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VERIFICATION OF TREATMENT SAMPLING PLAN

Area 1 Phase II

Trap Range Stabilization Project

Prepared For:

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Cincinnati, Ohio

[X] A - Conforms to the Subcontract Requirements
[ ] B - Minor Comment - Incorporate and Resubmit
[ ] C - Revise and Resubmit
Sig: _____ Date: 5/18/99

Prepared By:

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

1.0 INTRODUCTION 1
- 1.1 Purpose 2
- 1.2 Area Description 2
- 1.3 Scope and Objectives 3

2.0 SOIL SAMPLING AND ANALYSIS PROGRAM 3
- 2.1 Soil Sampling and Analysis Strategy 3
- 2.2 Sampling and Analysis Requirements 4
- 2.3 Location and Number of Samples 5
  - 2.3.1 Statistical Basis 6
  - 2.3.2 a posteriori Sample Size Test 9
- 2.4 QA/QC Requirements 12
- 2.5 Equipment Decontamination 13
- 2.6 Data Management 13
- 2.7 Health and Safety 14
- 2.8 Disposition of Wastes 15

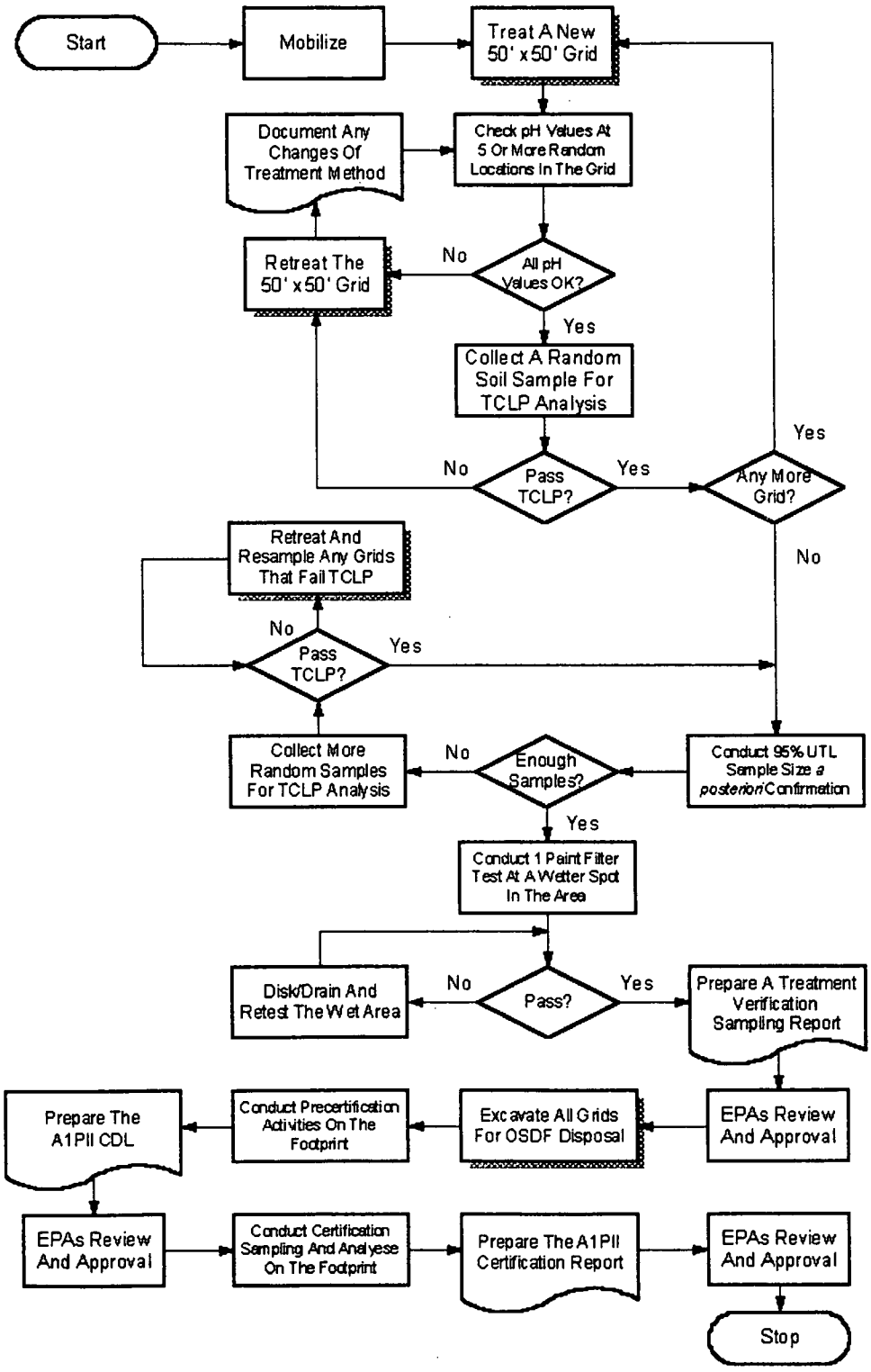
3.0 REFERENCES 15

EXECUTIVE SUMMARY

A sampling and analysis program is required for the treated soils at the Area 1 Phase II Trap Range to provide statistically defensible data confirming stabilization to below contract clean-up levels. Seventy-two 50 ft. by 50 ft. grids will be treated, which covers the entire four-acre area. One random sample location will be selected within each grid. Samples will be collected to a depth of 6, 8, or 12 inches, depending on the location in relationship to the areas delineated on the Construction Drawings. Samples will be given a unique identification number, sealed, packaged and shipped overnight to Waste Stream Technology, Inc. in Buffalo, NY for off-site analysis.

Samples will be analyzed for Toxicity Characteristic Leachate Procedure (TCLP). Fluor Daniel Fernald will split 10% of the samples for analysis at their on-site lab. If necessary, additional soil will be collected to split for U.S. EPA and Ohio EPA. Upon completion of the sampling and analysis program, a statistical analysis of the sample size will be performed to confirm that 72 below-TCLP-limit samples was sufficient to verify that all soils were treated to project requirements. An EPA paint filter liquids test will be conducted to determine the need of disking and draining (to be performed by others) at the end of stabilization. A Verification of Treatment Report will then be submitted to U.S. EPA and Ohio EPA for their review and approval.

Upon approval from U.S. EPA and Ohio EPA, the stabilized soil will be excavated by the Sewage Treatment Plant Excavation Contractor and disposed of in the Onsite Disposal Facility (OSDF). Precertification sampling activities in the excavation footprint will be performed, followed by preparation of the Certification of Design Letter (CDL). Soil sampling certification activities will be conducted after EPA's approval. The preceding description is graphically illustrated on the flow chart on the following page.



TRAP RANGE STABILIZATION, VERIFICATION, EXCAVATION, AND CERTIFICATION PROCESS

1.0 INTRODUCTION

Sevenson Environmental Services, Inc. (Sevenson) presents this Verification of Treatment Sampling Plan (VTSP) for the Area 1 Phase II Trap Range Stabilization project at the Fernald Environmental Management Project (FEMP) site in Fernald, Ohio. This plan has been prepared in accordance with the requirements of Section 02211 of the technical specifications.

Sevenson has been subcontracted to stabilize lead- and arsenic-impacted soils at the Trap Range site. Sevenson will use its patented MAECTITE® process to stabilize the soils in-situ.

MAECTITE® liquid reagent will be sprayed onto the ground surface and mixed into the soils with a flat-edged backhoe bucket. The mixing may be described as a back-and-forth folding motion, which will create a homogeneous mix.

The remediation area will be divided into surveyed grids for treatment control. Treatment grids will be 2,500 square foot (50 ft. by 50 ft.) areas adjacent to one another across the remediation area.

As discussed in Part 6 of the Construction Documents, the area and depth requiring soil stabilization is as shown on the Construction Drawings, specifically Drawing No. 92X-5900-G-00514. The soils will be stabilized to a typical depth of 6 inches, except for two specified areas where the soils will be stabilized to depths of 8 inches and 12 inches, respectively. Depth tolerances shall be minus 0 to plus 2 inches. Surveying will be performed to confirm the limits of stabilization.

As part of its scope of work, Sevenson will collect and analyze stabilized soil samples to verify that the treatment objectives have been achieved. The treated soils must meet the following criteria:

- Meet or exceed the requirements of the Toxicity Characteristic Leaching Procedure (TCLP) test for lead (5.0 mg/L) and arsenic (5.0 mg/L).

- Pass the EPA Paint Filter Liquids Test.

This VTSP has been developed to present a sampling and analysis program to demonstrate that the treatment process was successful in treating all of the contaminated soils to the project requirements.

1.1 Purpose

The purpose of the VTSP is to present a sampling and analysis program for the treated soils at the project site. The sampling and analysis program must provide statistically defensible data, confirming all of the site soils have been stabilized in accordance with the project requirements.

1.2 Area Description

The Area 1 Phase II Trap Range site is located in the southeast quadrant of the FEMP and southwest of the former Sewage Treatment Plant. FEMP employees used the range for recreational purposes from the mid-1950's until 1988. This activity resulted in the surface deposition of lead shot and clay fragments.

Site characterization studies have identified the presence of lead- and arsenic-impacted soils above the final remediation levels of 400 mg/kg and 12 mg/kg for lead and arsenic, respectively, at the Trap Range site. A pre-design investigation was performed to delineate the areas to be stabilized.

1.3 Scope and Objectives

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The primary objectives of the soil sampling and analysis program are to collect samples that are representative of the mixing and stabilization process. Further, the program must provide a 95% confidence level that more than 99% of the treated soil is below the TCLP criteria limits.

2.0 SOIL SAMPLING AND ANALYSIS PROGRAM

The soils treated by Sevenson's MAECTITE® process will be sampled and analyzed for treatment verification. The following sections present a description of the soil sampling and analysis strategy, sampling and analysis requirements, location and number of samples (including statistical basis), quality assurance/quality control (QA/QC) requirements, equipment decontamination, data management, health and safety, and disposition of wastes for this portion of the work.

2.1 Soil Sampling and Analysis Strategy

Sevenson will utilize a random sampling strategy for verification of treatment sampling and analysis. One sample location, identified as a survey coordinate, will be randomly generated for each treatment grid. A computer program will be used to generate the locations. This strategy is based on the assumption that each grid, after treatment, is uniform and homogeneous with respect to leachable lead and arsenic.

Initial samples will be obtained after the first few days of stabilization so that the full scale treatment process may be quickly evaluated. Subsequent sampling events will be performed approximately once per week for the remainder of stabilization. During each sampling event, grids treated during that week will be sampled for analysis.

2.2 Sampling and Analysis Requirements

2261

Sevenson will collect samples from each treated grid by advancing the sampling device to the stabilization depths (6, 8, or 12 inches) identified on the Construction Drawings. Sampling devices to be utilized may include a stainless steel soil trier, stainless steel bucket auger, or trowel. Sevenson will collect approximately 350 grams of treated soil for each sample. The samples will be homogenized in the field, using a stainless steel trowel and mixing basin, prior to being labeled, packaged, placed in an iced cooler (4°C), and shipped to the offsite laboratory for analyses.

The sample homogenization technique will be as follows:

1. Divide sample into quarters and thoroughly mix each quarter.
2. Combine two opposite quarters into halves and thoroughly mix each half.
3. Combine halves into one and thoroughly mix.
4. Return to Step 1 until sample has been mixed twice.
5. Place sample into applicable sample container for shipment to lab.

Each treatment/sampling grid will be given a unique identification number. The numbering system will assist in tracking the samples and facilitate the retrieval of analytical results. The samples will be numbered sequentially by treatment grid, beginning with TG01-01 (Treatment Grid 1, Sample Number 1). The treatment grid layout is shown on Figure 1.

The verification samples will be shipped overnight to Waste Stream Technology, Inc. (WST) in Buffalo, New York for offsite analysis. The analytical parameters and applicable test methods are listed in Table 1.

Table 1 Verification of Treatment Testing Area 1 Phase II Trap Range	
Parameter	**Method**
Soil Digestion	USEPA SW-846 Method 3051
TCLP Extraction	USEPA SW-846 Method 1311
Metals in TCLP Extraction Fluid (Pb, As)	USEPA SW-846 Method 6000/7000
Paint Filter Test	USEPA SW-846 Method 9095

If a sample does not meet the treatment criteria, the entire grid from which the sample was taken will be re-treated. The grid will then be re-sampled and analyzed for verification purposes.

Ten percent (10%) of the samples will be split with the Construction Manager and analyzed at their on-site laboratory. U.S. EPA and Ohio EPA may also wish to obtain split samples, in which case Sevenson will make additional soil available.

2.3 Location and Number of Samples

The sampling program involves collecting one sample from each 50 ft. by 50 ft. treatment grid. As discussed previously, one sample location will be randomly generated for each treatment grid. At least seventy-two (72) randomly generated samples (assuming all grids pass TCLP in the first round) will be tested to verify treatment of the Area 1 Phase II Trap Range site soils.

Upon completion of the sampling and analysis program, a statistical analysis of the sample size will be performed. This analysis will be used to confirm that 72 samples which pass TCLP was sufficient to verify that all of the soils were treated to the project requirements. Failed TCLP results will not be included in the final statistical test.

2.3.1 Statistical Basis

In order to verify the effectiveness of the MAECTITE® process to reduce leachable lead to levels below the TCLP limit of 5.0 mg/L, or 5000 parts per billion (ppb), one sample will be selected at a random location within each of the 72 treatment grids. Each treatment grid will be a 50 ft. by 50 ft. area with a stabilization depth of 6, 8, or 12 inches. Arsenic was not found at leachable concentrations above cleanup action levels during the pre-design investigation and is, therefore, not a driver in the stabilization.

From previous experience the expected mean residual leachable lead levels after treatment should be approximately 1000 ppb, with minimal variability; well below the 5000 ppb TCLP threshold. Based on this information, it is assumed that the 72 samples would be sufficient to verify the effectiveness of treatment. To test this assumption, the equation for the estimation of the Upper Tolerance Limit (UTL) was utilized. The comparison of the UTL (calculated from a sample population) against a threshold value is often used as a "not to be exceeded" test. The UTL is defined as the $(1-\alpha)\%$ upper confidence limit on the estimated p^{th} percentile of the population. The p^{th} percentile is chosen from the upper end of the distribution. The percentile used is the reasonable allowable portion of the population that could exceed the threshold without significant impact. Usually the 95^{th} or 99^{th} percentile is used, depending on the severity of the consequences of exceeding the threshold level. If the consequences of exceeding the threshold are very severe or catastrophic, then a higher percentile my be chosen, say the 99.5^{th}, or even the 99.9^{th}. To establish confidence that the actual population percentile does not exceed the threshold, a confidence bound (or limit) is placed on the percentile based on the sample data. It is most common to use a $\alpha = 5\%$ ($1 - \alpha = 95\%$) confidence limit on the selected percentile.

To test the assumption that 72 samples would be sufficient to verify the effectiveness of treatment, the estimated UTL could be compared to the threshold limit. Actually, ALL sample results are required to be less than the TCLP threshold, but for sample size determination the following UTL equation will be utilized:

$$UTL = \hat{\bar{x}} + \hat{s}K$$

where

$\hat{\bar{x}}$ = estimated sample mean residual level = $\frac{1}{n}\sum_{i=1}^{n} TCLP_i$,

$\hat{s}$ = estimated sample standard deviation = $\sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(TCLP_i - \hat{\bar{x}})^2}$, and

K = factors for estimating the upper limit on the p^{th} percentile from a normal distribution (Owen, 1962).

The K factors depend on the α level and the percentile. Appendix A3 from Statistical Methods for Environmental Pollution Monitoring (Gilbert, 1987) provides tables for $1 - \alpha = .90$ (90%) and $1 - \alpha = .95$ (95%) for the 90th, 95th, 97.5th, 99th, and 99.9th percentiles for sample sizes (n) from 2 to ∞. Table 3 at the end of this section is an abbreviated version of this table.

If we start with a UTL, the not to be exceeded threshold of a sample size and the percentile of interest and the desired confidence level, we can 'back' calculate the required sample mean over a range of coefficients of variation (CV). The CV is, simply, the standard deviation divided by the mean. Reversing the equation above, the required sample mean to meet the threshold can be expressed as:

$$\hat{\bar{x}} = UTL - \hat{s}K$$

$$= \frac{UTL}{1 + CV \times K}$$

where

$\hat{s}$ = estimated sample standard deviation, and

CV = coefficient of variation $= \frac{\hat{s}}{\hat{\bar{x}}}$.

The table below provides the estimated post-treatment mean lead level that would be needed to statistically meet the TCLP limit for the entire volume of treated soil, given that the confidence level is fixed at 95%, varying the CVs from 0.25 (small variability) to 1.5 (moderately high variability) for the 95th, 99th and 99.9th percentiles, and given that the sample size is 72.

Table 2

Estimated Mean TCLP Lead Concentration to Realize a UTL = 5000 ppb for Given Percentile and Coefficient of Variation (CV) for a Sample Size of 72

CV	95th percentile	99th percentile	99.9th percentile
0.25	3342	2959	2620
0.50	2509	2101	1775
0.67	2152	1761	1461
0.75	2009	1629	1342
1.00	1675	1330	1079
1.25	1436	1124	902
1.50	1257	973	775

Notes: Estimated means are expressed as parts per billion. K factors used in the calculations are interpolated values. The tabulated K factors in Table 3 were available for a sample size of 70 and 80 and the equivalent K factor for 72 was interpolated from these two factors.

It can be seen from Table 2 that, assuming that the commonly used 95th percentile is the percentile of interest, even at moderately high variability levels and the expected post treatment TCLP lead level of 1000 ppb, that 72 samples is more than sufficient to assess compliance with TCLP limits for the entire treated volume of soil. Assuming that the CV is smaller, as is expected, the sample average could be even twice the expected and still pass the statistical test. Clearly, 72 samples is sufficient to assess compliance. For this project, the 99th percentile will be used as the criterion to demonstrate full compliance with the TCLP requirements in the treated soil.

2.3.2 a posteriori Sample Size Test

After all samples have been collected and analyzed and all the results shown to be below the TCLP limit an *a posteriori* sample size determination will be performed using the same equation as above to confirm that the sample size was sufficient to assess compliance with the TCLP limit, even though all sample results were shown to be below the limit. In this case, we turn the equation around and solve for the *K* factor using the sample mean and standard deviation of the 72 samples, and then look up this factor in the table of factors for estimating the upper confidence limit on the p^{th} percentile from a normal distribution (Table 3). The sample size, n, associated with the largest tabled *K* factor less than the calculated *K* would be the required sample size to demonstrate that the UTL of the population is less than the TCLP limit. If this sample size is less than or equal to 72, we would conclude that the sample size was sufficient. In an unlikely scenario that the test indicates more samples are required, additional random samples will be collected and analyzed.

The following equation will be used to calculate the K factor:

$$K = \frac{UTL - \bar{x}}{s}$$

where

$\bar{x}$ = sample mean residual level = $\frac{1}{72}\sum_{i=1}^{72} TCLP_i$, and

s = sample standard deviation = $\sqrt{\frac{1}{72-1}\sum_{i=1}^{72} (TCLP_i - \bar{x})^2}$.

Table 3
Factors $K_{1-\alpha,p}$ for Estimating an Upper 100(1 — α)% Confidence Limit on the pth Percentile of a Normal Distribution

1 - α = .95	Percentile		
n	**95th**	**99th**	**99.9th**
2	26.260	37.094	49.276
3	7.656	10.553	13.857
4	5.144	7.042	9.214
5	4.210	5.749	7.509
6	3.711	5.065	6.614
7	3.401	4.643	6.064
8	3.188	4.355	5.689
9	3.032	4.144	5.414
10	2.911	3.981	5.204
11	2.815	3.852	5.036
12	2.736	3.747	4.900
13	2.670	3.659	4.787
14	2.614	3.585	4.690
15	2.566	3.520	4.607
16	2.523	3.463	4.534
17	2.486	3.414	4.471
18	2.455	3.370	4.415
19	2.423	3.331	4.364
20	2.396	3.295	4.319
21	2.371	3.262	4.276
22	2.350	3.233	4.238
23	2.329	3.206	4.204
24	2.309	3.181	4.171
25	2.292	3.158	4.143
30	2.220	3.064	4.022
35	2.166	2.994	3.934
40	2.126	2.941	3.866
45	2.092	2.897	3.811
50	2.065	2.863	3.766
60	2.022	2.807	3.695
70	1.990	2.766	3.643
80	1.965	2.733	3.601
90	1.944	2.706	3.567
100	1.927	2.684	3.539
120	1.899	2.649	3.495
145	1.874	2.617	3.455
300	1.800	2.522	3.335
500	1.763	2.475	3.277
∞	1.645	2.326	3.090

2.4 QA/QC Requirements

QA/QC requirements include collection of field quality control samples, laboratory quality control, field pH testing, and record keeping. A more detailed description of Contractor QA/QC will be presented in a Quality Assurance Plan (QAP) under separate cover.

Field quality control samples will be obtained, including field duplicate and equipment rinsate samples. Field duplicate samples will be taken at a frequency of one per ten soil samples. Equipment rinsate samples will be obtained at a frequency of one per twenty samples by rinsing deionized water over decontaminated sampling equipment. Rinsate samples will be preserved with HNO_3 to pH < 2.

All samples will be analyzed in accordance with EPA Level II data quality requirements. Laboratory quality control requirements will include matrix spikes, matrix spike duplicates, method blanks, laboratory duplicates, and serial dilutions. The laboratory shall have method detection studies available for review if requested by the Fluor Daniel Fernald (FDF).

Prior to collection of samples for TCLP testing, pH testing will be performed in the field to verify the soil mixing procedure. Five (5) random samples will be obtained from each treated grid for pH testing. The requirements for field pH testing will be evaluated during the treatability study and addressed in a Treatability Study Report and a Full Scale Stabilization Work Plan.

Record keeping requirements will include sampling documentation and chain-of-custody procedures. Sampling documentation will be included in a Daily Quality Control Report and is presented in the QAP. Standard chain-of-custody procedures will be used for this project. Specifically, each sample will be accompanied by a chain-of-custody form provided by the analytical laboratory.

2.5 Equipment Decontamination

The soil samples will be taken using a stainless steel soil trier, bucket auger, or trowel, and a stainless steel mixing basin. The sampling equipment shall be decontaminated prior to each sample using EPA Level II Decontamination procedures, as follows:

- Rinse with potable water.
- Wash and scrub with Alconox®.
- Rinse with potable water.
- Rinse twice with deionized, organic-free water.
- Air dry.

If visible material remains after the Level II Decontamination, then EPA Level III Decontamination will be performed. Level III Decontamination includes an additional acid rinse (nitric acid) and a solvent rinse (methanol).

Sampling equipment shall be stored in a clean, sealed plastic bag when not in use between samples. Further, the equipment shall be stored in a secure, clean location.

2.6 Data Management

WST laboratory data is managed using the Laboratory Information Management System (LIMS) for in-house sample scheduling, tracking, and data transcription. The LIMS system allows real-time tracking of all samples in-house. After the data is complete for each grid, a copy will be faxed to the Construction Manager for their information.

WST will prepare data reports to be included in a Verification of Treatment Report. Data reports will include the following information:

- Project identification.
- Field sample number.
- Laboratory sample number.
- Sample matrix description.
- Date of sample collection.
- Date of sample receipt at laboratory.
- Analytical method description and reference citation.
- Individual parameter results.
- Date of analysis (extraction, first run, and subsequent runs).
- Quantitation limits achieved.
- Dilution or concentration factors.
- Corresponding QC report, which includes a QC data verification checklist (to include method blanks, blank/spikes, and continuing calibration checks).

After all acceptable analytical data has been received from the laboratory, the Verification of Treatment Report will be written and submitted to the FDF.

2.7 Health and Safety

All work associated with this activity will be performed in accordance with the Project Specific Health and Safety Plan (to be provided by FDF) and Sevenson's Safe Work Plan. Potential hazards may include exposure to contaminants, heat stress, and radiological hazards. Safety controls will include use of air monitoring, the "buddy system", employee training, and a radiological program. It is anticipated that the work will be performed in Modified Level D (hardhat, steel-toed boots, safety glasses, and tyveks) personal protective equipment.

2.8 Disposition of Wastes

Upon completion of the analyses, WST will return all soil samples to the Fernald site for disposition. The samples will be transported in containers amenable for shipping.

3.0 REFERENCES

Gilbert, Richard O., 1987. *Statistical Methods for Environmental Pollution Monitoring.* Van Nostrand Reinhold, New York.

Owen, D.B., 1962. *Handbook of Statistical Tables.* Addison-Wesley, Palo Alto, CA.

EPA/530-SW-89-026: "Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Final Guidance", April, 1989.

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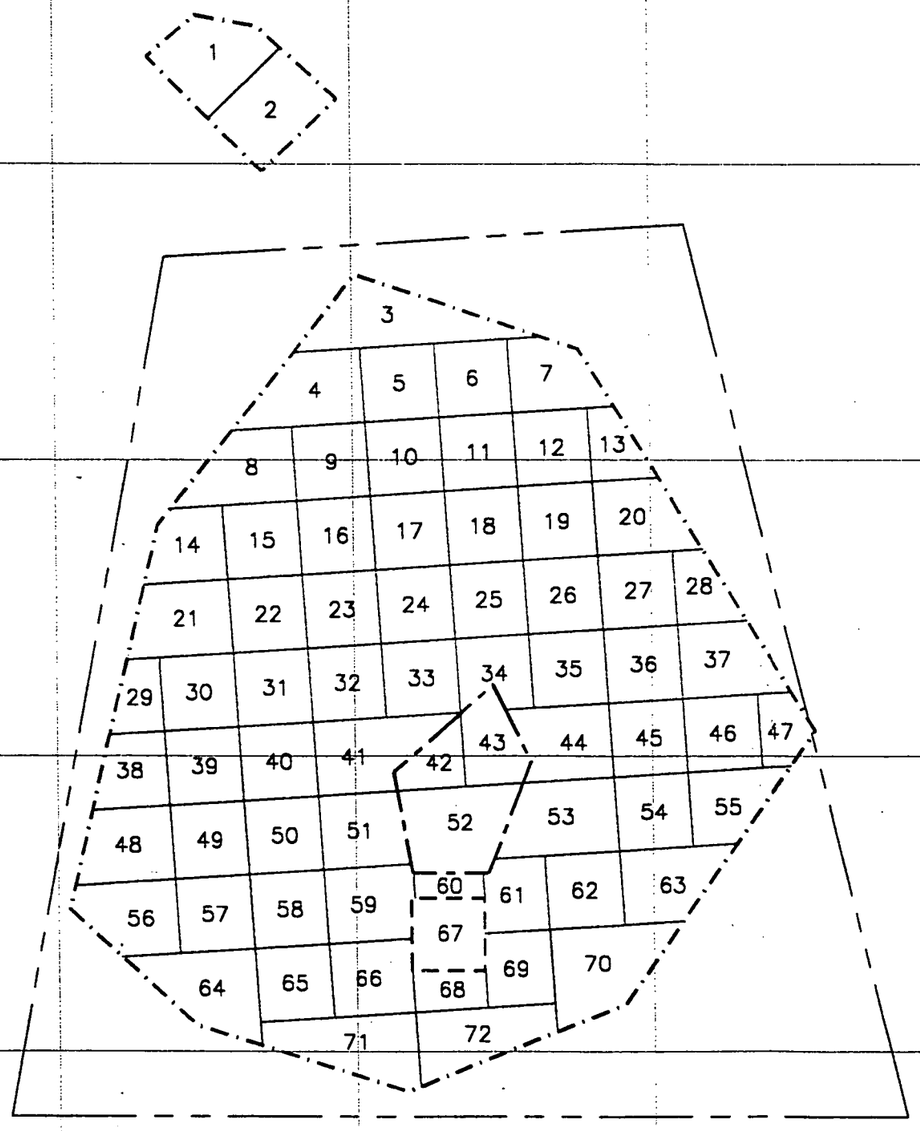

LEGEND

- STABILIZATION LIMIT TO 6" DEPTH
- STABILIZATION LIMIT TO 8" DEPTH
- STABILIZATION LIMIT TO 12" DEPTH
- SURVEY TRAVERSE

100 0 100

SCALE IN FEET

TREATMENT GRID LAYOUT

FLUOR DANIEL FERNALD
AREA 1 PHASE II
TRAP RANGE STABILIZATION PROJECT
FERNALD OHIO

SEVENSON ENVIRONMENTAL SERVICES, INC.

DRAWING		
FIG-1	DATE:	3/12/99
	DRAWN BY:	MB
	CHECKED BY:	SS
	CAD FILE:	FDGRID.DWG