM	9589	1103.41354	1405.02673
8/9/01	10:47:15AM	10938	1103.51306	1402.11472
8/9/01	10:47:17AM	12031	1102.50208	1404.05819
8/9/01	10:47:19AM	11325	1103.18829	1403.22271
8/9/01	10:47:21AM	10829	1101.43706	1404.56546
8/9/01	10:47:23AM	10602	1099.54339	1404.90317
8/9/01	10:47:25AM	10980	1100.51131	1405.31799
8/9/01	10:47:27AM	10830	1096.69537	1405.38378
8/9/01	10:47:29AM	10019	1094.17664	1406.34311
8/9/01	10:47:31AM	10177	1090.86267	1407.11243
8/9/01	10:47:33AM	10342	1087.46972	1408.69144
8/9/01	10:47:35AM	9389	1083.81094	1409.90373
8/9/01	10:47:37AM	9555	1080.70728	1411.30989
8/9/01	10:47:39AM	9526	1077.40134	1412.05555

DATE	TIME	RAD DATA	X-COORDINATE	Y-COORDINATE
8/9/01	10:47:41AM	9381	1074.14752	1412.35053
8/9/01	10:47:43AM	9180	1070.45026	1413.25713
8/9/01	10:47:45AM	9501	1067.11356	1414.77933
8/9/01	10:47:47AM	9513	1065.24204	1415.30923
8/9/01	10:47:49AM	9124	1064.90999	1414.67206
8/9/01	10:47:51AM	9170	1064.42525	1413.00926
8/9/01	10:47:53AM	9899	1064.44581	1413.59335
8/9/01	10:47:55AM	9511	1065.55788	1412.96968
8/9/01	10:47:57AM	8898	1069.52340	1414.18477
8/9/01	10:47:59AM	8398	1073.35956	1413.90301
8/9/01	10:48:01AM	9604	1076.86461	1413.36570
8/9/01	10:48:03AM	8797	1081.55500	1412.08035
8/9/01	10:48:05AM	8518	1084.69613	1410.79548
8/9/01	10:48:07AM	8101	1088.07118	1409.34953
8/9/01	10:48:09AM	9206	1092.23313	1408.78926
8/9/01	10:48:11AM	10407	1095.90347	1407.46478
8/9/01	10:48:13AM	10155	1099.38899	1406.73563
8/9/01	10:48:15AM	10632	1103.03502	1405.34628
8/9/01	10:48:17AM	11090	1105.33825	1404.12414
8/9/01	10:48:19AM	10543	1103.67157	1404.45826
8/9/01	10:48:21AM	10828	1102.95015	1402.33736
8/9/01	10:48:23AM	10911	1101.94879	1403.40835
8/9/01	10:48:25AM	11767	1103.42301	1402.95892
8/9/01	10:48:27AM	12807	1102.25814	1403.22944
8/9/01	10:48:29AM	12258	1102.04542	1403.27744
8/9/01	10:48:31AM	11587	1098.47807	1403.72072
8/9/01	10:48:33AM	10514	1095.28070	1404.50118
8/9/01	10:48:35AM	9845	1092.19491	1405.91410
8/9/01	10:48:37AM	9917	1088.78145	1406.19148
8/9/01	10:48:39AM	8821	1085.75491	1406.94901
8/9/01	10:48:41AM	8916	1082.16888	1408.10970
8/9/01	10:48:43AM	9673	1078.51422	1409.09963
8/9/01	10:48:45AM	9020	1074.61447	1410.04222
8/9/01	10:48:47AM	9268	1070.66400	1411.27333

DATE	TIME	RAD DATA	X-COORDINATE	Y-COORDINATE
8/9/01	10:48:49AM	8927	1067.12032	1412.63745
8/9/01	10:48:51AM	8749	1065.05539	1415.04265
8/9/01	10:48:53AM	8691	1065.00139	1414.61847
8/9/01	10:48:55AM	7969	1064.94538	1414.70596
8/9/01	10:48:57AM	8652	1063.38919	1414.47655
8/9/01	10:48:59AM	8817	1063.98279	1413.82723
8/9/01	10:49:01AM	8624	1067.81558	1413.12856
8/9/01	10:49:03AM	8137	1071.50181	1412.30174
8/9/01	10:49:05AM	7811	1075.58899	1411.22817
8/9/01	10:49:07AM	7892	1077.86958	1410.90838
8/9/01	10:50:38AM	8864	1066.37134	1416.37064
8/9/01	10:50:40AM	9058	1066.45513	1416.44173
8/9/01	10:50:42AM	8913	1067.73413	1415.72749
8/9/01	10:50:44AM	9478	1070.38323	1414.88395
8/9/01	10:50:46AM	9807	1073.83613	1413.80725
8/9/01	10:50:48AM	9534	1077.30707	1412.55802
8/9/01	10:50:50AM	9881	1080.88738	1411.63919
8/9/01	10:50:52AM	9236	1084.30563	1410.15977
8/9/01	10:50:54AM	8825	1088.21633	1409.03466
8/9/01	10:50:56AM	9371	1091.90322	1408.15498
8/9/01	10:50:58AM	10150	1095.85413	1407.02734
8/9/01	10:51:00AM	10846	1100.09842	1405.52694
8/9/01	10:51:02AM	10615	1102.44993	1405.12218
8/9/01	10:51:04AM	11623	1105.76779	1404.64126
8/9/01	10:51:06AM	10360	1103.14965	1403.57165
8/9/01	10:51:08AM	9588	1103.37440	1401.53580
8/9/01	10:51:10AM	8725	1104.22638	1400.24903
8/9/01	10:51:12AM	9144	1101.25809	1402.01002
8/9/01	10:51:14AM	9616	1100.08606	1402.60408
8/9/01	10:51:16AM	9629	1096.07162	1403.86917
8/9/01	10:51:18AM	9280	1092.28077	1405.54364
8/9/01	10:51:20AM	8334	1088.20298	1405.87503
8/9/01	10:51:22AM	8977	1084.33221	1407.30594
8/9/01	10:51:24AM	8700	1081.36882	1407.83543

DATE	TIME	RAD DATA	X-COORDINATE	Y-COORDINATE
8/9/01	10:51:26AM	8740	1077.41119	1408.86320
8/9/01	10:51:28AM	8584	1073.42707	1409.78111
8/9/01	10:51:30AM	8315	1069.59766	1410.80973
8/9/01	10:51:32AM	8660	1066.15083	1411.49053
8/9/01	10:51:34AM	8213	1063.92169	1411.96682
8/9/01	10:51:36AM	8243	1064.25207	1413.39215
8/9/01	10:51:38AM	8336	1061.58980	1414.04898
8/9/01	10:51:40AM	8210	1064.88845	1413.04930
8/9/01	10:51:42AM	8297	1068.77401	1412.05249
8/9/01	10:51:44AM	7472	1073.42359	1410.56355
8/9/01	10:51:46AM	7549	1077.90954	1410.26592
8/9/01	10:51:48AM	8390	1081.75037	1408.95841
8/9/01	10:51:50AM	8961	1086.30447	1407.65524
8/9/01	10:51:52AM	8698	1090.48432	1406.13343
8/9/01	10:51:54AM	8706	1094.30329	1405.56764
8/9/01	10:51:56AM	9025	1098.28381	1404.55879
8/9/01	10:51:58AM	9563	1101.40658	1402.72385
8/9/01	10:52:00AM	9530	1105.33601	1401.81368
8/9/01	10:52:02AM	9165	1105.28855	1400.78295
8/9/01	10:52:04AM	9042	1105.02710	1400.43149
8/9/01	10:52:06AM	8009	1106.84557	1397.23101
8/9/01	10:52:08AM	7971	1105.18367	1398.34341
8/9/01	10:52:10AM	7464	1102.41442	1399.50185
8/9/01	10:52:12AM	8193	1099.35246	1400.79120
8/9/01	10:52:14AM	8594	1097.30281	1400.84449
8/9/01	10:52:16AM	7929	1095.22381	1401.28818
8/9/01	10:52:18AM	7908	1091.07764	1402.92826
8/9/01	10:52:20AM	8329	1086.50391	1404.00717
8/9/01	10:52:22AM	8362	1083.23286	1405.22115
8/9/01	10:52:24AM	8538	1080.70048	1405.98123
8/9/01	10:52:26AM	8550	1076.88702	1407.18960
8/9/01	10:52:28AM	8215	1073.22212	1407.60935
8/9/01	10:52:30AM	8857	1069.11209	1408.82614
8/9/01	10:52:32AM	8759	1066.05968	1410.03038

DATE	TIME	RAD DATA	X-COORDINATE	Y-COORDINATE
8/9/01	10:52:34AM	8681	1062.58706	1410.71022
8/9/01	10:52:36AM	8731	1062.27127	1411.88885
8/9/01	10:52:38AM	8692	1060.45567	1411.94468
8/9/01	10:52:40AM	8521	1064.30489	1411.39045
8/9/01	10:52:42AM	8633	1069.16350	1410.15518
8/9/01	10:52:44AM	8697	1073.19574	1409.09079
8/9/01	10:52:46AM	8648	1077.16482	1407.61667
8/9/01	10:52:48AM	8609	1081.00274	1406.55493
8/9/01	10:52:50AM	8300	1085.12285	1405.11020
8/9/01	10:52:52AM	7830	1088.25529	1403.78640
8/9/01	10:52:54AM	8375	1093.07029	1402.58890
8/9/01	10:52:56AM	8486	1096.25783	1401.37796
8/9/01	10:52:58AM	8515	1100.76289	1399.55679
8/9/01	10:53:00AM	8248	1104.77884	1399.27064
8/9/01	10:53:02AM	8880	1108.97913	1397.23212
8/9/01	10:53:04AM	8061	1111.99366	1395.04684
8/9/01	10:53:06AM	8142	1112.76104	1394.26284
8/9/01	10:53:08AM	8321	1113.78366	1391.66064
8/9/01	10:53:10AM	7913	1112.22122	1393.24638
8/9/01	10:53:12AM	8437	1108.54329	1394.72653
8/9/01	10:53:14AM	8581	1104.23223	1395.14773
8/9/01	10:53:16AM	8674	1100.39535	1396.81640
8/9/01	10:53:18AM	8895	1095.67284	1397.41505
8/9/01	10:53:20AM	8436	1092.61733	1397.58155
8/9/01	10:53:22AM	7633	1088.51030	1399.13606
8/9/01	10:53:24AM	8081	1084.71646	1400.35549
8/9/01	10:53:26AM	8115	1080.48019	1401.69985
8/9/01	10:53:28AM	7546	1077.36163	1402.28533
8/9/01	10:53:30AM	7618	1074.66511	1402.84650
8/9/01	10:53:32AM	7608	1069.70818	1404.05685
8/9/01	10:53:34AM	8171	1065.92400	1405.29655
8/9/01	10:53:36AM	8236	1061.72833	1406.51403
8/9/01	10:53:38AM	9088	1061.04101	1408.17576
8/9/01	10:53:40AM	9149	1062.30367	1407.45858

DATE	TIME	RAD DATA	X-COORDINATE	Y-COORDINATE
8/9/01	10:53:42AM	9704	1065.83479	1405.91471
8/9/01	10:53:44AM	9527	1070.11544	1404.51190
8/9/01	10:53:46AM	9082	1074.33032	1403.84624
8/9/01	10:53:48AM	8147	1079.05519	1403.27928
8/9/01	10:53:50AM	8094	1083.44486	1401.76998
8/9/01	10:53:52AM	8318	1088.02647	1399.81101
8/9/01	10:53:54AM	8100	1091.56324	1399.41906
8/9/01	10:53:56AM	8077	1094.72974	1399.09296
8/9/01	10:53:58AM	8685	1098.75708	1397.30427
8/9/01	10:54:00AM	8777	1102.76956	1396.60744
8/9/01	10:54:02AM	8612	1105.36553	1395.66163
8/9/01	10:54:04AM	7685	1108.50744	1394.67989
8/9/01	10:54:06AM	7564	1112.28251	1393.76731
8/9/01	10:54:08AM	8232	1111.76150	1392.56824
8/9/01	10:54:10AM	8257	1113.50338	1389.34901
8/9/01	10:54:12AM	8062	1112.40050	1390.56142
8/9/01	10:54:14AM	8056	1108.47359	1390.63137
8/9/01	10:54:16AM	8258	1106.35496	1392.04584
8/9/01	10:54:18AM	8064	1102.25025	1391.98770
8/9/01	10:54:20AM	8553	1100.16515	1393.64514
8/9/01	10:54:22AM	8901	1096.82055	1394.24224
8/9/01	10:54:24AM	8326	1096.24040	1394.18738
8/9/01	10:54:48AM	8076	1096.45439	1394.24646
8/9/01	10:54:50AM	8550	1093.37901	1395.56409
8/9/01	10:54:52AM	8819	1090.74523	1395.95253
8/9/01	10:54:54AM	8953	1088.67834	1397.50883
8/9/01	10:54:56AM	8579	1084.51122	1397.62264
8/9/01	10:54:58AM	7699	1080.81098	1398.73228
8/9/01	10:55:00AM	7997	1076.89256	1399.42893
8/9/01	10:55:02AM	8204	1072.18751	1400.54104
8/9/01	10:55:04AM	8460	1068.37813	1402.10010
8/9/01	10:55:06AM	8763	1064.77257	1404.54064
8/9/01	10:55:08AM	9233	1061.96742	1404.91546
8/9/01	10:55:10AM	8640	1061.01153	1407.21458

DATE	TIME	RAD DATA	X-COORDINATE	Y-COORDINATE
8/9/01	10:55:12AM	9091	1062.24728	1404.56341
8/9/01	10:55:14AM	8979	1061.72333	1402.79994
8/9/01	10:55:16AM	9266	1060.44207	1402.03757
8/9/01	10:55:18AM	9829	1063.39486	1402.57159
8/9/01	10:55:20AM	9790	1065.70802	1402.40807
8/9/01	10:55:22AM	8783	1068.36932	1402.91963
8/9/01	10:55:24AM	8938	1072.27561	1402.23656
8/9/01	10:55:26AM	8625	1075.99117	1401.06008
8/9/01	10:55:28AM	8378	1080.17563	1399.98398
8/9/01	10:55:30AM	7989	1084.20855	1400.04679
8/9/01	10:55:32AM	7534	1087.90796	1399.21756
8/9/01	10:55:34AM	7802	1091.92730	1397.17296
8/9/01	10:55:36AM	7848	1096.21554	1396.26132
8/9/01	10:55:38AM	8449	1099.99072	1394.93413
8/9/01	10:55:40AM	8870	1103.19747	1393.56523
8/9/01	10:55:42AM	8199	1107.25945	1392.85803
8/9/01	10:55:44AM	7672	1109.63292	1392.07047
8/9/01	10:55:46AM	8099	1113.20363	1390.63311
8/9/01	10:55:48AM	8347	1113.49963	1392.05083
8/9/01	10:55:50AM	8062	1114.20789	1389.75560
8/9/01	10:55:52AM	8455	1115.66182	1387.28488
8/9/01	10:55:54AM	8988	1113.53243	1388.35757
8/9/01	10:55:56AM	8335	1108.42170	1390.72537
8/9/01	10:55:58AM	8747	1104.74437	1390.78618
8/9/01	10:56:00AM	8054	1101.41354	1390.80912
8/9/01	10:56:02AM	8001	1097.74979	1391.74756
8/9/01	10:56:04AM	8620	1094.60061	1393.92057
8/9/01	10:56:06AM	9262	1091.00768	1394.38537
8/9/01	10:56:08AM	9013	1087.79892	1395.45950
8/9/01	10:56:10AM	8139	1084.87824	1396.20451
8/9/01	10:56:12AM	7707	1081.37297	1397.49543
8/9/01	10:56:14AM	7591	1077.59945	1398.46569
8/9/01	10:56:16AM	8010	1074.31571	1399.36062
8/9/01	10:56:18AM	8336	1070.80901	1399.68361

DATE	TIME	RAD DATA	X-COORDINATE	Y-COORDINATE
8/9/01	10:56:20AM	8762	1067.19488	1400.61567
8/9/01	10:56:22AM	9170	1063.18499	1400.97053
8/9/01	10:56:24AM	9387	1064.10300	1400.38906
8/9/01	10:56:26AM	8786	1064.22957	1400.81984
8/9/01	10:56:28AM	8754	1064.47756	1400.80134
8/9/01	10:56:30AM	9262	1064.44254	1403.98035
8/9/01	10:56:32AM	9234	1065.09896	1405.56986
8/9/01	10:56:34AM	9648	1065.70133	1409.29238
8/9/01	10:56:36AM	8256	1067.02854	1411.80910
8/9/01	10:56:38AM	8422	1068.00256	1416.40378
8/9/01	10:56:40AM	8616	1068.75511	1419.56637
8/9/01	10:56:42AM	8045	1067.85217	1420.06598
8/9/01	10:56:44AM	8774	1070.45396	1421.69968
8/9/01	10:56:46AM	8466	1071.34854	1421.60301
8/9/01	10:56:48AM	8480	1069.85668	1421.70499

SAMPLE CALCULATIONS FOR
FSS SAMPLE LOCATION SELECTION

Purpose: To determine the required number of samples, the random start grid location, and the triangle leg lengths for FSS Unit.

Given:
1) alpha = 0.025 (State Accepted)
2) Beta = 0.10 (USACE Accepted)
3) DCGL = 35 pCi/g (U-238) or 2.8 pCi/g (Th-232)
4) LBGR = 17.5 pCi/g (U-238) or 1.4 pCi/g (Th-232)
5) delta = 17.5 pCi/g (U-238) or 1.4 pCi/g (Th-232)
6) sigma = 5.35 for U-238 and 0.25 for Th-232.
7) Area of FSS Unit = 1,999 square meters

Calculations: 1) Number of Samples, N/2 for Wilcoxon Rank Sum Test

<u>Relative Shift</u>

delta/sigma for U-238:	17.5/5.35 =	3.3	
delta/sigma for Th-232:	1.4/0.25 =	5.6	Therefore use 4.0

From Table 5.3 - Contaminant Present in Background

N/2 = 9 samples for U-238
N/2 = 9 samples for Th-232

Therefore use 9 samples for FSS Unit

2) Spacing between sampling locations, L (assume square grid)

For a square grid L = square root (Area / N)

L= (1,999/9)^1/2 = 15 meters
48.9 feet

3) Random start coordinates

Maximum Northing:	1,927	
Minimum Northing:	1,799	
		Difference = 128 feet
Maximum Easting:	1,602	
Minimum Easting:	1,434	
		Difference = 168 feet

4) Use Table I-6 to pick random numbers between zero and one

Total Columns = 30 Total Rows = 100

Pick Column 21 and Row 83 for Northing, therefore 0.853117

Pick Column 12 and Row 46 for Easting, therefore 0.237361

Northing = 0.853117*(128)+1,799 = 1,908 feet

Easting = 0.237361*(168)+1,434 = 1,474 feet

Random start point falls within FSS Unit .

Construct other points for sampling locations.

Sampling Coordinates

Location	Northing	Easting	Comments
CFS-0X-01	1,908	1,474	Random Start Point
CFS-0X-02	1,908	1,523	
CFS-0X-03	1,908	1,572	
CFS-0X-04	1,866	1,451	
CFS-0X-05	1,866	1,499	
CFS-0X-06	1,866	1,548	
CFS-0X-07	1,866	1,597	
CFS-0X-08	1,824	1,523	
CFS-0X-09	1,824	1,572	

Conclusions: Based on the random starting point and calculated leg lengths, 9 sampling points were able to be placed within Unit.

RESRAD Model Area Factor Parameter Summary and Area Factor Dose Model Calculations

Contaminated Zone Dimensions	
Area:	2000.00 square meters
Thickness:	2.00 meters
Cover Depth:	0.00 meters

Initial Soil Concentrations, pCi/g	
Th-232	2.800E+00
U-238	3.500E+01

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.00
TDOSE(t):	6.319E+00	9.213E+00	1.534E+01	3.153E+01	4.362E+01	4.382E+01	4.199E+01	7.25
M(t):	2.106E-01	3.071E-01	5.114E-01	1.051E+00	1.454E+00	1.461E+00	1.400E+00	2.41

Maximum TDOSE(t): 7.255E+01 mrem/yr at t = 1.000E+03 years

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	1500.00 square meters	Th-232	2.800E+00
Thickness:	2.00 meters	U-238	3.500E+01
Cover Depth:	0.00 meters		

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.00
TDOSE(t):	6.279E+00	9.160E+00	1.526E+01	3.135E+01	4.336E+01	4.356E+01	4.175E+01	7.22
M(t):	2.093E-01	3.053E-01	5.086E-01	1.045E+00	1.445E+00	1.452E+00	1.392E+00	2.41

Maximum TDOSE(t): 7.229E+01 mrem/yr at t = 1.000E+03 years

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	1000.00 square meters	Th-232	2.800E+00
Thickness:	2.00 meters	U-238	3.500E+01
Cover Depth:	0.00 meters		

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.00
TDOSE(t):	6.231E+00	9.098E+00	1.516E+01	3.114E+01	4.307E+01	4.327E+01	4.146E+01	6.55
M(t):	2.077E-01	3.033E-01	5.053E-01	1.038E+00	1.436E+00	1.442E+00	1.382E+00	2.18

Maximum TDOSE(t): 6.553E+01 mrem/yr at t = 1.000E+03 years

Contaminated Zone Dimensions	
Area:	500.00 square meters
Thickness:	2.00 meters
Cover Depth:	0.00 meters

Initial Soil Concentrations, pCi/g	
Th-232	2.800E+00
U-238	3.500E+01

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.00
TDOSE(t):	4.550E+00	6.608E+00	1.123E+01	2.414E+01	3.403E+01	3.426E+01	3.288E+01	4.39
M(t):	1.517E-01	2.203E-01	3.745E-01	8.048E-01	1.134E+00	1.142E+00	1.096E+00	1.46

Maximum TDOSE(t): 4.398E+01 mrem/yr at t = 1.000E+03 years

Contaminated Zone Dimensions	
Area:	100.00 square meters
Thickness:	2.00 meters
Cover Depth:	0.00 meters

Initial Soil Concentrations, pCi/g	
Th-232	2.800E+00
U-238	3.500E+01

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.00
TDOSE(t):	2.955E+00	4.257E+00	7.449E+00	1.700E+01	2.453E+01	2.476E+01	2.381E+01	2.52
M(t):	9.849E-02	1.419E-01	2.483E-01	5.668E-01	8.176E-01	8.252E-01	7.936E-01	8.42

Maximum TDOSE(t): 2.528E+01 mrem/yr at t = 1.000E+03 years

Contaminated Zone Dimensions	
Area:	50.00 square meters
Thickness:	2.00 meters
Cover Depth:	0.00 meters

Initial Soil Concentrations, pCi/g	
Th-232	2.800E+00
U-238	3.500E+01

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.00
TDOSE(t):	2.575E+00	3.697E+00	6.488E+00	1.493E+01	2.161E+01	2.182E+01	2.098E+01	2.13
M(t):	8.582E-02	1.232E-01	2.163E-01	4.978E-01	7.204E-01	7.273E-01	6.995E-01	7.12

Maximum TDOSE(t): 2.207E+01 mrem/yr   at t =   50.2 ± 0.1 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) an
As mrem/yr and Fraction of Total Dose At t = 5.023E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Th-232	1.909E+01	0.8648	2.035E-01	0.0092	2.728E-02	0.0012	7.313E-01	0.0331	2.077E-03	0.0001
U-238	1.772E+00	0.0803	1.282E-01	0.0058	1.979E-07	0.0000	8.671E-02	0.0039	2.861E-04	0.0000
Total	2.086E+01	0.9451	3.317E-01	0.0150	2.728E-02	0.0012	8.180E-01	0.0371	2.363E-03	0.0001

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) an
As mrem/yr and Fraction of Total Dose At t = 5.023E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

*Sum of all water independent and dependent pathways.

Contaminated Zone Dimensions	
Area:	10.00 square meters
Thickness:	2.00 meters
Cover Depth:	0.00 meters

Initial Soil Concentrations, pCi/g	
Th-232	2.800E+00
U-238	3.500E+01

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.00
TDOSE(t):	1.655E+00	2.338E+00	4.055E+00	9.296E+00	1.345E+01	1.357E+01	1.304E+01	1.27
M(t):	5.518E-02	7.794E-02	1.352E-01	3.099E-01	4.484E-01	4.525E-01	4.348E-01	4.25

Maximum TDOSE(t): 1.374E+01 mrem/yr at t = 50.0 ± 0.1 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) an
As mrem/yr and Fraction of Total Dose At t = 5.002E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Th-232	1.214E+01	0.8836	1.711E-01	0.0125	2.426E-03	0.0002	1.463E-01	0.0106	4.154E-04	0.0000
U-238	1.147E+00	0.0835	1.079E-01	0.0079	3.909E-08	0.0000	1.735E-02	0.0013	5.726E-05	0.0000
Total	1.328E+01	0.9671	2.789E-01	0.0203	2.426E-03	0.0002	1.636E-01	0.0119	4.727E-04	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) an
As mrem/yr and Fraction of Total Dose At t = 5.002E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

*Sum of all water independent and dependent pathways.

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	5.00 square meters	Th-232	2.800E+00
Thickness:	2.00 meters	U-238	3.500E+01
Cover Depth:	0.00 meters		

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.00
TDOSE(t):	1.168E+00	1.619E+00	2.755E+00	6.226E+00	8.977E+00	9.052E+00	8.688E+00	8.44
M(t):	3.895E-02	5.398E-02	9.185E-02	2.075E-01	2.992E-01	3.017E-01	2.896E-01	2.81

Maximum TDOSE(t): 9.163E+00 mrem/yr at t = 49.74 ± 0.10 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) an
As mrem/yr and Fraction of Total Dose At t = 4.974E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Th-232	8.053E+00	0.8788	1.587E-01	0.0173	8.562E-04	0.0001	7.312E-02	0.0080	2.077E-04	0.0000
U-238	7.653E-01	0.0835	1.001E-01	0.0109	1.923E-08	0.0000	8.685E-03	0.0009	2.866E-05	0.0000
Total	8.818E+00	0.9624	2.588E-01	0.0282	8.562E-04	0.0001	8.181E-02	0.0089	2.364E-04	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) an
As mrem/yr and Fraction of Total Dose At t = 4.974E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

*Sum of all water independent and dependent pathways.

Contaminated Zone Dimensions	
Area:	1.00 square meters
Thickness:	2.00 meters
Cover Depth:	0.00 meters

Initial Soil Concentrations, pCi/g	
Th-232	2.800E+00
U-238	3.500E+01

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.00
TDOSE(t):	5.128E-01	6.586E-01	1.026E+00	2.149E+00	3.036E+00	3.047E+00	2.906E+00	2.79
M(t):	1.709E-02	2.195E-02	3.420E-02	7.163E-02	1.012E-01	1.016E-01	9.687E-02	9.30

Maximum TDOSE(t): 3.093E+00 mrem/yr at t = 48.22 ± 0.10 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) an
As mrem/yr and Fraction of Total Dose At t = 4.822E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Th-232	2.602E+00	0.8414	1.331E-01	0.0430	7.635E-05	0.0000	1.462E-02	0.0047	4.152E-05	0.0000
U-238	2.559E-01	0.0827	8.442E-02	0.0273	3.515E-09	0.0000	1.746E-03	0.0006	5.760E-06	0.0000
Total	2.858E+00	0.9241	2.175E-01	0.0703	7.635E-05	0.0000	1.636E-02	0.0053	4.728E-05	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) an
As mrem/yr and Fraction of Total Dose At t = 4.822E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

*Sum of all water independent and dependent pathways.

Scan MDC Calculation

D GAMMA WALKOVER SCAN: FIDLER

Assume: 90% True Positive and 25% False Positive. An observation interval of 2-seconds and p = 0.5 for the Surveyor efficiency. The activity fraction used for Colonie depleted U is 99.59/0.45 % wt $^{238/235}$U, or 2.0052 % act ^{235}U with respect to ^{238}U. The soil is uniformly mixed with a density of 1.6 g/cc. Disc dimensions are 28 cm radius and 15 cm thick. No soil cover over the contaminated zone. FIDLER is centered 4-inches above the contaminated soil disk. Actual background with the FIDLER on-site is 8,000 cpm. Microshield results for Colonie DepU, 47669 cpm/uR/hr (weighted eff.) and exposure rate with buildup of 0.2206 uR/hr

D.1 Determination of Number of Source Counts

For a 2-inch x 2-inch gamma scintillation detector, the typical background count rate over open land areas is approximately 8,000 to 8,000 cpm. For the purposes of this scan sensitivity estimate that 8, 000 cpm is the background onsite.

The value of b_i is, therefore:

$$b_i = (8{,}000\text{ cpm})(2\text{ second})\left(\frac{\text{minute}}{60\text{ seconds}}\right) = 266.7\text{ counts}$$

and the value of S_i is:

$$MDCR = 1.96\sqrt{266.7}\left(\frac{60\sec}{1\min}\right) = 1{,}920.5\text{ cpm}$$

D.2 Calculation of MDCR$_{\text{surveyor}}$

The MDCR$_{\text{surveyor}}$ is calculated as;

$$MDCR_{Surveyor} = \frac{MDCR}{\sqrt{p}}$$

A value of p = 0.5 for the surveyor efficiency was chosen as a conservative estimate, yielding a surveyor MDCR for this detector and application as:

$$\frac{1{,}920.5\text{ cpm}}{\sqrt{0.5}} = 2{,}716\text{ cpm}$$

D.3 Estimate of U-238 Scan MDCs

Using these values, the scan MDC for a FIDLER detector is estimated as:

$$ScanMDC(^{238}U) = \left(\frac{2716 cpm}{47669 cpm/uR/hr}\right)\times\left(\frac{35 pCi/g}{0.2206 \mu R/hr}\right) = 9.04 pCi/g$$

For Thorium-232 MARSSIM's performs the MDC calculation in Table 6.7, this is calculated for a 2 in.x 2 in. NaI detector. This is calculated to be 66.6 Bq./kg or 1.8 pCi/gm.

Table 6.7 NaI(Tl) Scintillation Detector Scan MDCs for Common Radiological Contaminants[a]

Radionuclide/Radioactive Material	1.25 in. by 1.5 in. NaI Detector		2 in. by 2 in. NaI Detector	
	Scan MDC (Bq/kg)	Weighted cpm/μR/h	Scan MDC (Bq/kg)	Weighted cpm/μR/h
Am-241	1,650	5,830	1,170	13,000
Co-60	215	160	126	430
Cs-137	385	350	237	900
Th-230	111,000	4,300	78,400	9,580
Ra-226 (in equilibrium with progeny)	167	300	104	760
Th-232 decay series (Sum of all radionuclides in he thorium decay series)	1,050	340	677	830
Th-232 (In equilibrium with progeny in decay series)	104	340	66.6	830
Depleted Uranium[b] (0.34% U-235)	2,980	1,680	2,070	3,790
Natural Uranium[b]	4,260	1,770	2,960	3,990
3% Enriched Uranium[b]	5,070	2,010	3,540	4,520
20% Enriched Uranium[b]	5,620	2,210	3,960	4,940
50% Enriched Uranium[b]	6,220	2,240	4,370	5,010
75% Enriched Uranium[b]	6,960	2,250	4,880	5,030

[a] Refer to text for complete explanation of factors used to calculate scan MDCs. For example, the background level for the 1.25 in. by 1.5 in. NaI detector was assumed to be 4,000 cpm, and 10,000 cpm for the 2 in. by 2 in. NaI detector. The observation interval was 1-sec and the level of performance was selected to yield *d'* of 1.38.
[b] Scan MDC for uranium includes sum of ^{238}U, ^{235}U, and ^{234}U.