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FINAL SAMPLING AND ANALYSIS PLAN FOR SITE 8B AND 8CNCBC GULFPORT MS
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FINAL
SAMPLING AND ANALYSIS PLAN
FOR
SITE 8B AND 8C

NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

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Naval Facilities Engineering Command
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ACRONYMS AND ABBREVIATIONS

CLEAN	Comprehensive Long-Term Environmental Action Navy
COC	chemical of concern
COMPQAP	Comprehensive Quality Assurance Plan
CTO	Contract Task Order
HLA	Harding Lawson Associates
HO	Herbicide Orange
HHRA	human health risk assessment
MDEQ	Mississippi Department of Environmental Quality
MDNR	Michigan Department of Natural Resources
MSL	mean sea level
NCBC	Naval Construction Battalion Center
ppt	parts per trillion
QA	quality assurance
QC	quality control
SOP	Standard Operating Procedure
SOUTHNAV-FACENGCOM	Southern Division, Naval Facilities Engineering Command
TTNUS	Tetra Tech NUS, Inc.
UCL	Upper Confidence Limit
USEPA	U.S. Environmental Protection Agency

SAMPLING ANALYSIS PLAN

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1.0 SITE BACKGROUND

Site 8 (Areas A, B, and C) comprises approximately 30 acres of (NCBC) Gulfport and lies in the north central portion of the installation. Site 8 topography is relatively flat with an undulating surface indicative of past remedial activities. Site layout is shown on Figure 1. (Appendix A).

From 1968 through 1977, Site 8 was used as a storage area for 850,000 gallons of the defoliant Herbicide Orange (HO) contained in 55-gallon drums. Based on the level of storage and handling of HO, Site 8 was subdivided into areas 8A, 8B and 8C during site environmental investigations; with Site 8A being the primary storage area and Sites 8B and 8C used to handle overflow HO stockpile. During the period of HO storage, damaged and leaking drums were removed from the site; however, limited documentation exists regarding the magnitude of any HO release or the conditions surrounding the disposal of the leaking drums.

During the storage of the ash on Site 8A, no protective barriers were used, leaving the ash piles exposed and in direct contact with the soil. Investigative work between 1995 and 2000 (Dioxin Delineation Studies) included a base-wide investigation of dioxins in soil, sediment and groundwater, and identified the pathways of off-site contaminant migration. In 1998 through 1999, a basewide groundwater assessment was conducted by Harding Lawson Associates, Inc., (HLA). HLA also conducted a surface water and sediment delineation study, which identified the on-base drainage ditches as the pathways for dioxin-contaminated soil and sediment migration from Site 8A. The complete delineation of dioxin in the surface water and groundwater pathways is presented in the Dioxin Delineation Remedial Investigation Report (HLA, 2000)

However, existing confirmation data for Site 8 surface soil was performed of lower resolution (Method 8280) dioxin methodology with a detection/reporting limit closer to 1 (ppb). This type of data was suitable for Site 8 when earlier plans included a cover or soil cement for the entire site. More recent developments (Remedial Design, Tetra Tech NUS, Inc.(TtNUS) 2004) indicate that only Site 8 A will have a cover and that B and C must be restored to pre-storage functionality. Given these circumstances, a high resolution confirmation of the remedial activities conducted in the mid-1980s should be completed to determine if the site meets current (MDEQ) guidelines, and if the results exceed the guidelines, then sufficient characterization should be completed to support any future remedial activities. The goals and objectives for Site 8 Areas B and C are discussed in the following section.

2.0 SAMPLING OBJECTIVES

The primary objective of this sampling effort is to characterize the levels and distribution of the remaining HO-related dioxins in the surface soil at Site 8 Areas B and C to determine if these areas meet current MDEQ standards or if additional remedial activities are necessary.

Given the history of remedial activities and earlier confirmation sampling only relatively low-level (<200 (ppt) dioxin contamination is anticipated in the surface soil. Therefore a sampling strategy was developed to determine if soil contamination has been remediated to acceptable levels based on the MDEQ guidance. This strategy will incorporate the procedures outlined in the MDEQ approved *Verification of Soil Remediation* as developed by the Michigan Department of Natural Resources (MDNR, 1994).

This strategy will also incorporate the use of the latest bio-assay dioxin sampling and analysis techniques (USEPA) Method 4025m) in conjunction with high resolution Method 8290 laboratory analysis to increase the sampling density and provide for fewer mobilizations based on the rapid turn around times and lower cost of the bio-assay tests. Approximately 10% of samples analyzed using Method 4025 will be split for laboratory analysis using Method 8290.

Ultimately, the results of this sampling will be used to determine if additional remedial activities are necessary at Site 8 areas B and C or if these areas qualify for closure.

3.0 SAMPLE LOCATION AND FREQUENCY

As stated above, the sample location and frequency described in this plan are based upon the Michigan Department of Environmental Quality *Verification of Soil Remediation* (MDNR 1994), as initially presented by the USEPA, *Test Methods for Evaluating Solid* Wastes, *SW-846 Volume II: Field Methods* (EPA) 1986). Given the unpredictable nature of the distribution of surface soil contamination at Site 8, a biased sampling approach, frequently used for the ditch systems at the base, is not appropriate. Therefore, a statistically driven random sampling strategy is the recommended approach. This approach employs the use of a grid to facilitate the unbiased selection of sampling points and accepted statistical tools for evaluation of the resulting data. These strategies provide a 95(%) confidence level of determining any hot spot concentrations at this site.

3.1 ESTABLISHING THE GRID

The grid system established for a site must be proportional to the size of the site and incorporate the level of confidence desired, as well as the spatial variability of the media to be sampled. Given the large size and unpredictable distribution patterns of contamination at B and C, a grid interval using the following formula (MDNR 1994) was developed:

$$GI = ((A * \bullet)/SF)^{1/2} \quad \text{or} \quad \sqrt{\frac{A\pi}{SF}}$$

Where:
- A = area to be grid (square feet)
- GI = grid interval
- SF = Site factor (unitless)
- • = 3.14159

Given the uncontaminated roadway (and associated roadbed) between Areas B and C, the sites were treated separately in terms of establishing a grid to eliminate unnecessary sampling. The resulting grid interval is 36 feet for Area B and 26 feet for Area C as shown on the Figure in Appendix A.

These grids result in a great number of nodes over the surface of Areas B and C; however this statistical technique does not require that every node be sampled as described in the following section.

3.2 SAMPLING FREQUENCY

Based on the guidance for *Verification of Soil Remediation* (MDNR 1994), the sampling of the grid is accomplished by assigning coordinates to all of the nodes and randomly selecting nodes using a random number generator. A minimum of 12 samples is required or 25% (whichever is larger).

145
53
198

In this case, 25% of the nodes results in 145 sampling locations for Area B and 53 sampling locations for Area C. The randomly selected sampling nodes are shown on the Figure in Appendix A. 10% of all primary locations will have confirmation analysis using Method 8290 at an offsite laboratory.

3.3 EVALUATION OF FIELD DATA

The use of bio-assay sampling will allow for rapid analysis of sample results. As a result, hot spot identification and characterization will be possible while the field crews are still mobilized. Therefore, any bio-assay result above the MDEQ restricted screening level for soil (38 ppt) will result in the collection of samples from the surrounding eight nodes for follow-up bio-assay (Method 4025) analysis.

To ensure that vertical contamination is addressed, a deeper sample will be collected at the original site of the sample exceeding the screening level. The sampling depths will be 0 to 6 inches, 6 to 12 inches, and deeper if necessary, although data from previous removals suggests that vertical contamination will be limited to the top 12 inches.

This technique will eliminate additional mobilizations to determine the extent of any hotspots that are discovered. As is discussed in the QAPP, all 4025 data will have a prescribed set of Quality Controls to ensure a high level of comparability with the 8290 sample results.

Data reduction, statistical evaluation and validation processes are described in detail in Section 6.

4.0 SAMPLE DESIGNATION

Sample designation will include a two-digit site identification, a four digit sample identifier based on the grid location; and single digit identifiers for media, sample depth, method and quality assurance code. The ten character sample designation for this program will be based on the explanations in the following table:

Table 4-1

Sample Designation Table

	Site _ID	**Samp_ID (Grid Loc)**	**Media**	**Depth**	**Method**	**QA**
Number of Characters	2	4	1	1	1	1
Explanation	8B 8C	~~01~~ 4 = Column 27 = Row	S = surface soil	1 = 0-6" 2 = 6"-12" 3 = 12"-18"	4 = 4025 8 = 8290	P =primary D = duplicate M = Matrix Spike S = MS Dup

5.0 SAMPLE EQUIPMENT AND PROCEDURES

This section will describe the specific equipment and sampling procedures necessary to complete the sampling procedures. These descriptions are consistent with TtNUS specific (SOPs) (TtNUS 2004) (Appendix B).

5.1 SAMPLE EQUIPMENT AND DECONTAMINATION

The primary pieces of equipment to collect the soil samples for this program will be stainless steel augers, bowls, and spoons. Thorough blending of these samples will be achieved by using a cordless drill in the field with a stainless steel paint stirring rod.

Sample decontamination is a priority due to the extremely low levels of contaminants in this study. The following list discusses field decontamination of the equipment used in this study. A broader discussion of decontamination procedures is contained in (QAPP).

- Dislodge gross soil contamination from equipment at sample site.
- Rinse equipment in tap water.
- Wash equipment in tap water and Alconox® using brushes to remove remaining visible soil particles.
- Rinse with isopropyl alcohol.
- Rinse with deionized water.
- Air dry and wrap with aluminum foil.

Decontaminated equipment should be segregated from used equipment at all times.

5.2 SAMPLING PROCEDURES

The procedure for the collection of the soil samples is:

[ALL EQUIPMENT MUST BE THOROUGHLY DECONTAMINATED BEFORE USE]

- Locate and confirm grid location.
- Mark sample location with flag indicating grid location for surveying.
- Collect sample using stainless steel auger. Minimum volume is 12 ounces.

- Place sample in stainless steel bowl using stainless spoon (if necessary).
- Remove rock and root debris.
- Completely homogenize sample using cordless power drill and stainless steel mixer.
- Split samples as necessary and place in proper sample container.
- Confirm sample container has proper site/sample identification on label.
- Maintain proper sample custody procedures until sample is shipped to lab.

6.0 SAMPLE HANDLING AND ANALYSES

Sampling handling, data analysis, and analysis are discussed in this section.

6.1 SAMPLING HANDLING

All samples collected during this effort will follow chain of custody procedures outlined in TtNUS corporate SOPs (TtNUS, 2004) (Appendix B). These procedures include sample identification (discussed in Section 4.1), preservation, secure custody seals, and records keeping.

Samples for both Method 4025 and Method 8290 will be maintained identically, and will be delivered in a cooler, chilled to 4 degrees Celsius, to their respective laboratories.

6.2 DATA ANALYSIS

One of the major components of this investigation will be the continual monitoring of the performance of Method 4025 versus the Method 8290 confirmation samples. This monitoring will be accomplished by comparing the 95% upper confidence limit (UCL) values for representative results from each method. This analysis will allow discussion of the overall site UCL value within a calculated range to support future actions.

6.3 CORRECTIVE ACTIONS

Given the use of two methods to determine site conditions, the following corrective actions for Method 4025 are necessary to promote the highest level of data quality.

False Positives - If a result is determined to be a false positive, the extract will be re-immersed using a new bioassay tube and analyzed on the photometer. A second false positive will require a new extraction and analysis.

False Negatives – A false negative will require re-extraction.

Spike Data – Internal spike recovery must fall within 35% to 120%. Recovery failure (high or low) will require that the entire sample delivery group must be re-extracted and analyzed using new bioassay tubes.

REFERENCES

MDEQ (Mississippi Department of Environmental Quality) 1999. *Tier I TRG Table*, Office of Pollution Control, Jackson, Mississippi

MDNR (Michigan Department of Natural Resources) 1994. *Verification of Soil Remediation,* Environmental Response Division

TtNUS (Tetra Tech NUS, Inc.) 1999. *Comprehensive Quality Assurance Plan*, Tallahassee, Florida.

USEPA (U.S. Environmental Protection Agency) 1996b. *Environmental Investigations Standard Operating Procedure Quality Assurance Manual (EISOPQAM),* Environmental Compliance Branch, Region 4, Science and Ecosystems Support Division, Athens, Georgia.

USEPA (U.S. Environmental Protection Agency) 1999d. *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review,* EPA/540/R-94/012, Office of Emergency and Remedial Response, Washington, D.C.

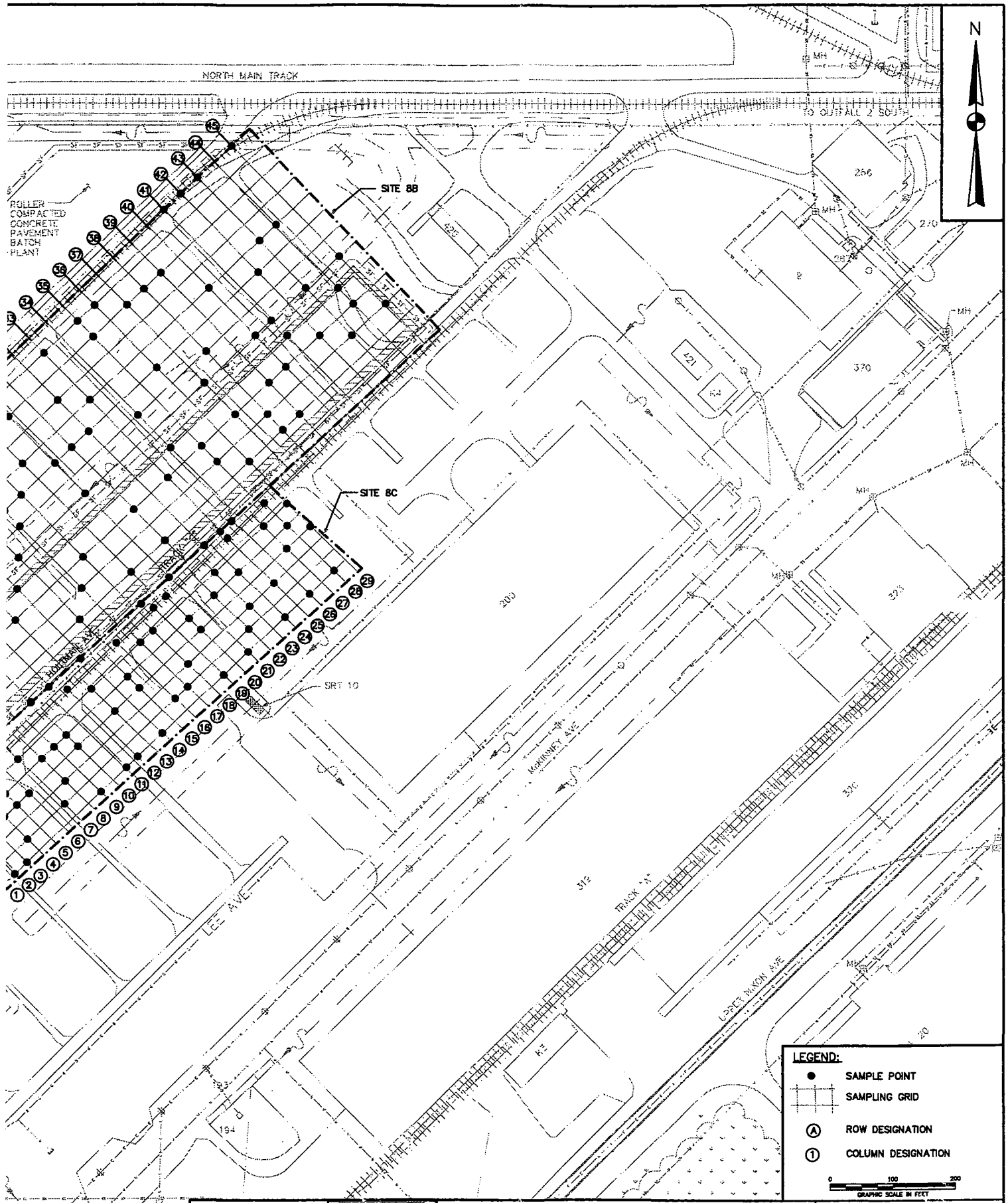
USEPA (U.S. Environmental Protection Agency) 1994e. *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review,* EPA/540/R-94/013, Office of Emergency and Remedial Response, Washington, D.C.

APPENDICE A

FIGURE

APPENDICE B

STANDARD OPERATING PROCEDURES (SOPS)



DRAWN BY DM	DATE 11/23/04	
CHECKED BY	DATE	
REVISED BY	DATE	
SCALE AS NOTED		

NAVFAC

SAMPLING GRID PLAN
SITE 8 - HERBICIDE ORANGE STORAGE AREA
NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI

CONTRACT NO. 7379
OWNER NO. CTO
APPROVED BY DATE
DRAWING NO. FIGURE
REV 0

ACAD: 8408CM04.dwg 11/23/04 DM PIT

SG - Soil Gas Sample
SL - Sludge Sample
SP - Seep Sample
SS - Surface Soil Sample
ST - Storm Sewer Water Sample
SW - Surface Water Sample
TP - Test Pit Sample
TW - Temporary Well Sample
WC - Well Construction Material Sample
WP - Wipe Sample
WS - Waste/Solid Sample
WW - Wastewater Sample

Sample Location - Examples of the location field are as follows:

001 - Monitoring Well 1
N32E92 - Grid location 32 North and 92 East
D096 - Investigation derived waste drum number 96

Species Identifier - Examples of species identifier are as follows:

BC - Blue Crab
GB - Blue Gill
CO - Corn
SB - Soybean

5.4 Examples of Sample Nomenclature

The first round monitoring well groundwater sample collected from existing monitoring well 001 at SWMU 16 for a filtered sample would be designated as 016MW00101-F.

The second round monitoring well groundwater sample collected from existing monitoring well C20P2 at Site 23 for an unfiltered sample would be designated as 023MWC20P202.

The second surface water sample collected from point 01 at SWMU 130 for an unfiltered sample would be designated as 130SW00102.

A surface soil sample collected from grid location 32 North and 92 East at Site 32 at the 0- to 2-foot interval would be designated as 032SSN32E920002.

A subsurface soil sample from soil boring 03 at SWMU 32 at an interval of 4 to 5 feet bgs would be designated as 032SB0030405.

A sediment sample collected at SWMU 19 from 0 to 6 inches at location 14 would be designated as 019SD0140001. The sample data sheet would reflect the precise depth at which this sample was collected.

During biota sampling for full body analysis the first time a minnow trap was checked at grid location A25 of SWMU 1415 three small blue gills were captured, collected and designated with the sample ID of 1415BSBA25BG001. The second time blue gill were collected at the same location (grid location A25 at SWMU 1415) the sample ID designation given was 1415BSBA25BG002.

Note: No dash (-) or spacing is used between the segments with the exception of the filtered segment. The "F" used for a filtered aqueous sample is preceded by a dash "-F".

5.5 Field Quality Assurance/Quality Control (QA/QC) Sample Nomenclature)

Field QA/QC will be designated using a different coding system. The QC code will consist of a three- to four-segment alpha-numeric code that identifies the sample QC type, the date the sample was collected, and the number of this type of QC sample collected on that date.

AA	NNNNNN	NN	-F
QC Type	Date	Sequence Number (per day)	Filtered (aqueous only, if needed)

The QC types are identified as:

TB = Trip Blank
RB = Rinsate Blank (Equipment Blank)
FD = Field Duplicate
AB = Ambient Conditions Blank
WB = Source Water Blank

The sampling time recorded on the Chain-of-Custody Form, labels, and tags for duplicate samples will be 0000 so that the samples are "blind" to the laboratory. Notes detailing the sample number, time, date, and type will be recorded on the routine sample log sheets and will document the location of the duplicate sample (sample log sheets are not provided to the laboratory). Documentation for all other QC types (TB, RB, AB, and WB) will be recorded on the QC Sample Log sheet (see SOP on Field Documentation).

5.6 Examples of Field QA/QC Sample Nomenclature

The first duplicate of the day for a filtered ground water sample collected on June 3, 2000 would be designated as FD06030001-F.

The third duplicate of the day taken of a subsurface soil sample collected on November 17, 2003 would be designated as FD11170303.

The first trip blank associated with samples collected on October 12, 2000 would be designated as TB10120001.

The only rinsate blank collected on November 17, 2001 would be designated as RB11170101.

6.0 DEVIATIONS

Any deviation from this SOP must be addressed in detail in the site specific planning documents.

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		Effective Date 09/03	Revision 2
		Applicability Tetra Tech NUS, Inc.	
		Prepared Earth Sciences Department	
Subject FIELD DOCUMENTATION		Approved D. Senovich	

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1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to identify and designate the field data record forms, logs and reports generally initiated and maintained for documenting Tetra Tech NUS field activities.

2.0 SCOPE

Documents presented within this procedure (or equivalents) shall be used for all Tetra Tech NUS field activities, as applicable. Other or additional documents may be required by specific client contracts or project planning documents.

3.0 GLOSSARY

None

4.0 RESPONSIBILITIES

Project Manager (PM) - The Project Manager is responsible for obtaining hardbound, controlled-distribution logbooks (from the appropriate source), as needed. In addition, the Project Manager is responsible for placing all field documentation used in site activities (i.e., records, field reports, sample data sheets, field notebooks, and the site logbook) in the project's central file upon the completion of field work.

Field Operations Leader (FOL) - The Field Operations Leader is responsible for ensuring that the site logbook, notebooks, and all appropriate and current forms and field reports illustrated in this guideline (and any additional forms required by the contract) are correctly used, accurately filled out, and completed in the required time-frame.

5.0 PROCEDURES

5.1 Site Logbook

5.1.1 General

The site logbook is a hard-bound, paginated, controlled-distribution record book in which all major onsite activities are documented. At a minimum, the following activities/events shall be recorded or referenced (daily) in the site logbook:

- All field personnel present
- Arrival/departure of site visitors
- Time and date of H&S training
- Arrival/departure of equipment
- Time and date of equipment calibration
- Start and/or completion of borehole, trench, monitoring well installation, etc.
- Daily onsite activities performed each day
- Sample pickup information
- Health and Safety issues (level of protection observed, etc.)
- Weather conditions

A site logbook shall be maintained for each project. The site logbook shall be initiated at the start of the first onsite activity (e.g., site visit or initial reconnaissance survey). Entries are to be made for every day

that onsite activities take place which involve Tetra Tech NUS or subcontractor personnel. Upon completion of the fieldwork, the site logbook must become part of the project's central file.

The following information must be recorded on the cover of each site logbook:

- Project name
- Tetra Tech NUS project number
- Sequential book number
- Start date
- End date

Information recorded daily in the site logbook need not be duplicated in other field notebooks (see Section 5.2), but must summarize the contents of these other notebooks and refer to specific page locations in these notebooks for detailed information (where applicable). An example of a typical site logbook entry is shown in Attachment A.

If measurements are made at any location, the measurements and equipment used must either be recorded in the site logbook or reference must be made to the field notebook in which the measurements are recorded (see Attachment A).

All logbook, notebook, and log sheet entries shall be made in indelible ink (black pen is preferred). No erasures are permitted. If an incorrect entry is made, the entry shall be crossed out with a single strike mark, and initialed and dated. At the completion of entries by any individual, the logbook pages used must be signed and dated. The site logbook must also be signed by the Field Operations Leader at the end of each day.

5.1.2 Photographs

When movies, slides, or photographs are taken of a site or any monitoring location, they must be numbered sequentially to correspond to logbook/notebook entries. The name of the photographer, date, time, site location, site description, and weather conditions must be entered in the logbook/notebook as the photographs are taken. A series entry may be used for rapid-sequence photographs. The photographer is not required to record the aperture settings and shutter speeds for photographs taken within the normal automatic exposure range. However, special lenses, films, filters, and other image-enhancement techniques must be noted in the logbook/notebook. If possible, such techniques shall be avoided, since they can adversely affect the accuracy of photographs. Chain-of-custody procedures depend upon the subject matter, type of camera (digital or film), and the processing it requires. Film used for aerial photography, confidential information, or criminal investigation require chain-of-custody procedures. Once processed, the slides of photographic prints shall be consecutively numbered and labeled according to the logbook/notebook descriptions. The site photographs and associated negatives and/or digitally saved images to compact disks must be docketed into the project's central file.

5.2 Field Notebooks

Key field team personnel may maintain a separate dedicated field notebook to document the pertinent field activities conducted directly under their supervision. For example, on large projects with multiple investigative sites and varying operating conditions, the Health and Safety Officer may elect to maintain a separate field notebook. Where several drill rigs are in operation simultaneously, each site geologist assigned to oversee a rig must maintain a field notebook.

5.3 Field Forms

All Tetra Tech NUS field forms (see list in Section 6.0 of this SOP) can be found on the company's intranet site (http://intranet.ttnus.com) under Field Log Sheets. Forms may be altered or revised for project-specific needs contingent upon client approval. Care must be taken to ensure that all essential information can be documented. Guidelines for completing these forms can be found in the related sampling SOP.

5.3.1 Sample Collection, Labeling, Shipment, Request for Analysis, and Field Test Results

5.3.1.1 Sample Log Sheet

Sample Log Sheets are used to record specified types of data while sampling. The data recorded on these sheets are useful in describing the sample as well as pointing out any problems, difficulties, or irregularities encountered during sampling. A log sheet must be completed for each sample obtained, including field quality control (QC) samples.

5.3.1.2 Sample Label

A typical sample label is illustrated in Attachment B. Adhesive labels must be completed and applied to every sample container. Sample labels can usually be obtained from the appropriate Program source electronically generated in-house, or are supplied from the laboratory subcontractor.

5.3.1.3 Chain-of-Custody Record Form

The Chain-of-Custody (COC) Record is a multi-part form that is initiated as samples are acquired and accompanies a sample (or group of samples) as they are transferred from person to person. This form must be used for any samples collected for chemical or geotechnical analysis whether the analyses are performed on site or off site. One carbonless copy of the completed COC form is retained by the field crew, one copy is sent to the Project Manager (or designee), while the original is sent to the laboratory. The original (top, signed copy) of the COC form shall be placed inside a large Ziploc-type bag and taped inside the lid of the shipping cooler. If multiple coolers are sent but are included on one COC form, the COC form should be sent with the cooler containing vials for VOC analysis or the cooler with the air bill attached. The air bill should then state how many coolers are included with that shipment. An example of a Chain-of-Custody Record form is provided as Attachment C. Once the samples are received at the laboratory, the sample cooler and contents are checked and any problems are noted on the enclosed COC form (any discrepancies between the sample labels and COC form and any other problems that are noted are resolved through communication between the laboratory point-of-contact and the Tetra Tech NUS Project Manager). The COC form is signed and copied. The laboratory will retain the copy while the original becomes part of the samples' corresponding analytical data package.

5.3.1.4 Chain-of-Custody Seal

Attachment D is an example of a custody seal. The Custody seal is an adhesive-backed label. It is part of a chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field and sealed in coolers for transport to the laboratory. The COC seals are signed and dated by the sampler(s) and affixed across the lid and body of each cooler (front and back) containing environmental samples (see SOP SA-6.1). COC seals may be available from the laboratory; these seals may also be purchased from a supplier.

5.3.1.5 Geochemical Parameters Log Sheets

Field Analytical Log Sheets are used to record geochemical and/or natural attenuation field test results.

5.3.2 Hydrogeological and Geotechnical Forms

5.3.2.1 Groundwater Level Measurement Sheet

A Groundwater Level Measurement Sheet must be filled out for each round of water level measurements made at a site.

5.3.2.2 Data Sheet for Pumping Test

During the performance of a pumping test (or an in-situ hydraulic conductivity test), a large amount of data must be recorded, often within a short time period. The Pumping Test Data Sheet facilitates this task by standardizing the data collection format for the pumping well and observation wells, and allowing the time interval for collection to be laid out in advance.

5.3.2.3 Packer Test Report Form

A Packer Test Report Form must be completed for each well upon which a packer test is conducted.

5.3.2.4 Boring Log

During the progress of each boring, a log of the materials encountered, operation and driving of casing, and location of samples must be kept. The Summary Log of Boring, or Boring Log is used for this purpose and must be completed for each soil boring performed. In addition, if volatile organics are monitored on cores, samples, cuttings from the borehole, or breathing zone, (using a PID or FID), these readings must be entered on the boring log at the appropriate depth. The "Remarks" column can be used to subsequently enter the laboratory sample number, the concentration of key analytical results, or other pertinent information. This feature allows direct comparison of contaminant concentrations with soil characteristics.

5.3.2.5 Monitoring Well Construction Details Form

A Monitoring Well Construction Details Form must be completed for every monitoring well, piezometer, or temporary well point installed. This form contains specific information on length and type of well riser pipe and screen, backfill, filter pack, annular seal and grout characteristics, and surface seal characteristics. This information is important in evaluating the performance of the monitoring well, particularly in areas where water levels show temporal variation, or where there are multiple (immiscible) phases of contaminants. Depending on the type of monitoring well (in overburden or bedrock, stick-up or flush mount), different forms are used.

5.3.2.6 Test Pit Log

When a test pit or trench is constructed for investigative or sampling purposes, a Test Pit Log must be filled out by the responsible field geologist or sampling technician.

5.3.2.7 Miscellaneous Monitoring Well Forms

Monitoring Well Materials Certificate of Conformance should be used as the project directs to document all materials utilized during each monitoring well installation.

The Monitoring Well Development Record should be used as the project directs to document all well development activities.

5.3.2.8 Miscellaneous Field Forms - QA and Checklists

Container Sample and Inspection Sheet should be used as the project directs each time a container (drum, tank, etc.) is sampled and/or inspected.

QA Sample Log Sheet should be used at the project directs each time a QA sample is colleted, such as Rinsate Blank, Source Blank, etc.

Field Task Modification Request (FTMR) will be prepared for all deviations from the project planning documents. The FOL is responsible for initiating the FTMRs. Copies of all FTMRs will be maintained with the onsite planning documents and originals will be placed in the final evidence file.

The Field Project Daily Activities Check List and Field Project Pre-Mobilization Checklist should be used during both the planning and field effort to assure that all necessary tasks are planned for and completed. These two forms are not a requirement but a useful tool for most field work.

5.3.3 Equipment Calibration and Maintenance Form

The calibration or standardization of monitoring, measuring or test equipment is necessary to assure the proper operation and response of the equipment, to document the accuracy, precision or sensitivity of the measurement, and determine if correction should be applied to the readings. Some items of equipment require frequent calibration, others infrequent. Some are calibrated by the manufacturer, others by the user.

Each instrument requiring calibration has its own Equipment Calibration Log which documents that the manufacturer's instructions were followed for calibration of the equipment, including frequency and type of standard or calibration device. An Equipment Calibration Log must be maintained for each electronic measuring device used in the field; entries must be made for each day the equipment is used or in accordance with the manufacturer's recommendations.

5.4 Field Reports

The primary means of recording onsite activities is the site logbook. Other field notebooks may also be maintained. These logbooks and notebooks (and supporting forms) contain detailed information required for data interpretation or documentation, but are not easily useful for tracking and reporting of progress. Furthermore, the field logbook/notebooks remain onsite for extended periods of time and are thus not accessible for timely review by project management.

5.4.1 Daily Activities Report

To provide timely oversight of onsite contractors, Daily Activities Reports are completed and submitted as described below.

5.4.1.1 Description

The Daily Activities Report (DAR) documents the activities and progress for each day's field work. This report must be filled out on a daily basis whenever there are drilling, test pitting, well construction, or other related activities occurring which involve subcontractor personnel. These sheets summarize the work performed and form the basis of payment to subcontractors. The DAR form can be found on the TtNUS intranet site.

5.4.1.2 Responsibilities

It is the responsibility of the rig geologist to complete the DAR and obtain the driller's signature acknowledging that the times and quantities of material entered are correct.

5.4.1.3 Submittal and Approval

At the end of the shift, the rig geologist must submit the Daily Activities Report to the Field Operations Leader (FOL) for review and filing. The Daily Activities Report is not a formal report and thus requires no further approval. The DAR reports are retained by the FOL for use in preparing the site logbook and in preparing weekly status reports for submission to the Project Manager.

5.4.2 Weekly Status Reports

To facilitate timely review by project management, photocopies of logbook/notebook entries may be made for internal use.

It should be noted that in addition to summaries described herein, other summary reports may also be contractually required.

All Tetra Tech NUS field forms can be found on the company's intranet site at http://intranet.ttnus.com under Field Log Sheets.

6.0 LISTING OF TETRA TECH NUS FIELD FORMS FOUND ON THE TTNUS INTRANET SITE. HTTP://INTRANET.TTNUS.COM CLICK ON FIELD LOG SHEETS

Groundwater Sample Log Sheet
Surface Water Sample Log Sheet
Soil/Sediment Sample Log Sheet
Container Sample and Inspection Sheet
Geochemical Parameters (Natural Attenuation)
Groundwater Level Measurement Sheet
Pumping Test Data Sheet
Packer Test Report Form
Boring Log
Monitoring Well Construction Bedrock Flush Mount
Monitoring Well Construction Bedrock Open Hole
Monitoring Well Construction Bedrock Stick Up
Monitoring Well Construction Confining Layer
Monitoring Well Construction Overburden Flush Mount
Monitoring Well Construction Overburden Stick Up
Test Pit Log
Monitoring Well Materials Certificate of Conformance
Monitoring Well Development Record

Daily Activities Record
Field Task Modification Request
Hydraulic Conductivity Test Data Sheet
Low Flow Purge Data Sheet
QA Sample Log Sheet
Equipment Calibration Log
Field Project Daily Activities Checklist
Field Project Pre-Mobilization Checklist

ATTACHMENT A
TYPICAL SITE LOGBOOK ENTRY

START TIME: _____ DATE: _____

SITE LEADER: _____

PERSONNEL:

TtNUS	DRILLER	SITE VISITORS
_____	_____	_____
_____	_____	_____
_____	_____	_____

WEATHER: Clear, 68°F, 2-5 mph wind from SE

ACTIVITIES:

1. Steam jenney and fire hoses were set up.
2. Drilling activities at well ____ resumes. Rig geologist was _____. See Geologist's Notebook, No. 1, page 29-30, for details of drilling activity. Sample No. 123-21-S4 collected; see sample logbook, page 42. Drilling activities completed at 11:50 and a 4-inch stainless steel well installed. See Geologist's Notebook, No. 1, page 31, and well construction details for well _____.
3. Drilling rig No. 2 steam-cleaned at decontamination pit. Then set up at location of well _____.
4. Well _____ drilled. Rig geologist was _____. See Geologist's Notebook, No. 2, page ____ for details of drilling activities. Sample numbers 123-22-S1, 123-22-S2, and 123-22-S3 collected; see sample logbook, pages 43, 44, and 45.
5. Well _____ was developed. Seven 55-gallon drums were filled in the flushing stage. The well was then pumped using the pitcher pump for 1 hour. At the end of the hour, water pumped from well was "sand free."
6. EPA remedial project manger arrives on site at 14:25 hours.
7. Large dump truck arrives at 14:45 and is steam-cleaned. Backhoe and dump truck set up over test pit _____.
8. Test pit _____ dug with cuttings placed in dump truck. Rig geologist was _____. See Geologist's Notebook, No. 1, page 32, for details of test pit activities. Test pit subsequently filled. No samples taken for chemical analysis. Due to shallow groundwater table, filling in of test pit ___ resulted in a very soft and wet area. A mound was developed and the area roped off.
9. Express carrier picked up samples (see Sample Logbook, pages 42 through 45) at 17:50 hours. Site activities terminated at 18:22 hours. All personnel off site, gate locked.

_____

Field Operations Leader

ATTACHMENT B

Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, 15220 (412)921-7090	Project: Site: Location:	
Sample No:		Matrix:
Date:	Time:	Preserve:
Analysis:		
Sampled by:	Laboratory:	

TETRA TECH NUS, INC. CHAIN OF CUSTODY | NUMBER 3413 | PAGE ___ OF ___

PROJECT NO:	FACILITY:	PROJECT MANAGER	PHONE NUMBER	LABORATORY NAME AND CONTACT:
SAMPLERS (SIGNATURE)		FIELD OPERATIONS LEADER	PHONE NUMBER	ADDRESS
		CARRIER/WAYBILL NUMBER		CITY, STATE

STANDARD TAT ☐
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

CONTAINER TYPE - PLASTIC (P) or GLASS (G)
PRESERVATIVE USED

DATE YEAR	TIME	SAMPLE ID	LOCATION ID	TOP DEPTH (FT)	BOTTOM DEPTH (FT)	MATRIX (GW, SO, SW, SD, QC, ETC.)	COLLECTION METHOD GRAB (G) COMP (C)	No. OF CONTAINERS	TYPE OF ANALYSIS								COMMENTS

1. RELINQUISHED BY	DATE	TIME	1. RECEIVED BY	DATE	TIME
2. RELINQUISHED BY	DATE	TIME	2. RECEIVED BY	DATE	TIME
3. RELINQUISHED BY	DATE	TIME	3. RECEIVED BY	DATE	TIME

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

4/02R
FORM NO. TtNUS-001

ATTACHMENT C

ATTACHMENT D

CHAIN-OF-CUSTODY SEAL

CUSTODY SEAL	**Signature**
Date	**Date**
Signature	**CUSTODY SEAL**

TETRA TECH NUS, INC.	STANDARD OPERATING PROCEDURES	Number SA-1.3	Page 1 of 20
		Effective Date 09/03	Revision 7
		Applicability Tetra Tech NUS, Inc.	
		Prepared Earth Sciences Department	
Subject SOIL SAMPLING		Approved D. Senovich	

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1.0 PURPOSE

This procedure discusses the methods used to collect surface, near surface, and subsurface soil samples. Additionally, it describes the method for sampling of test pits and trenches to determine subsurface soil and rock conditions, and recover small-volume or bulk samples.

2.0 SCOPE

This procedure is applicable to the collection of surface, near surface and subsurface soils for laboratory testing, which are exposed through hand digging, hand augering, drilling, or machine excavating at hazardous substance sites.

3.0 GLOSSARY

Composite Sample - A composite sample exists as a combination of more than one sample at various locations and/or depths and times, which is homogenized and treated as one sample. This type of sample is usually collected when determination of an average waste concentration for a specific area is required. Composite samples are not to be collected for volatile organics analysis.

Grab Sample - One sample collected at one location and at one specific time.

Non-Volatile Sample - A non-volatile sample includes all other chemical parameters (e.g., semivolatiles, pesticides/PCBs, metals, etc.) and those engineering parameters that do not require undisturbed soil for their analysis.

Hand Auger - A sampling device used to extract soil from the ground in a relatively undisturbed form.

Thin-Walled Tube Sampler - A thin-walled metal tube (also called a Shelby tube) used to recover relatively undisturbed soil samples. These tubes are available in various sizes, ranging from 2 to 5 inches outside diameter (OD) and from 18 to 54 inches in length.

Split-Barrel Sampler - A steel tube, split in half lengthwise, with the halves held together by threaded collars at either end of the tube. Also called a split-spoon sampler, this device can be driven into resistant materials using a drive weight mounted in the drilling string. A standard split-barrel sampler is typically available in two common lengths, providing either 20-inch or 26-inch longitudinal clearance for obtaining 18-inch or 24-inch-long samples, respectively. These split-barrel samplers commonly range in size from 2-inch OD to 3-1/2 inch OD. The larger sizes are commonly used when a larger volume of sample material is required.

Test Pit and Trench - Open, shallow excavations, typically rectangular (if a test pit) or longitudinal (if a trench), excavated to determine the shallow subsurface conditions for engineering, geological, and soil chemistry exploration and/or sampling purposes. These pits are excavated manually or by machine (e.g., backhoe, clamshell, trencher excavator, or bulldozer).

Confined Space - As stipulated in 29 CFR 1910.146, a confined space means a space that: 1) is large enough and so configured that an employee can bodily enter and perform assigned work; 2) has limited or restricted means for entry or exit (for example tanks, vessels, silos, storage bins, hoppers, vaults, pits, and excavations); and 3) is not designed for continuous employee occupancy. TtNUS considers all confined space as permit-required confined spaces.

4.0 RESPONSIBILITIES

Project Manager - The Project Manager is responsible for determining sampling objectives, as well as, the field procedures used in the collection of soil samples. Additionally, in consultation with other project personnel (geologist, hydrogeologist, etc.), the Project Manager establishes the need for test pits or trenches, and determines their approximate locations and dimensions.

Site Safety Officer (SSO) - The SSO (or a qualified designee) is responsible for providing the technical support necessary to implement the project Health and Safety Plan. This will include (but not be limited to) performing air quality monitoring during sampling, boring and excavation activities, and to ensure that workers and offsite (downwind) individuals are not exposed to hazardous levels of airborne contaminants. The SSO/designee may also be required to advise the FOL on other safety-related matters regarding boring, excavation and sampling, such as mitigative measures to address potential hazards from unstable trench walls, puncturing of drums or other hazardous objects, etc.

Field Operations Leader (FOL) - The FOL is responsible for finalizing the location of surface, near surface, and subsurface (hand and machine borings, test pits/trenches) soil samples. He/she is ultimately responsible for the sampling and backfilling of boreholes, test pits and trenches, and for adherence to OSHA regulations during these operations.

Project Geologist/Sampler - The project geologist/sampler is responsible for the proper acquisition of soil samples and the completion of all required paperwork (i.e., sample log sheets, field notebook, boring logs, test pit logs, container labels, custody seals, and chain-of-custody forms).

Competent Person - A Competent Person, as defined in 29 CFR 1929.650 of Subpart P - Excavations, means one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

5.0 PROCEDURES

5.1 Overview

Soil sampling is an important adjunct to groundwater monitoring. Sampling of the soil horizons above the groundwater table can detect contaminants before they have migrated into the water table, and can establish the amount of contamination sorbed on aquifer solids that have the potential of contributing to groundwater contamination.

Soil types can vary considerably on a hazardous waste site. These variations, along with vegetation, can affect the rate of contaminant migration through the soil. It is important, therefore, that a detailed record be maintained during the sampling operations, particularly noting the location, depth, and such characteristics as grain size, color, and odor. Subsurface conditions are often stable on a daily basis and may demonstrate only slight seasonal variation especially with respect to temperature, available oxygen and light penetration. Changes in any of these conditions can radically alter the rate of chemical reactions or the associated microbiological community, thus further altering specific site conditions. As a result, samples must be kept at their at-depth temperature or lower, protected from direct light, sealed tightly in approved glass containers, and be analyzed as soon as possible.

The physical properties of the soil, its grain size, cohesiveness, associated moisture, and such factors as depth to bedrock and water table, will limit the depth from which samples can be collected and the method required to collect them. Often this information on soil properties can be obtained from published soil surveys available through the U.S. Geological Surveys and other government or farm agencies. It is the

intent of this procedure to present the most commonly employed soil sampling methods used at hazardous waste sites.

5.2 Soil Sample Collection

5.2.1 Procedure for Collecting Soil Samples for Volatile Organic Compounds

The above described traditional sampling techniques, used for the collection of soil samples for volatile organic analysis, have recently been evaluated by the scientific community and determined to be ineffective in producing accurate results (biased low) due to the loss of volatile organics in the sampling stages and microbial degradation of aromatic volatiles. One of the newly adopted sampling procedures for collecting soil samples includes the field preservation of samples with methanol or sodium bisulfate to minimize volatilization and biodegradation. These preservation methods may be performed either in the field or laboratory, depending on the sampling methodology employed.

Soil samples to be preserved by the laboratory are currently being performed using method SW-846, 5035. Laboratories are currently performing low level analyses (sodium bisulfate preservation) and high level analyses (methanol preservation) depending on the end users needs.

It should be noted that a major disadvantage of the methanol preservation method is that the laboratory reporting limits will be higher than conventional testing. The reporting levels using the new method for most analytes are 0.5 µg/g for GC/MS and 0.05 µg/g for GC methods.

The alternative preservation method for collecting soil samples is with sodium bisulfate. This method is more complex to perform in the field and therefore is not preferred for field crews. It should also be noted that currently, not all laboratories have the capabilities to perform this analysis. The advantage to this method is that the reporting limits (0.001 µg/g for GC/PID or GC/ELCD, or 0.010 for GC/MS) are lower than those described above.

The following procedures outline the necessary steps for collecting soil samples to be preserved at the laboratory, and for collecting soil samples to be preserved in the field with methanol or sodium bisulfate.

5.2.1.1 Soil Samples to be Preserved at the Laboratory

Soil samples collected for volatile organics that are to be preserved at the laboratory will be obtained using a hermetically sealed sample vial such as an EnCore™ sampler. Each sample will be obtained using a reusable sampling handle provided with the EnCore™ sampler. The sample is collected by pushing the EnCore™ sampler directly into the soil, ensuring that the sampler is packed tight with soil, leaving zero headspace. Using this type of sampling device eliminates the need for field preservation and the shipping restrictions associated with preservatives. A complete set of instructions is included with each Encore™ sampler shipment by the manufacturer.

Once the sample is collected, it should be placed on ice immediately and shipped to the laboratory within 48 hours (following the chain-of-custody and documentation procedures outlined in SOP SA-6.1). Samples must be preserved by the laboratory within 48 hours of sample collection.

If the lower detection limits are necessary, an option would be to collect several EnCore™ samplers at a given sample location. Send all samplers to the laboratory and the laboratory can perform the required preservation and analyses.

5.2.1.2 Soil Samples to be Preserved in the Field

Soil samples preserved in the field may be prepared for analyses using both the low-level (sodium bisulfate preservation) method and medium-level (methanol preservation) method.

Methanol Preservation (Medium Level):

Soil samples to be preserved in the field with methanol will utilize 40-60 mL glass vials with septum lids. Each sample bottle will be filled with 25 mL of demonstrated analyte-free purge and trap grade methanol. Bottles may be prespiked with methanol in the laboratory or prepared in the field.

Soil will be collected with the use of a decontaminated (or disposable), small-diameter coring device such as a disposable tube/plunger-type syringe with the tip cut off. The outside diameter of the coring device must be smaller than the inside diameter of the sample bottle neck.

A small electronic balance or manual scale will be necessary for measuring the volume of soil to be added to the methanol preserved sample bottle. Calibration of the scale should be performed prior to use and intermittently throughout the day according to the manufacturers requirements.

The sample should be collected by pulling the plunger back and inserting the syringe into the soil to be sampled. The top several inches of soil should be removed before collecting the sample. Approximately 10 grams $\pm$2g (8-12 grams) of soil should be collected. The sample should be weighed and adjusted until obtaining the required amount of sample. The sample weight should be recorded to the nearest 0.01 gram in the field logbook and/or sample log sheet. The soil should then be extruded into the methanol preserved sample bottle taking care not to contact the sample container with the syringe. The threads of the bottle and cap must be free of soil particles.

After capping the bottle, swirl the sample (do not shake) in the methanol and break up the soil such that all of the soil is covered with methanol. Place the sample on ice immediately and prepare for shipment to the laboratory as described in SOP SA-6.1.

Sodium Bisulfate Preservation (Low Level):

Samples to be preserved using the sodium bisulfate method are to be prepared as follows:

Add 1 gram of sodium bisulfate to 5 mL of laboratory grade deionized water in a 40-60 mL glass vial with septum lid. Bottles may be prespiked in the laboratory or prepared in the field. The soil sample should be collected in a manner as described above and added to the sample container. The sample should be weighed to the nearest 0.01 gram as described above and recorded in the field logbook or sample log sheet.

Care should be taken when adding the soil to the sodium bisulfate solution. A chemical reaction of soils containing carbonates (limestone) may cause the sample to effervesce or the vial to possibly explode.

When preparing samples using the sodium bisulfate preservation method, duplicate samples must be collected using the methanol preservation method on a one for one sample basis. The reason for this is because it is necessary for the laboratory to perform both the low level and medium level analyses. Place the sample on ice immediately and prepare for shipment to the laboratory as described in SOP SA-6.1.

If the lower detection limits are necessary, an option to field preserving with sodium bisulfate would be to collect 3 EnCore™ samplers at a given sample location. Send all samplers to the laboratory and the laboratory can perform the required preservation and analyses.

5.2.2 Procedure for Collecting Non-Volatile Soil Samples

Non-volatile soil samples may be collected as either grab or composite samples. The non-volatile soil sample is thoroughly mixed in a stainless steel or disposable, inert plastic tray, using a stainless steel trowel or other approved tool, then transferred into the appropriate sample container(s). Head space is permitted in a non-volatile soil sample container to allow for sample expansion.

5.2.3 Procedure for Collecting Undisturbed Soil Samples (ASTM D1587-83)

When it is necessary to acquire undisturbed samples of soil for purposes of engineering parameter analysis (e.g., permeability), a thin-walled, seamless tube sampler (Shelby tube) will be employed. The following method will be used:

1. Remove all surface debris (e.g., vegetation, roots, twigs, etc.) from the specific sampling location and drill and clean out the borehole to the sampling depth, being careful to minimize the chance for disturbance of the material to be sampled. In saturated material, withdraw the drill bit slowly to prevent loosening of the soil around the borehole and to maintain the water level in the hole at or above groundwater level.

2. The use of bottom discharge bits or jetting through an open-tube sampler to clean out the borehole shall not be allowed. Use of any side-discharge bits is permitted.

3. A stationary piston-type sampler may be required to limit sample disturbance and aid in retaining the sample. Either the hydraulically operated or control rod activated-type of stationary piston sampler may be used. Prior to inserting the tube sampler into the borehole, check to ensure that the sampler head contains a check valve. The check valve is necessary to keep water in the rods from pushing the sample out the tube sampler during sample withdrawal and to maintain a suction within the tube to help retain the sample.

4. To minimize chemical reaction between the sample and the sampling tube, brass tubes may be required, especially if the tube is stored for an extended time prior to testing. While steel tubes coated with shellac are less expensive than brass, they're more reactive, and shall only be used when the sample will be tested within a few days after sampling or if chemical reaction is not anticipated. With the sampling tube resting on the bottom of the hole and the water level in the boring at groundwater level or above, push the tube into the soil by a continuous and rapid motion, without impacting or twisting. In no case shall the tube be pushed farther than the length provided for the soil sample. Allow about 3 inches in the tube for cuttings and sludge.

5. Upon removal of the sampling tube from the hole, measure the length of sample in the tube and also the length penetrated. Remove disturbed material in the upper end of the tube and measure the length of sample again. After removing at least an inch of soil from the lower end and after inserting an impervious disk, seal both ends of the tube with at least a 1/2-inch thickness of wax applied in a way that will prevent the wax from entering the sample. Clean filler must be placed in voids at either end of the tube prior to sealing with wax. Place plastic caps on the ends of the sample tube, tape the caps in place, and dip the ends in wax.

6. Affix label(s) to the tube as required and record sample number, depth, penetration, and recovery length on the label. Mark the "up" direction on the side of the tube with indelible ink, and mark the end of the sample. Complete Chain-of-Custody (see SOP SA-6.3) and other required forms (including Attachment A of this SOP). Do not allow tubes to freeze, and store the samples vertically with the same orientation they had in the ground, (i.e., top of sample is up) in a cool place out of the sun at all times. Ship samples protected with suitable resilient packing material to reduce shock, vibration, and disturbance.

Thin-walled undisturbed tube samplers are restricted in their usage by the consistency of the soil to be sampled. Often, very loose and/or wet samples cannot be retrieved by the samplers, and soils with a consistency in excess of very stiff cannot be penetrated by the sampler. Devices such as Dennison or Pitcher core samplers can be used to obtain undisturbed samples of stiff soils. Using these devices normally increases sampling costs, and therefore their use shall be weighed against the need for acquiring an undisturbed sample.

5.3 Surface Soil Sampling

The simplest, most direct method of collecting surface soil samples (most commonly collected to a depth of 6 inches) for subsequent analysis is by use of a stainless steel trowel. Surface soils are considered 0-12 inches bgs.

In general, the following equipment is necessary for obtaining surface soil samples:

- Stainless steel or pre-cleaned disposable trowel.
- Real-time air monitoring instrument (e.g., PID, FID, etc.).
- Latex gloves.
- Required Personal Protective Equipment (PPE).
- Required paperwork (see SOP SA-6.3 and Attachment A of this SOP).
- Required decontamination equipment.
- Required sample container(s).
- Wooden stakes or pin flags.
- Sealable polyethylene bags (i.e., Ziploc® baggies).
- Heavy duty cooler.
- Ice.
- Chain-of-custody records and custody seals.

When acquiring surface soil samples, the following procedure shall be used:

1. Carefully remove vegetation, roots, twigs, litter, etc., to expose an adequate soil surface area to accommodate sample volume requirements.

2. Using a decontaminated stainless steel trowel, follow the procedure cited in Section 5.2.1 for collecting a volatile soil sample. Surface soil samples for volatile organic analysis should be collected from 6-12 inches bgs only.

3. Thoroughly mix (in-situ) a sufficient amount of soil to fill the remaining sample containers and transfer the sample into those containers utilizing the same stainless steel trowel employed above. Cap and securely tighten all sample containers.

4. Affix a sample label to each container. Be sure to fill out each label carefully and clearly, addressing all the categories described in SOP SA-6.3.

5. Proceed with the handling and processing of each sample container as described in SOP SA-6.2.

5.4 Near-Surface Soil Sampling

Collection of samples from near the surface (depth of 6-18 inches) can be accomplished with tools such as shovels and stainless steel or pre-cleaned disposable trowels.

The following equipment is necessary to collect near surface soil samples:

- Clean shovel.
- The equipment listed under Section 5.3 of this procedure.
- Hand auger.

To obtain near-surface soil samples, the following protocol shall be observed:

1. With a clean shovel, make a series of vertical cuts to the depth required in the soil to form a square approximately 1 foot by 1 foot.

2. Lever out the formed plug and scrape the bottom of the freshly dug hole with a decontaminated stainless steel or pre-cleaned disposable trowel to remove any loose soil.

3. Follow steps 2 through 5 listed under Section 5.3 of this procedure.

5.5 Subsurface Soil Sampling With a Hand Auger

A hand augering system generally consists of a variety of all stainless steel bucket bits (i.e., cylinders 6-1/2" long, and 2-3/4", 3-1/4", and 4" in diameter), a series of extension rods (available in 2', 3', 4' and 5' lengths), and a cross handle. A larger diameter bucket bit is commonly used to bore a hole to the desired sampling depth and then withdrawn. In turn, the larger diameter bit is replaced with a smaller diameter bit, lowered down the hole, and slowly turned into the soil at the completion depth (approximately 6 inches). The apparatus is then withdrawn and the soil sample collected.

The hand auger can be used in a wide variety of soil conditions. It can be used to sample soil both from the surface, or to depths in excess of 12 feet. However, the presence of rock layers and the collapse of the borehole normally contribute to its limiting factors.

To accomplish soil sampling using a hand augering system, the following equipment is required:

- Complete hand auger assembly (variety of bucket bit sizes).
- Stainless steel mixing bowls.
- The equipment listed under Section 5.3 of this procedure.

To obtain soil samples using a hand auger, the following procedure shall be followed:

1. Attach a properly decontaminated bucket bit to a clean extension rod and further attach the cross handle to the extension rod.

2. Clear the area to be sampled of any surface debris (vegetation, twigs, rocks, litter, etc.).

3. Begin augering (periodically removing accumulated soils from the bucket bit) and add additional rod extensions as necessary. Also, note (in a field notebook, boring log, and/or on standardized data sheets) any changes in the color, texture or odor of the soil.

4. After reaching the desired depth, slowly and carefully withdraw the apparatus from the borehole.

5. Remove the soiled bucket bit from the rod extension and replace it with another properly decontaminated bucket bit. The bucket bit used for sampling is commonly smaller in diameter than the bucket bit employed to initiate the borehole.

6. Carefully lower the apparatus down the borehole. Care must be taken to avoid scraping the borehole sides.

7. Slowly turn the apparatus until the bucket bit is advanced approximately 6 inches.

8. Discard the top of the core (approximately 1"), which represents any loose material collected by the bucket bit before penetrating the sample material.

9. Fill volatile sample container(s), using a properly decontaminated stainless steel trowel, with sample material directly from the bucket bit. Refer to Section 5.2.1 of this procedure.

10. Utilizing the above trowel, remove the remaining sample material from the bucket bit and place into a properly decontaminated stainless steel mixing bowl and thoroughly homogenize the sample material prior to filling the remaining sample containers. Refer to Section 5.2.2 of this procedure.

11. Follow steps 4 and 5 listed under Section 5.3 of this procedure.

5.6 Subsurface Soil Sampling With a Split-Barrel Sampler (ASTM D1586-84)

Split-barrel (split-spoon) samplers consist of a heavy carbon steel or stainless steel sampling tube that can be split into two equal halves to reveal the soil sample (see Attachment B). A drive head is attached to the upper end of the tube and serves as a point of attachment for the drill rod. A removable tapered nosepiece/drive shoe attaches to the lower end of the tube and facilitates cutting. A basket-like sample retainer can be fitted to the lower end of the split tube to hold loose, dry soil samples in the tube when the sampler is removed from the drill hole. This split-barrel sampler is made to be attached to a drill rod and forced into the ground by means of a 140-lb. or larger casing driver.

Split-barrel samplers are used to collect soil samples from a wide variety of soil types and from depths greater than those attainable with other soil sampling equipment.

The following equipment is used for obtaining split-barrel samples:

- Drilling equipment (provided by subcontractor).
- Split-barrel samplers (O.D. 2 inches, I.D. 1-3/8 inches, either 20 inches or 26 inches long); Larger O.D. samplers are available if a larger volume of sample is needed.
- Drive weight assembly, 140-lb. weight, driving head and guide permitting free fall of 30 inches.
- Stainless steel mixing bowls.
- Equipment listed under Section 5.3 of this procedure.

The following steps shall be followed to obtain split-barrel samples:

1. Remove the drive head and nosepiece, and open the sampler to reveal the soil sample. Immediately scan the sample core with a real-time air monitoring instrument (e.g., FID, PID, etc.). Carefully separate the soil core, with a decontaminated stainless steel knife or trowel, at about 6-inch intervals while scanning the center of the core for elevated readings. Also scan stained soil, soil lenses, and anomalies (if present), and record readings.

2. Collect the volatile sample from the center of the core where elevated readings occurred. If no elevated readings where encountered the sample material should still be collected from the core's

center (this area represents the least disturbed area with minimal atmospheric contact). Refer to Section 5.2.1 of this procedure.

3. Using the same trowel, remove remaining sample material from the split-barrel sampler (except for the small portion of disturbed soil usually found at the top of the core sample) and place the soil into a decontaminated stainless steel mixing bowl. Thoroughly homogenize the sample material prior to filling the remaining sample containers. Refer to Section 5.2.2 of this procedure.

4. Follow steps 4 and 5 listed under Section 5.3 of this procedure.

5.7 Subsurface Soil Sampling Using Direct Push Technology

Subsurface soil samples can be collected to depths of 40+ feet using direct push technology (DPT). DPT equipment, responsibilities, and procedures are described in SOP SA-2.5.

5.8 Excavation and Sampling of Test Pits and Trenches

5.8.1 Applicability

This subsection presents routine test pit or trench excavation techniques and specialized techniques that are applicable under certain conditions.

During the excavation of trenches or pits at hazardous waste sites, several health and safety concerns arise which control the method of excavation. No personnel shall enter any test pit or excavation over 4 feet deep except as a last resort, and then only under direct supervision of a Competent Person (as defined in 29 CFR 1929.650 of Subpart P - Excavations). Whenever possible, all required chemical and lithological samples should be collected using the excavator bucket or other remote sampling apparatus. If entrance is still required, all test pits or excavations must be stabilized by bracing the pit sides using specifically designed wooden or steel support structures. Personnel entering the excavation may be exposed to toxic or explosive gases and oxygen-deficient environments. Any entry may constitute a Confined Space and must be done in conformance with all applicable regulations. In these cases, substantial air monitoring is required before entry, and appropriate respiratory gear and protective clothing is mandatory. There must be at least two persons present at the immediate site before entry by one of the investigators. The reader shall refer to OSHA regulations 29 CFR 1926, 29 CFR 1910.120, 29 CFR 1910.134, and 29 CFR 1910.146.

Excavations are generally not practical where a depth of more than about 15 feet is desired, and they are usually limited to a few feet below the water table. In some cases, a pumping system may be required to control water levels within the pit, providing that pumped water can be adequately stored or disposed. If data on soils at depths greater than 15 feet are required, the data are usually obtained through test borings instead of test pits.

In addition, hazardous wastes may be brought to the surface by excavation equipment. This material, whether removed from the site or returned to the subsurface, must be properly handled according to any and all applicable federal, state, and local regulations.

5.8.2 Test Pit and Trench Excavation

These procedures describe the methods for excavating and logging test pits and trenches excavated to determine subsurface soil and rock conditions. Test pit operations shall be logged and documented (see Attachment C).

Test pits and trenches may be excavated by hand or by power equipment to permit detailed description of the nature and contamination of the in-situ materials. The size of the excavation will depend primarily on the following:

- The purpose and extent of the exploration.
- The space required for efficient excavation.
- The chemicals of concern.
- The economics and efficiency of available equipment.

Test pits normally have a cross section that is 4 to 10 feet square; test trenches are usually 3 to 6 feet wide and may be extended for any length required to reveal conditions along a specific line. The following table, which is based on equipment efficiencies, gives a rough guide for design consideration:

Equipment	Typical Widths, in Feet
Trenching machine	2
Backhoe	2-6
Track dozer	10
Track loader	10
Excavator	10
Scraper	20

The lateral limits of excavation of trenches and the position of test pits shall be carefully marked on area base maps. If precise positioning is required to indicate the location of highly hazardous waste materials, nearby utilities, or dangerous conditions, the limits of the excavation shall be surveyed. Also, if precise determination of the depth of buried materials is needed for design or environmental assessment purposes, the elevation of the ground surface at the test pit or trench location shall also be determined by survey. If the test pit/trench will not be surveyed immediately, it shall be backfilled and its position identified with stakes placed in the ground at the margin of the excavation for later surveying.

The construction of test pits and trenches shall be planned and designed in advance as much as possible. However, field conditions may necessitate revisions to the initial plans. The final depth and construction method shall be determined by the field geologist. The actual layout of each test pit, temporary staging area, and spoils pile will be predicated based on site conditions and wind direction at the time the test pit is made. Prior to excavation, the area can be surveyed by magnetometer or metal detector to identify the presence of underground utilities or drums.

As mentioned previously, no personnel shall enter any test pit or excavation except as a last resort, and then only under direct supervision of a Competent Person. If entrance is still required, Occupational Safety and Health Administration (OSHA) requirements must be met (e.g., walls must be braced with wooden or steel braces, ladders must be in the hole at all times, and a temporary guardrail must be placed along the surface of the hole before entry). It is emphasized that the project data needs should be structured such that required samples can be collected without requiring entrance into the excavation. For example, samples of leachate, groundwater, or sidewall soils can be taken with telescoping poles, etc.

Dewatering may be required to assure the stability of the side walls, to prevent the bottom of the pit from heaving, and to keep the excavation dry. This is an important consideration for excavations in cohesionless material below the groundwater table. Liquids removed as a result of dewatering operations must be handled as potentially contaminated materials. Procedures for the collection and disposal of such materials should be discussed in the site-specific project plans.

5.8.3 Sampling in Test Pits and Trenches

5.8.3.1 General

Test pits and trenches are usually logged as they are excavated. Records of each test pit/trench will be made as presented in Attachment C. These records include plan and profile sketches of the test pit/trench showing materials encountered, their depth and distribution in the pit/trench, and sample locations. These records also include safety and sample screening information.

Entry of test pits by personnel is extremely dangerous, shall be avoided unless absolutely necessary, and can occur only after all applicable Health and Safety and OSHA requirements have been met.

The final depth and type of samples obtained from each test pit will be determined at the time the test pit is excavated. Sufficient samples are usually obtained and analyzed to quantify contaminant distribution as a function of depth for each test pit. Additional samples of each waste phase and any fluids encountered in each test pit may also be collected.

In some cases, samples of soil may be extracted from the test pit for reasons other than waste sampling and chemical analysis, for instance, to obtain geotechnical information. Such information would include soil types, stratigraphy, strength, etc., and could therefore entail the collection of disturbed (grab or bulk) or relatively undisturbed (hand-carved or pushed/driven) samples, which can be tested for geotechnical properties. The purposes of such explorations are very similar to those of shallow exploratory or test borings, but often test pits offer a faster, more cost-effective method of sampling than installing borings.

5.8.3.2 Sampling Equipment

The following equipment is needed for obtaining samples for chemical or geotechnical analysis from test pits and trenches:

- Backhoe or other excavating machinery.
- Shovels, picks, hand augers, and stainless steel trowels/disposable trowels.
- Sample container - bucket with locking lid for large samples; appropriate bottleware for chemical or geotechnical analysis samples.
- Polyethylene bags for enclosing sample containers; buckets.
- Remote sampler consisting of 10-foot sections of steel conduit (1-inch-diameter), hose clamps and right angle adapter for conduit (see Attachment D).

5.8.3.3 Sampling Methods

The methods discussed in this section refer to test pit sampling from grade level. If test pit entry is required, see Section 5.8.3.4.

- Excavate trench or pit in several depth increments. After each increment, the operator will wait while the sampler inspects the test pit from grade level to decide if conditions are appropriate for sampling. (Monitoring of volatiles by the SSO will also be used to evaluate the need for sampling.) Practical depth increments range from 2 to 4 feet.

- The backhoe operator, who will have the best view of the test pit, will immediately cease digging if:

  - Any fluid phase or groundwater seepage is encountered in the test pit.
  - Any drums, other potential waste containers, obstructions or utility lines are encountered.
  - Distinct changes of material are encountered.

This action is necessary to permit proper sampling of the test pit and to prevent a breach of safety protocol. Depending upon the conditions encountered, it may be required to excavate more slowly and carefully with the backhoe.

For obtaining test pit samples from grade level, the following procedure shall be followed:

- Remove loose material to the greatest extent possible with backhoe.

- Secure walls of pit if necessary. (There is seldom any need to enter a pit or trench which would justify the expense of shoring the walls. All observations and samples should be taken from the ground surface.)

- Samples of the test pit material are to be obtained either directly from the backhoe bucket or from the material once it has been deposited on the ground. The sampler or Field Operations Leader directs the backhoe operator to remove material from the selected depth or location within the test pit/trench. The bucket is brought to the surface and moved away from the pit. The sampler and/or SSO then approaches the bucket and monitors its contents with a photoionization or flame ionization detector. The sample is collected from the center of the bucket or pile and placed in sample containers using a decontaminated stainless steel trowel or disposable spatula.

- If a composite sample is desired, several depths or locations within the pit/trench are selected and a bucket is filled from each area. It is preferable to send individual sample bottles filled from each bucket to the laboratory for compositing under the more controlled laboratory conditions. However, if compositing in the field is required, each sample container shall be filled from materials that have been transferred into a mixing bucket and homogenized. Note that homogenization/compositing is not applicable for samples to be subjected to volatile organic analysis.

- Using the remote sampler shown in Attachment D, samples can be taken at the desired depth from the side wall or bottom of the pit. The face of the pit/trench shall first be scraped (using a long-handled shovel or hoe) to remove the smeared zone that has contacted the backhoe bucket. The sample shall then be collected directly into the sample jar, by scraping with the jar edge, eliminating the need to utilize samplers and minimizing the likelihood of cross-contamination. The sample jar is then capped, removed from the assembly, and packaged for shipment.

- Complete documentation as described in SOP SA-6.3 and Attachment C of this SOP.

5.8.3.4 <u>In-Pit Sampling</u>

Under rare conditions, personnel may be required to enter the test pit/trench. This is necessary only when soil conditions preclude obtaining suitable samples from the backhoe bucket (e.g., excessive mixing of soils or wastes within the test pit/trench) or when samples from relatively small discrete zones within the test pit are required. This approach may also be necessary to sample any seepage occurring at discrete levels or zones in the test pit that are not accessible with remote samplers.

In general, personnel shall sample and log pits and trenches from the ground surface, except as provided for by the following criteria:

- There is no practical alternative means of obtaining such data.
- The Site Safety Officer and Competent Person determines that such action can be accomplished without breaching site safety protocol. This determination will be based on actual monitoring of the pit/trench after it is dug (including, at a minimum, measurements of volatile organics, explosive gases and available oxygen).
- A Company-designated Competent Person determines that the pit/trench is stable or is made stable (by grading the sidewalls or using shoring) prior to entrance of any personnel. OSHA requirements must be strictly observed.

If these conditions are satisfied, one person will enter the pit/trench. On potentially hazardous waste sites, this individual will be dressed in safety gear as required by the conditions in the pit. He/she will be affixed to a safety rope and continuously monitored while in the pit.

A second individual will be fully dressed in protective clothing including a self-contained breathing device and on standby during all pit entry operations. The individual entering the pit will remain therein for as brief a period as practical, commensurate with performance of his/her work. After removing the smeared zone, samples shall be obtained with a decontaminated trowel or spoon. As an added precaution, it is advisable to keep the backhoe bucket in the test pit when personnel are working below grade. Such personnel can either stand in or near the bucket while performing sample operations. In the event of a cave-in they can either be lifted clear in the bucket, or at least climb up on the backhoe arm to reach safety.

5.8.3.5 Geotechnical Sampling

In addition to the equipment described in Section 5.8.3.2, the following equipment is needed for geotechnical sampling:

- Soil sampling equipment, similar to that used in shallow drilled boring (i.e., open tube samplers), which can be pushed or driven into the floor of the test pit.
- Suitable driving (i.e., a sledge hammer) or pushing (i.e., the backhoe bucket) equipment which is used to advance the sampler into the soil.
- Knives, spatulas, and other suitable devices for trimming hand-carved samples.
- Suitable containers (bags, jars, tubes, boxes, etc.), labels, wax, etc. for holding and safely transporting collected soil samples.
- Geotechnical equipment (pocket penetrometer, torvane, etc.) for field testing collected soil samples for classification and strength properties.

Disturbed grab or bulk geotechnical soil samples may be collected for most soils in the same manner as comparable soil samples for chemical analysis. These collected samples may be stored in jars or plastic-lined sacks (larger samples), which will preserve their moisture content. Smaller samples of this type are usually tested for their index properties to aid in soil identification and classification, while larger bulk samples are usually required to perform compaction tests.

Relatively undisturbed samples are usually extracted in cohesive soils using open tube samplers, and such samples are then tested in a geotechnical laboratory for their strength, permeability and/or compressibility. The techniques for extracting and preserving such samples are similar to those used in performing Shelby tube sampling in borings, except that the sampler is advanced by hand or backhoe,

rather than by a drill rig. Also, the sampler may be extracted from the test pit by excavation around the sampler when it is difficult to pull it out of the ground. If this excavation requires entry of the test pit, the requirements described in Section 5.8.3.4 of this procedure must be followed. The open tube sampler shall be pushed or driven vertically into the floor or steps excavated in the test pit at the desired sampling elevations. Extracting tube samples horizontally from the walls of the test pit is not appropriate, because the sample will not have the correct orientation.

A sledge hammer or the backhoe may be used to drive or push the sampler or tube into the ground. Place a piece of wood over the top of the sampler or sampling tube to prevent damage during driving/pushing of the sample. Pushing the sampler with a constant thrust is always preferable to driving it with repeated blows, thus minimizing disturbance to the sample. If the sample cannot be extracted by rotating it at least two revolutions (to shear off the sample at the bottom), hand-excavate to remove the soil from around the sides of the sampler. If hand-excavation requires entry of the test pit, the requirements in Section 5.8.3.4 of this procedure must be followed. Prepare, label, pack and transport the sample in the required manner, as described in SOP SA-6.3 and SA-6.1.

5.8.4 Backfilling of Trenches and Test Pits

All test pits and excavations must be either backfilled, covered, or otherwise protected at the end of each day. No excavations shall remain open during non-working hours unless adequately covered or otherwise protected.

Before backfilling, the onsite crew shall photograph all significant features exposed by the test pit and trench and shall include in the photograph a scale to show dimensions. Photographs of test pits shall be marked to include site number, test pit number, depth, description of feature, and date of photograph. In addition, a geologic description of each photograph shall be entered in the site logbook. All photographs shall be indexed and maintained as part of the project file for future reference.

After inspection, backfill material shall be returned to the pit under the direction of the FOL.

If a low permeability layer is penetrated (resulting in groundwater flow from an upper contaminated flow zone into a lower uncontaminated flow zone), backfill material must represent original conditions or be impermeable. Backfill could consist of a soil-bentonite mix prepared in a proportion specified by the FOL (representing a permeability equal to or less than original conditions). Backfill can be covered by "clean" soil and graded to the original land contour. Revegetation of the disturbed area may also be required.

5.9 Records

The appropriate sample log sheet (see Attachment A of this SOP) must be completed by the site geologist/sampler. All soil sampling locations should be documented by tying in the location of two or more nearby permanent landmarks (building, telephone pole, fence, etc.) or obtaining GPS coordinates; and shall be noted on the appropriate sample log sheet, site map, or field notebook. Surveying may also be necessary, depending on the project requirements.

Test pit logs (see Attachment C of this SOP) shall contain a sketch of pit conditions. In addition, at least one photograph with a scale for comparison shall be taken of each pit. Included in the photograph shall be a card showing the test pit number. Boreholes, test pits and trenches shall be logged by the field geologist in accordance with SOP GH-1.5.

Other data to be recorded in the field logbook include the following:

- Name and location of job.
- Date of boring and excavation.

- Approximate surface elevation.
- Total depth of boring and excavation.
- Dimensions of pit.
- Method of sample acquisition.
- Type and size of samples.
- Soil and rock descriptions.
- Photographs.
- Groundwater levels.
- Organic gas or methane levels.
- Other pertinent information, such as waste material encountered.

6.0 REFERENCES

American Society for Testing and Materials, 1987. ASTM Standards D1587-83 and D1586-84. ASTM Annual Book of Standards. ASTM. Philadelphia, Pennsylvania. Volume 4.08.

NUS Corporation, 1986. Hazardous Material Handling Training Manual.

NUS Corporation and CH2M Hill, August, 1987. Compendium of Field Operation Methods. Prepared for the U.S. EPA.

OSHA, Excavation, Trenching and Shoring 29 CFR 1926.650-653.

OSHA, Confined Space Entry 29 CFR 1910.146.

ATTACHMENT A
SOIL & SEDIMENT SAMPLE LOG SHEET

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Page___ of ___

Project Site Name: _____
Project No.: _____

[] Surface Soil
[] Subsurface Soil
[] Sediment
[] Other: _____
[] QA Sample Type: _____

Sample ID No.: _____
Sample Location: _____
Sampled By: _____
C.O.C. No.: _____

Type of Sample:
[] Low Concentration
[] High Concentration

GRAB SAMPLE DATA

Date:	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time:			
Method:			
Monitor Reading (ppm):			

COMPOSITE SAMPLE DATA

Date:	Time	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings				
(Range in ppm):				

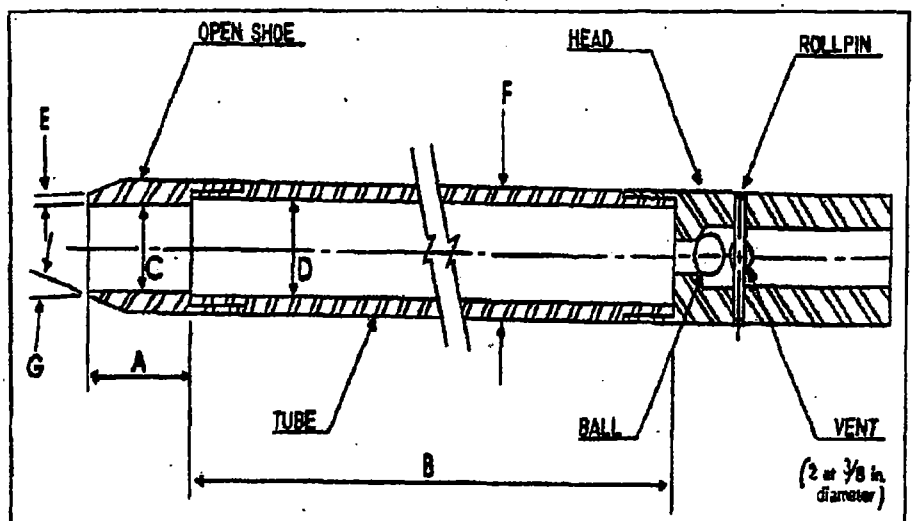
SAMPLE COLLECTION INFORMATION

Analysis	Container Requirements	Collected	Other

OBSERVATIONS/NOTES:	NAT:

Circle if Applicable:		Signature(s):
MS/MSD	Duplicate ID No.:	

ATTACHMENT B
SPLIT-SPOON SAMPLER



A = 1.0 to 2.0 in. (25 to 50 mm)
B = 18.0 to 30.0 in. (0.457 to 0.762 m)
C = 1.375 ± 0.005 in. (34.93 ± 0.13 mm)
D = 1.50 ± 0.05 – 0.00 in. (38.1 ± 1.3 – 0.0 mm)
E = 0.10 ± 0.02 in. (2.54 ± 0.25 mm)
F = 2.00 ± 0.05 – 0.00 in. (50.8 ± 1.3 – 0.0 mm)
G = 15.0° to 23.0°

The 1½ in. (38 mm) inside diameter split barrel may be used with a 16-gage wall thickness split liner. The penetrating end of the drive shoe may be slightly rounded. Metal or plastic retainers may be used to retain soil samples.

ATTACHMENT C
TEST PIT LOG

Tetra Tech NUS, Inc.

TEST PIT LOG

Page ___ of ___

PROJECT NAME: _____ TEST PIT No.: _____
PROJECT NUMBER: _____ DATE: _____
LOCATION: _____ GEOLOGIST: _____

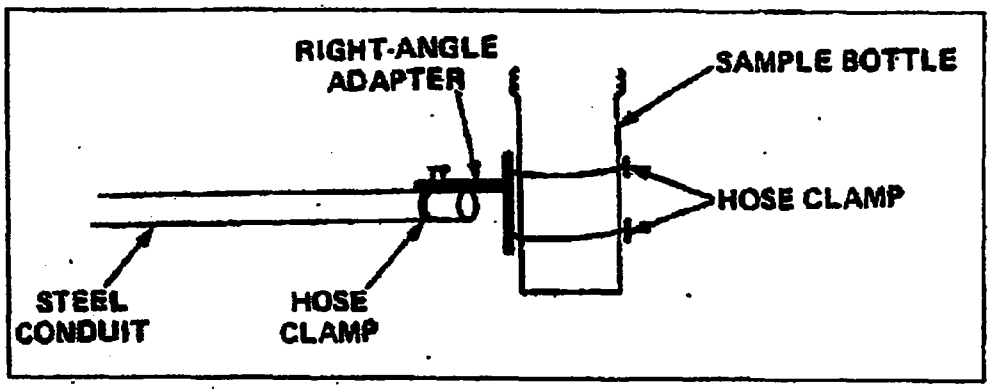
Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION	USCS	Remarks	PID/FID READING	

TEST PIT CROSS SECTION AND / OR PLAN VIEW

REMARKS: _____

PHOTO LOG: _____

ATTACHMENT D
REMOTE SAMPLE HOLDER FOR TEST PIT/TRENCH SAMPLING



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		Effective Date 03/00	Revision 1
		Applicability Tetra Tech NUS, Inc.	
		Prepared Earth Sciences Department	
Subject SPECIALIZED MEDIA SAMPLING		Approved D. Senovich	

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1.0 PURPOSE

The purpose of this procedure is to provide general reference information for use in planning for and implementing sampling programs involving one or a combination of the following specialized media: sampling containers of unknown contents, tank sampling, lagoon sampling, waste pile sampling, or dioxin sampling.

2.0 SCOPE

2.1 Container Sampling

This procedure is applicable to opening and sampling of containers (e.g., 55-gallon drums, cylinders, packaged laboratory waste, etc.) when the characteristics and hazards associated with the contents have not been determined.

2.2 Tank Sampling

This procedure covers tank inspection and sampling techniques for use in assessing the condition and contents of tanks. This guideline does not address actual entry for internal inspection or sampling which requires strict Health and Safety protocols during this potentially hazardous activity.

2.3 Lagoon Sampling

This procedure describes requirements and methods for collecting samples of liquid, sludges, sediments and bottom soils from lagoons containing hazardous materials. Factors which affect access to appropriate sampling locations and methods of obtaining samples at these locations are discussed herein. In this guideline, however, strong emphasis is given to the stringent health and safety requirements related to lagoon sampling. Since many lagoons contain highly concentrated wastes and present direct physical hazards via inhalation or contact, extreme care must be taken with all lagoon sampling programs.

2.4 Waste Pile Sampling

This procedure describes methods for collecting solid waste samples from homogeneous and heterogeneous waste piles.

2.5 Dioxin Sampling

The areas addressed in this procedure include sample collection and handling, documentation, packaging and shipping, and decontamination for aqueous, soil/sediment and wipe samples to be analyzed for TCDD. As personnel protection and sampling are dependent upon site conditions (the extent of contamination, the medium to be sampled, etc.) they are better discussed in the Health and Safety Plan and will not be covered here. It should be noted that the techniques presented in this guideline are subject to revision and modification. The user will follow the most up-to-date revisions or site-specific modifications of this guideline.

3.0 GLOSSARY

Air Reactive Wastes - Some chemicals, such as white phosphorus or barium oxide, react with oxygen in the air, while others, such as sodium, cesium or various metal hydrides, react with the moisture or water vapor in the air. Many of these compounds are explosive when they come in contact with air or water.

Caisson - A large diameter circular tube or pipe from which lagoon or impoundment liquid can be removed to allow collection of a "dry" sample of bottom solids.

Container - Any drum, bottle, can, bag, etc., with a capacity of 120 gallons (450 liters) or less.

Core Sample - A sediment sample from taken in such a way as to preserve the horizontal and vertical integrity of the sample for subsequent physical and/or chemical characterization of specific vertical intervals.

Glass Thief - A glass tube, usually 4 feet long and 3/4 inches in diameter, used for taking samples from drums. The tube is usually broken and disposed of in the drum following sampling.

Lagoon - Any onsite impoundment, depression, excavation, or diked area containing liquids where waste materials have been deposited.

TCDD - Abbreviation for the compound 2,3,7,8-tetrachloro-dibenzo-p-diozin (also called dioxin). TCDD will be used throughout this guideline.

4.0 RESPONSIBILITIES

Project Manager (PM) - responsible to assure that the need for specialized media sampling is justified and that the sampling techniques chosen are adequate to obtain a representative sample and prevent spills and/or atmospheric releases.

Field Operations Leader (FOL) - responsible for implementing the sampling plan and for overseeing the sampling effort in the field.

Health and Safety Officer (HSO) - responsible for developing the safety-related procedures for specialized media sampling and for assuring their correct implementation in the field.

5.0 PROCEDURES

5.1 Container Sampling

5.1.1 General Principles

In general, a container opening and sampling program will have one of the following objectives:

- To determine the presence of waste and/or hazardous materials on the site. Such a program involves a very limited number of containers, perhaps as few as one.
- To characterize the range of materials present at a site. Containers would be chosen for sampling by means of systematic selection criteria.
- To characterize container contents for such purposes as segregation or bulking for storage and/or disposal. This program may involve opening and sampling every container on a site, and performing onsite compatibility testing.

The guidance presented is based on field experience in working with containers on hazardous substance sites. It will be evident that in many cases pre-established procedures cannot be given, and professional judgment is required because of the number of variables involved. For example, one can never be certain of any assessment of the potential contents of a container, or the accuracy of labels. Only educated

guesses can be made by a thorough review of all available background data, such as potential sources of the wastes.

Three basic risks are involved in moving and opening closed containers: (1) exposure of personnel to toxic materials, (2) fire, and (3) explosion. The first risk can be reasonably eliminated through the use of proper skin and respiratory protection equipment. The use of Level A protection acceptably reduces the risk of a worker being injured by toxic vapors, mists, or splashes. In the same way, standard fire prevention procedures can be used to reduce the fire hazard through the use of detector instruments and proper equipment. These include the use of non-sparking tools and intrinsically safe radios, pumps, and other equipment, as well as the staging of fire fighting equipment and the elimination of other possible ignition sources.

The explosive risk, however, is not as easily handled, and thus is the primary consideration in any container-opening operation. Even if no solid evidence of the presence of explosives is found during the preliminary data collection, one can never be certain that explosive material have not been disposed of at the site. In order to provide the same reasonable level of protection against this risk as against toxic exposure and fire, a very cautious approach, such as the one recommended in this procedure, should be used.

5.1.2 Background Review

This section details the elements of a site background review necessary to prepare a Sampling Plan for drum opening. The decision of whether or not to conduct the operations depends on the assessment of the site history. Therefore, it is important that the following tasks are completed thoroughly.

5.1.2.1 Preliminary Assessment and Site Inspection

Any existing data should be consulted in planning for a container-opening operation. Of special importance are items that can be used to characterize the types of hazardous materials present at the site (e.g., generator records, manifests, inventories, personal interviews, monitoring data). The review of all such data should search for the possible presence of shock-sensitive explosives and/or reactive chemicals.

5.1.2.2 Explosive Product Survey

If the site is a waste disposal or storage operations, a survey of commercial producers or users of explosives within the area served by the facility must be conducted. The determination of the area covered in this survey is a judgment that should be based on locations of known waste generators that used the facility and geographic locations of the site. Agencies that could assist in identifying explosive producers or users are local and state police units, state transportation departments, the U.S. Department of Transportation (DOT), and EPA or state hazardous waste permit offices. Standard Industrial Classification (SIC) codes can be used to locate producers of explosives from lists of manufacturers available from state commerce agencies, local chamber of commerce, planning agencies, etc.

5.1.2.3 Site Visit

A site visit is required prior to planning a drum opening operation. Information on the following should be gathered during the site visit:

- Site boundaries - fences, roads, natural boundaries, etc.
- Access points and travel routes on the site.

- Topographic features
- Adjacent land uses - residential, agricultural, public use areas, commercial establishments, schools, natural areas, etc.
- Power lines, railroad, and public roads close to the site.
- Container storage areas - provide observational details; describe if drums are jumbled, stacked, piled, arranged in rows, etc. General condition of drums indicates if containers can be grouped according to contents, or any other classification method. Note damaged drums (e.g., bulging, dented, punctured, rusty, etc.) and determine if overpack drums are necessary.
- Buildings and other site structures, as well as any other disposal areas such as lagoons, surface piles, etc.
- Location of water sources.
- Location of potential staging areas.

During the site visit, local officials should be contacted to arrange for fire protection and police support during the operation. Interviews should also be conducted with site workers, local officials, and any other people familiar with the site's history.

The central purpose of the background review is to evaluate the risk presented to personnel engaged in drum-opening operations. Assessment of drum contents is most important because it identifies specific risks. However, other site features also affect the hazard potential. Leaking and corroded drums, crowded and poorly organized conditions, and drums of unknown and apparently diverse origins are conditions that require careful planning.

There are no accurate quantitative methods available to evaluate the total risk. Assessment of the danger is subjective and should be done by personnel experienced in field operations at hazardous sites. Good professional judgment is required, and project management must feel that adequate information is available to support a decision to conduct the drum-opening operations. Any positive indication of shock-sensitive materials that might react or explode requires special consideration. Unlabelled drums and containers shall be considered to contain hazardous substances and handled accordingly until the contents are positively identified and the drum is labeled.

5.1.3 Container Selection Considerations

The containers selected for opening and sampling will depend on the purpose of the operations and on considerations of safety--that is, a container that may detonate is to be avoided. Even though drums are found at disposal sites where the contents are unknown, it is worthwhile to consider drum markings and types as well as drum groupings.

When considering sampling, the first choice of drums would be those marked with known hazardous materials (trade name, chemical name, empirical formula), or hazard labeling. Next would be those isolated by themselves, of uncommon shape or banding, or material contained in an exotic metal container (e.g., aluminum, nickel, monel, stainless steel). Then consideration should be given to the unmarked drum piles or stacks.

When sampling for site characterization purposes, a concerted effort should be made to distinguish drum lots and to get an accurate drum count among the lots.

On most sites, there is some organization or pattern to the way the material was placed on the site. The pattern is occasionally as detailed as finding the flammable solvents in one area, acids in another, cyanide in another, recoverable metals in a fourth, and so on. Some disposal facilities stencil control numbers on drums to indicate specific lots. Often, the only indication that a group of drums is related will be their color, size, or type.

Approach isolated groups of containers with care, but do try to determine why they were segregated. Occasionally a group of drums is found marked 'DFW' (roughly translates as "Don't Fool With") because of their extreme hazard or because the people handling them have had an accident or other unusual experience with them.

An attempt should be made to avoid drums that are structurally damaged or if their movement or sampling would endanger a team member. Samples of drums in stacks or piles should not be taken if at all possible.

Before sampling drums of unknown content, an external radioactivity scan must be conducted with the results recorded in the field notebook. On a site where many different types of containers are present, they should be sampled in the following order, based on what they can be expected to contain and in increasing order of hazard:

- Paper, plastic, cloth, and burlap bags.
- Glass carboys and jugs (except chemical reagent or laboratory-packed bottles).
- Fiberboard drums.
- Plastic and polyethylene carboys and containers.
- Plastic-lined steel drums.
- Steel drums.
- Exotic metal drums.
- Odd containers (distended, isolated, marked "DFW," etc.).

Attachment A contains information on the types, sizes, DOT designation, openings, and recommended opening techniques for the various kinds of containers. Any drum without a DOT designation should be avoided, as it may have military origins. The DOT designation, which is usually found on the bottom of a drum, can be useful in determining the material of the drum.

5.1.4 Container Handling and Staging

NOTE: A Drum/Container Management Plan will be developed for each site in which drums/containers will be handled, sampled, or staged. The Plan will be prepared consistent with the requirements of Paragraph (j) of 29 CFR 1910.120 (OSHA's Hazardous Waste and Emergency Response Standard, or HAZWOPER). This Plan will discuss site-specific issues related to drum/container management, and will be included as part of the Health and Safety Plan. The following text discusses, in a general fashion, the minimum practices and procedures to be followed. Where provided, the guidance of the site-specific Drum/Container Management Plan shall be followed to supplement this SOP. In the case of overlapping requirements, the more stringent requirement shall take precedence.

When practical, drums and containers shall be inspected and their integrity shall be assured prior to being moved. Drums or containers that cannot be inspected before being moved because of storage conditions shall be moved to an accessible location and inspected prior to further handling.

Personnel involved in handling and transporting containerized waste shall work in teams containing no fewer than two people. Visual contact shall be maintained between members of the working team at all

times. All team members shall be able to communicate between themselves and with the Site Health and Safety Officer by a safe two-way radio at all times on the work site. In addition, employees shall be warned of the potential hazards associated with the contents of the drums or containers.

Prior to physically handling a drum or other container, the following preliminary classifications checklist must be reviewed and each response noted in a field notebook:

- Is the drum radioactive?
- Does the drum exhibit leakage or deterioration, i.e., is it unsound?
- Does the drum exhibit apparent internal pressure?
- Is the drum empty?
- Does the drum contain markings which would indicate that the contents are potentially explosive?

The results of the preliminary classification checklist dictate which specific procedures shall be followed in handling, opening, and sampling the drum.

The handling, movement, and transport of drums and other containers should be by use of mechanical equipment only; equipment may consist of a grappler equipped backhoe, front-end loader, or drum dollie. Drum transportation may be with front-end loaders or fork lifts with modified carrying platforms. When necessary, portions of equipment that contact drums or canisters should be constructed of non-ferrous metals or contact portions should be coated or lined to preclude spark generation. Handling and transport equipment must be equipped with full frontal and side splash and explosion shields. Class ABC fire extinguishers shall be fitted to the body of each piece of equipment.

When possible, drums or other containers to be sampled should be opened and sampled in place to minimize handling. However, when drums are stacked or are close together, they may have to be moved to prevent sympathetic detonation of, or chemical reaction with, other drums around the one being opened. The main criterion is distance to other drums--a reasonable distance should be maintained to keep the drum to be opened segregated from others.

Drums or containers exhibiting the following characteristics require special treatment in handling and sampling:

- Leaking or deteriorated drums
- Bulging drums
- Drums containing explosive or shock-sensitive waste
- Drums containing radioactive waste
- Lab packs
- Gas cylinders

When drums are moved, they should be taken to a staging and sampling area that is diked or bermed to control spillage. Again, this area should be far enough away from other drums on the site to prevent a chain reaction. Only one container at a time should be placed in the staging area and opened. One crew can be moving and setting up the remote-opening equipment on the next container while another crew is sampling, labeling, and resealing the first container.

Containers that are inside warehouses, basements, or other buildings must be moved outside before they can be opened. If this is not possible, the Project Manager must be contacted for special assistance in developing the opening plan. Adequate ventilation is critical for container-opening operations.

5.1.5 Remote Opening

Because of the possibility of encountering a drum containing a shock-sensitive material, any drum to be moved and/or sampled should be remotely shaken. One way of doing this is to carefully tie a rope around the drum and shake it from behind a barrier at a safe distance.

The required method of opening drums is by remote means (except as noted in Attachment A). Three types of remote-opening equipment are available: the bung spinner, the remote-controlled drill, and the drum piercer.

The bung spinner consists of:

- Air impact wrench with non-sparking adapter.
- Drum-mounting bracket.
- Two-stage regulator.
- Compressed-air cylinder with 100 feet of air hose and control valve.

The impact wrench is mounted over the bung on top of the drum by means of the steel-mounting bracket. The air tank, regulator, and control valve can be placed up to 100 feet away from the drum in a well-protected location.

A remote-controlled, air-operated, self-feeding, and self-retracting drill can also be used. This tool consists of:

- Self-feeding and self-retracting drill.
- Drum-mounting bracket.
- 100 feet of air and control hoses.
- Two-stage high-pressure regulator.
- Compressed air cylinder.
- Filter/regulator/lubricator unit.

As with the bung spinner, the air tank, regulator, and control valves can be placed up to 100 feet away from the drum in a well-protected location. There are two controls on this piece of equipment--a start valve and an emergency retract valve.

The drum piercer consists of:

- Hydraulic ram with hand pump.
- 100 feet of hydraulic hose.
- Drum-mounting bracket (top or side).
- Piercing nail.

This unit uses the same bracket as the drum drill. The hydraulic ram slowly forces the steel piercer through the drum surface as the hand pump is operated. When the 1/2-inch-diameter hole is complete, opening a relief valve on the pump allows the spring to retract the piercer from the hole.

When any of these pieces of equipment are used, the control lines are to be extended to their maximum, and drum-opening personnel are to operate the controls from behind sandbags, a concrete or brick structure, or other solid barriers. Remember, the opening surfaces of the drill or bung spinner should be decontaminated after each use.

The following guidelines are offered for other types of containers:

- Ring-closed, open-top drums - Loosen the ring and then remove it remotely by means of a rope. If it is necessary to cut the ring, do so near the bolt or clamp/lever so that there will be a place to attach the rope.

- Glass carboys or jugs with lapped/ground-glass stopper or plastic cap - Slowly release any retaining wire and vent any pressure. Remove the stopper or cap by hand only.

- Fiberpacks or corrugated cardboard containers - Release the locking ring and remove the ring and lid by hand.

- Plastic or polyethylene carboys and plastic-lined drums (when necessary) - Use a non-sparking aluminum, brass, or beryllium bung wrench of the proper size. Do not use a bung wrench on any distended drums of this type; remote methods will be applied.

- Plastic Kraft paper, burlap, or cloth bags - Use a trowel or sampling trier. The bags should be resealed or placed in an overpack.

5.1.6 Problem Containers

Special handling techniques are required for containers which may expose personnel to particularly hazardous conditions. These techniques are described in general below, although site-specific conditions may require the development of specialized methods in the Sampling Plan.

5.1.6.1 Leaking or Deteriorated Drums

- The contents of drums that exhibit leakage or apparent deterioration must immediately be transferred to a repack drum. Equipment, including transfer pumps used in the repack operation, must be of explosion-proof construction or otherwise be classified for the material being transferred.

- Leaking drums containing sludges or semi-solids, drums that are structurally sound but which are open and contain liquid or solid waste, and drums which are deteriorated but can be moved without rupture, must be immediately placed in overpack containers.

5.1.6.2 Bulging Drums

- Drums which potentially may be under internal pressure, as evidenced by bulging, must be sampled in place. Extreme care shall be exercised when working with and adjacent to potentially pressurized drums.

- Should movement of a pressurized drum be unavoidable, handle only with a grappler unit constructed for explosive containment. The bulging drum should be moved only as far as necessary to allow seating on firm ground or it should be carefully overpacked.

- Openings into pressurized drums shall be plugged and the bung holes fitted with pressure venting caps set at 5 psi release.

5.1.6.3 Drums Containing Explosive or Shock Sensitive Waste

- If drums containing wastes that have been identified by sampling, or are suspected by visual examination to be explosive in nature are found, the Project Manager and HSO must be notified immediately, before the drums are handled in any way.

- If the Project Manager and HSO approve handling of these drums, they shall be handled with extreme caution. Initial handling shall be by a grappler unit constructed for explosive containment. Drums shall be palletized prior to transport to a high hazard interim storage and disposal area.

- If at any time during site activities, an explosive, pursuant to provisions of Title 18, U.S. Code, Chapter 40 (Importation, Manufacture, Distribution, and Storage of Explosive Materials, 1975 Explosives List) is identified, it should be secured and the appropriate personnel and/or agencies notified.

- Identification of an explosive substance during the course of site activities is usually based on the experience of the onsite personnel. Potentially explosive materials usually may be identified by their physical characteristics--texture, color, density, etc., as well as the way they are packaged or labeled. Most explosives are solids. In some cases they are packaged in water-tight containers to exclude water, while in other cases they are packaged wet to preclude explosion.

- Prior to handling or transporting drums containing explosive wastes, personnel working in the area shall be removed to a safe distance (as determined by the HSO). Continuous contact with the command post shall be maintained until handling or transporting operations are complete. An audible siren signal system, similar to that employed in conventional blasting operations, shall be used to signify the commencement and completion of explosive waste handling or transporting activities.

5.1.6.4 Drums Containing Radioactive Waste

- Drums containing radioactive wastes shall not be handled until radiation levels have been determined by an initial field survey which is recorded in a field notebook. The survey shall include background levels, direct gamma readings and laboratory analysis of drum surface wipe samples.

- Depending on the level of radiation encountered, handling and transport may require special shielding devices to protect personnel. Following handling and transport, equipment used shall be surveyed by the HSO and decontaminated to background levels prior to recommencing work. Surveys shall also be made of the ground surface in the vicinity of original drum storage to identify potential soil contamination by spilled or leaked radioactive waste. Prior to recommencing work in the area, radioactive soil areas shall be isolated to prevent tracking of radioactive contaminants about the site, and workers who entered the area should have their gloves and boots surveyed for radiation.

5.1.6.5 Packaged Laboratory Wastes (Lab Packs)

- If drums known or suspected of containing discarded laboratory chemicals, reagents or other potentially dangerous materials in small volume, or individual containers are found, the Project Manager is to be notified immediately, before the drums or containers are moved or opened.

- If the Project Manager and HSO approve the handling of these containers, they shall be handled with extreme caution. Until otherwise categorized, they shall be considered explosive or shock sensitive wastes. Initial handling shall be by a grappler unit constructed for explosive containment. Drums shall be palletized and overpacked, if required, prior to transport to the Lab pack staging area for sorting, identification, repacking and/or stabilization.

- Prior to handling or transporting Lab Packs from the existing drum area, personnel working in the immediate area shall be removed to a safe distance. Continuous contact with the command post shall be maintained until handling or transporting operations are complete. An audible siren signal system, similar to that employed in conventional blasting operations will be used to signify the commencement and cessation of Lab Pack handling or transporting activities.

5.1.6.6 Air Reactive Wastes

- If the presence of an air reactive substance is verified or suspected, the material should be immediately segregated and transported to a separate high-hazard interim storage and/or disposal area.
- Air reactive wastes may be discovered during opening or sampling operations. Air reactive substances normally require special packaging. They may be stored under water or some other liquid to minimize air contact. They may also be found in sealed ampoules, corrugated drums, stainless steel canisters, or specially lined drums.

5.1.6.7 Gas Cylinders

- Gas cylinders, when encountered, should be stored and disposed of on a special case basis depending on the integrity of the cylinders and type of substance they are expected to contain.

5.1.7 Container Sampling

5.1.7.1 Equipment

- Personal protection equipment.
- One or two 500 mL, wide-mouth amber glass bottle with Teflon cap liner unless the medium reacts with silica.
- Uniquely numbered sample identification labels filled out and affixed to sample containers before sampling commences.
- 4-foot x 3/4-inch ID glass sampling thief/glass tube for aqueous media.
- Plastic or teflon coated trowel for solid media (trowel must be HSO approved).
- Remotely operated opening device.
- One gallon covered cans half-filled with absorbent material (for offsite shipment only).

5.1.7.2 Sampling Procedures

NOTE: Employees not actually involved in opening drums or containers shall be kept a safe distance from the drums or containers being opened.

All drums and mechanical equipment should be grounded prior to the commencement of sampling. If the bung or container lid can be removed, sample contained liquids using a glass thief, which shall then be broken and discarded within the barrel. A barrel that has a badly rusted bung, or that cannot be sampled as above, shall be safely entered with a hydraulic penetrating device operated remotely. All openings shall be plugged except during sampling operation.

The steps to be followed in sampling are as follows:

- Record any markings, special drum conditions, and type of opening in the field notebook, on the sample log sheet, and, later, on the Chain-of-Custody form and locate the general area on a sketch of the site.

- Stencil an identifying number on the drums and record in logbook. Consult the sampling plan for identifications.
- Make certain that the drum/container is set on a firm base, preferably in a fully upright position. Never stand upon or work from drums or containers.
- Open the drum/container as described in Section 5.1.5 and Attachment A.
- Insert glass tubing almost to the bottom of the drum or until a solid layer is encountered. A little over 1 foot of the 4-foot glass sampling thief/glass tube should extend above the drum.
- Allow the waste in the drum to reach its natural level in the glass tube. Then cap the top of the sampling tube with a tapered stopper, ensuring liquid does not come into contact with stopper.
- Carefully remove the capped tube from the drum and insert the uncapped end in the sample container. Do not spill liquid on the outside of the sample container. Release the stopper and allow the glass thief to drain completely into the sample container.
- Deliver 100 to 250 mL of the sample (the sampling plan will specify the amount) to a clean, wide-mouth, 500-mL (1-pint) glass sample jar. If the sample is not free flowing and is taken through a bung opening, repeated sampling may be necessary.
- Place the used sampling tube, along with paper towels or waste rags used to wipe up any spills, into an empty metal barrel for subsequent disposal. If glass tubing has been used, it may be broken and left inside the drum being sampled.
- Cap the sample container tightly and place pre-labeled sample container in a carrier.
- Replace the bung or lids or place plastic over the drum/container.
- Measure the sample for radioactivity and record results in a field notebook. If the meter readings exceed 10 mR/hr, notify the HSO and FOL immediately; they in turn will notify the Project Manager.
- Fill out a Chain-of-Custody Record and carefully pack samples. The finished package will be custody-sealed for shipment to the laboratory. The preferred procedure includes the use of a custody seal across filament tape that is wrapped around the package at least three times. The custody seal (paper, plastic, or metal) is then folded over and stuck to itself so that the only access to the samples is by cutting the filament tape or breaking the seal to unwrap the tape. The seal is signed before the package is shipped.
- Complete the appropriate traffic report. Drum samples are always considered to be high-hazard samples.

5.1.7.3 <u>Sample Preservation and Packing Procedures for Drummed Waste Samples</u>

- No preservatives shall be used.
- Unless the contents of the drum can be positively identified, the sample(s) collected must be shipped as high-hazard samples (see SA-6.2; Sample Handling and Attachment B).
- Arrange for the appropriate transportation mode consistent with the type of hazardous waste involved.

5.1.8 Resealing and Siting Containers

All containers opened for sampling need to be resealed to prevent the escape of vapors and possible reactions from rainwater, air and so on. The resealing methods will depend on the opening methods used and include the following.

- Replacing the bung, screw cap, etc.
- Replacing the lid and retaining ring.
- Placing the drum in an overpack (larger drum) when it cannot be resealed by any other method.
- If a hole is drilled, use of a special rubber or plastic plug. A drum bonnet should be used to ensure that rainwater does not seep around the plug.

It is important to note that these resealing methods are for the purpose of preventing leakage from the container while it is in storage on the site. If the container is to be moved off the site, DOT regulations regarding transportation of drums must be complied with. These will generally require more rigorous sealing procedures.

Once the drum is sampled and resealed, it should be properly identified and left where it cannot react with other containers on the site. For a small number of drums, the storage areas may be the staging and opening area. In any event, the sampled drums should be placed in an area away from other groups of containers on the site. The reason is that slowly progressing chemical reactions can start when a container is opened and the contents exposed to air or the disturbance caused by handling the drum. Such a reaction could take hours or even days to occur.

5.2 Tank Sampling

5.2.1 Access for Sampling

If possible, tanks will be opened and sampled from the top. The physical size, shape, construction material and location of access will determine the best methods of opening and sampling. In some cases, (for example, if the tank is being sampled from a valve at the bottom of the tank) it may be necessary to have spill response personnel on site in case of an accidental release.

When liquids are contained in sealed vessels, gas vapor pressures build up, sludges settle out, and density layering develops. The potential for explosive reactions or the release of noxious gases when containers are opened require considerable safeguards. The vessels should be opened with extreme caution. Preliminary sampling of any headspace gases is typically warranted. As a minimum, a preliminary check with an explosimeter or an organic vapor analyzer will determine levels of personnel protection and may be of aid in selecting a sampling method.

5.2.2 Tank Sampling

At least two persons must always perform tank sampling: one should collect the actual samples and the other should stand back, usually at the head of the access stairway and observe, ready to assist or call for help. If the walls or roof of the tank are corroded, the samplers should not attempt to climb up the outside of a tank, but instead an aerial lift should be used to gain access to the sampling point.

The sampling of tanks is similar to the sampling of drums. The techniques for sampling are the same, except sampling equipment may need to be longer to give a representative sample of deep tanks. Steps to be followed in tanks sampling include the following:

- Record the tank's condition, markings, openings or valve types, and approximate size in gallons in the site logbook and on the sample log sheet. Note the tank location on the site sketch.

- Attach an identification number to the tank using a stencil or weatherproof tag. Number succeeding tanks consecutively. Record the numbers in the site logbook.

- Determine whether the tank contents are stratified by inserting a long plastic or glass tube sampler, withdrawing it, and examining the tube contents. Samples of stratified contents can be taken using a bomb sampler, weighted bottle, or a Kemmerer sampler. For a description of these methods, see Attachment C of this Guideline. If a composite sample is desired, take one sample each for the upper, middle, and lower sections of the tank or for each identified layer, and composite them in one container.

  NOTE: If a reaction is observed when the glass tube is inserted (violent agitation, fumes, light, etc.) the investigators should leave the area immediately. If the glass tube becomes cloudy or smokey after insertion into the tank, the presence of hydrofluoric acid is indicated and a comparable length of rigid plastic tubing should be used.

- If contents of the tank are homogenous, a sample may be taken using glass tubes. See Attachment D for details of this procedure.

- After collecting the sample in the appropriate pre-labeled container(s), tighten the lid, and fill out the appropriate sample log sheets and Chain-of-Custody Record.

5.2.3 Sample Packaging and Shipping

Many samples collected from storage tanks will be shipped as high-hazard samples (see SA-6.2; Sample Handling and Attachment B).

5.3 Lagoon Sampling

5.3.1 Methods of Obtaining Access to Sampling Locations

Because the collected samples must be representative of conditions throughout a lagoon, sampling directly from the shore is usually only appropriate for sampling of very small lagoons or impoundments (less than 10,000 square feet). Samples can also be collected from a platform suspended from shore-based machinery such as a "cherry picker." These platforms may extend to a maximum of 20-25 feet from the shore, depending on the available support on the lagoon bank. Platforms can be outfitted with suitable protective guardrails to provide a relatively safe working environment. However, space is limited and it is often difficult for more than two people to work effectively.

In situations where samples must be collected from the interior sections of a lagoon, a flotation device is often required. Safety is the overriding factor in such an operation and special care must be exercised to insure that a stable work platform is provided.

In many cases, commercially available vessels are not appropriate for lagoon sampling and must be modified to increase stability, facilitate sampling operations over the side or through the hull and allow enough room for personnel, sampling equipment and personal protection equipment. Provisions must also be made to decontaminate or dispose of the vessel after use. Custom designed and built vessels and equipment may also be appropriate, depending on the situation.

A flat-bottomed boat may be used for lagoon sampling but this may still represent a dangerously unstable condition. To overcome instability, a sampling platform can be constructed from two flat-bottomed boats outfitted with a frame, guardrails, stabilizing legs at each corner and an opening in the center.

This opening can be used for caisson placement, hand coring, or liquid sample collection. Other designs and configurations are also possible.

Independent of final design, platforms may be moved over the lagoon by means of ropes, oars or attached outboard motors. The use of ropes is favored for all but the largest lagoons because the ropes will also keep the platform in position. Where movement of the sampling platform is hindered by viscous surface deposits or other impediments, winches or motor vehicles may be required to move the platform.

5.3.2 Methods of Sample Collection

When collecting liquid samples from the shore, the sampling container can be filled directly (as for the collection of surface water samples) or a sampling bucket can be thrown into the lagoon interior to collect samples before transfer to the sampling container. In the latter case, care must be taken to insure that the sample bucket construction materials are inert to the lagoon materials and will not cause potential interferences (contamination) with the analyses of interest. Also, the bucket should not be allowed to drag along the bottom and thus contaminate the liquid sample with sediment.

Samples of sludges and sediments can be collected directly from the shore in a manner similar to the collection of liquid samples. However, substantial mixing with overlying liquid is likely. For compacted or cemented bottom materials, samples may be collected directly from the shore using a trowel or a drive sampler (e.g., split barrel).

In collecting liquid samples from suspended or floating platforms, various surface water and tank sampling devices (such as the Bacon Bomb Sampler or a weighted bottled sampler) may be used. Direct methods used for shore sampling may also be applied. Use of these specialized samplers is essential if samples from discrete depths are required. Except for very shallow lagoons, sampling from the surface is not recommended because of the likelihood that non-representative samples will be obtained.

Sediment coring samples can be obtained from floating or suspended platforms. Sediment coring may be required to examine the extent of contaminant migration below the lagoon floor. Special considerations in this instance include breaching of the lagoon liner, degree of consolidation of lagoon bottom sediments or sludges, depth of the lagoon, and the desired depth of the sample. Generally, sediment core samples can be obtained using an open ended pipe (hand corer) which is driven by hand into the sediments. A sledge hammer is usually adequate for driving the sampler. The sampler should be equipped with a suitable check-valve assembly so that an interior vacuum can be maintained to hold the material in the sampler. The core materials can then be extracted and examined and sampled, or the pipe capped with the sample still within and the entire assembly sent to the lab for analysis. This method will probably not work well with highly liquid samples. In this case, a vacuum pump, weighted bottle sampler, or modified Kemmerer/Van Dorn Sampler may suffice.

In cases where collection of subsurface soil or sediment samples is hindered by the presence of overlying liquid, the liquid will either have to be removed or impounded away from the sampling location prior to sample collection with a hand auger or drive sampler. Application of the former method requires adequate pumping capacity and temporary liquid storage facilities which are often not available or expensive.

If samples are taken from a bottom layer which has served as a seal for the lagoon contents, resealing with a bentonite or equivalent "plug" will be required. This can only be done when dry samples are taken. There is no way to adequately seal the bottom after sample removal by the hand coring method unless the overlying water is removed.

As an alternative to evacuating the lagoon, the liquid may be impounded away from the bottom sampling location by means of implanting a caisson in the lagoon bottom. This caisson may consist of a large diameter pipe which is forced into the lagoon bottom so that liquid can be removed, seepage subsequently controlled and a "dry" lagoon bottom sample obtained via a hand auger or driven sampler. In some cases, a double caisson arrangement may be needed with seepage constantly removed from the outer casing. Caissons are normally driven in place by hand although heavy machinery (backhoes, cherry pickers) may be used if installation is close to shore.

Caisson installation can be a difficult and time-consuming task. It should only be used when alternate methods for collection of bottom sludges or soil samples are not available and when there is a danger of breaching the liner.

5.3.3 Sample Packaging and Shipping

Many samples collected from lagoons will be shipped as high-hazard samples (see SA-6.1; Non-Radiological Sample Handling and Attachment B).

5.4 Waste Pile Sampling

5.4.1 Methods of Sample Collection

The use of stainless steel scoops or trowels to obtain small discrete samples of homogeneous waste piles is usually sufficient for most conditions. Layered (nonhomogeneous) piles require the use of tube/core samplers to obtain cross-sectional samples.

- Collect small equal portions of the waste from several points around the pile, penetrating it as far as practical. Use numbered stakes, if possible, to mark the sampling locations and locate sampling points on the site sketch.
- Place the waste sample in a pre-labeled sample container. Record all the required information in the field logbook and on the sample log sheet and other required forms.

5.4.2 Sample Packaging and Shipping

Many samples collected from waste piles will be shipped as high-hazard samples (see SA-6.1; Sample Handling and Attachment B).

5.5 Dioxin Sampling

5.5.1 Sample Collection and Handling

5.5.1.1 Aqueous Samples

Samples collected for TCDD analysis may be taken using the appropriate methods for collecting other aqueous samples. It is important to use amber glass and to protect samples from light, as the concentration of TCDD is affected by exposure to light.

5.5.1.2 Soil/Sediment Samples

Soil and sediment samples are collected using conventional sampling techniques and equipment. In areas where a highly compacted material such as asphalt covers the soil to be sampled, the overburden is

to be broken and removed, using picks and shovels, until a 1-foot-square area is cleared. All holes are backfilled after sample collection with clean appropriate material(s).

Before the sample is placed in its container, it is homogenized using a stainless steel spoon and mixing bowl. Prior to filling, each sample jar is placed inside a clean plastic baggie held secure with a rubber band. Stainless steel scoops or spoons are used to transfer the homogenized sample to the jar. After filling and capping, the baggie and rubber band are removed, if visual contamination is present, 1,1,1-trichloroethane, allowed to dry, and then placed in a clean baggie. Samples are stored away from light.

5.5.1.3 Wipe Samples

Wipe samples are often collected to determine the extent of surface contamination. The following procedures will be implemented when collecting wipe samples for TCDD analysis (OSHA, 1984):

- Using clean gloves, pre-load vials with appropriate filters. The type of filter will depend on the type of analysis to be performed. Glass fiber filters are to be used with HPLC or GC analysis; paper filters are used with any other analysis.
- Prepare a rough drawing of each of the locations to be sampled.
- Withdraw filter from vial. Solvents such as hexane, methanol and isopropyl alcohol are often used to wet the filter before wiping. These also depend on the analysis to be performed. In some cases, distilled, deionized water is used.
- Wipe a 4-square-inch (100-square-centimeter) area.
- Fold the filter with the exposed area in, fold again, place in vial and cap the vial. It is especially important that the sampler change gloves between samples.
- Include at least one blank filter treated in the same manner, excluding wiping, for each sampled area.

5.5.2 Sample Documentation

In order to track each sample through shipping and analysis, the following documents will be prepared:

- Sample Labels (One per sample bottle).
- Chain-of-Custody Records and Seals.
- Airbills (One for each shipment to an individual laboratory).

In addition, a field log book will be kept by the sampling team leader. The log book will include daily entries describing all site and sampling activities.

5.5.3 Sample Packaging and Shipping

In many cases, samples collected for TCDD analysis may be shipped as high-hazard samples. See Procedure SA-6.1 and Attachment B for proper high-hazard packaging and shipping procedures.

5.5.4 Decontamination

All sampling equipment is to be decontaminated as follows:

- Alconox and potable water wash
- Potable water rinse
- Alcohol rinse
- 1,1,1-Trichloroethane rinse
- Air dry

A sample of the 1,1,1-trichloroethane must be submitted as a rinsate sample. A volume of 6 ounces is to be collected in an 8-ounce glass jar.

All wastes are to be containerized and properly labeled.

6.0 REFERENCES

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ATTACHMENT A
TECHNIQUES FOR OPENING CONTAINERS

Types	Size	DOT Designation	Type of Opening	Recommended Opening Technique
Steel drum, open-head, unlined and lined	5-110G	DOT 5 - DOT 6 - DOT 17 - DOT 37 - DOT 42 -	Detachable steel lid with a clamp or lever-locking ring, or a ring with forged lugs and secured by a bolt.	Remove bolt. If possible, relieve pressure on clamp or lever-locking ring remotely (i.e., lanyard); remove ring with lanyard. Remove lid by hand.
Steel drum, closed-head, lined	5-110G	DOT 5 - DOT 6 - DOT 17 - DOT 37 - DOT 42 -	Plastic bung opening not larger than 2.3 inches.	Preferred method is to remotely open bung. Manually open otherwise.
Steel drum, closed-head, unlined (steel, monel, stainless, nickel, and aluminum)	5-110G	DOT 5 - DOT 6 - DOT 17 - DOT 37 - DOT 42 -	Steel or other metal bung not over 2.3 inches.	Remote method.
Burlap bag, double Kraft paper bag, cloth bag, plastic bag	Various	DOT 36 - DOT 44 - DOT 45 -	Various.	Open with sharp implement; reseal bag or overpack in fiberpack.
Glass carboys and jugs	6-20G	Usually DOT 1 - branded into the wooden outer sheathing; often sheathing is no longer present.	Lapped or ground glass stopper; occasionally a plastic screw cap will be encountered.	Manually.
Laboratory reagent bottles (amber bottles), small reagent cans	Various	None	Screw top or press lid.	Usually encountered in lab packs. Not to be handled or sampled. Replace drum lid carefully. Contact ZPMO for action.
Polyethylene and other plastic drums or barrels	5-110G	DOT 2 -	Usually bung opening not over 2.7 inches in diameter.	Manually.
Gas cylinders	Various	DOT 3 - DOT 4 - DOT 8 - DOT 39 -	Valve, threaded fitting, quick-connect or puncture-type fittings.	Not to be handled or sampled. Contact ZPMO for action.
Fiberpack or corrugated	5-110G	DOT 12 - DOT 21 - DOT 23 -	Usually a detachable plastic lid with a clamp or lever-locking ring.	Manually remove locking ring and lid.

ATTACHMENT B
PROCEDURES FOR PACKAGING AND SHIPPING HIGH-HAZARD SAMPLES

The U.S. Department of Transportation and other regulatory agencies have specific requirements addressing the packaging, labeling and shipping of hazardous materials (including high-hazard samples). These requirements may or may not apply to Tetra Tech NUS depending upon the chemical and physical properties of samples to be shipped. Given that these requirements can vary considerably, and it is illegal to ship hazardous materials that are not properly packaged and labeled, specific procedures for hazardous materials cannot be identified within the scope of this SOP. Should site activities generate a potentially hazardous material in the form of a collected sample, the following actions must be taken:

- As soon as possible after collecting a high-hazard sample (or as early as possible in anticipation of collecting a high-hazard sample), the FOL must contact Health Sciences in Pittsburgh (412/921/7090). This notification must include the volume of the sample collected, the likely composition of the sample, and any observed properties (color, odor, etc.) of interest in characterizing the sample. Do not wait until you are about to package the sample to contact Health Sciences, as this may delay shipping your sample on-time.

- In concert with Health Sciences, the Proper Shipping Name will be identified for the sample to be shipped. Health Sciences will also identify how the sample needs to be packaged and labeled, and will coordinate securing the proper package and label(s) for shipment if necessary.

- Only employees who have participated in the TtNUS course "Shipping Hazardous Materials" (or similar pre-approved DOT shipping course) are permitted to offer a hazardous material for shipment. If you have not received this training, but anticipate you will need to ship a hazardous material, you should contact Health Sciences or your local Safety Representative to arrange to receive this training.

Questions regarding application of this guidance for high-hazard samples or any other hazardous material should be directed to Health Sciences in Pittsburgh.

ATTACHMENT B
PROCEDURES FOR PACKAGING AND SHIPPING HIGH-HAZARD SAMPLES

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Questions regarding application of this guidance for high-hazard samples or any other hazardous material should be directed to Health Sciences in Pittsburgh.

ATTACHMENT C
METHODS OF SAMPLING STRATIFIED CONTENTS OF TANKS

1. Sampling Using the Bacon Bomb Sampler

Discussion

The Bacon Bomb (Figure C-1) is designed for the withdrawal of samples by the "thief" method from various levels within a storage tank. It consists of a cylindrical body with an internal tapered plunger that acts as a valve to admit the sample. A line attached to the top of the plunger is used to open and close the valve. A removable top cover provides a point of attachment for the sample and has a locking mechanism to keep the plunger closed after sampling. The Bacon Bomb is usually constructed of chrome-plated brass and bronze with a rubber O-ring acting as the plunger sealing surface. Stainless steel versions are also available. The volumetric capacity is 8, 16, or 32 ounces (236, 473, or 946 milliliters).

Uses

The Bacon Bomb is a heavy sampler for viscous materials held in large storage tanks or in lagoons. If a more non-reactive sampler is needed, the stainless steel version should be used or the samplers could be coated with Teflon.

Sampling Method

1. Attach the sample line and the plunger line to the sampler.
2. Measure and then mark the sampling line at the desired depth for sampling.
3. Gradually lower the sampler by the sample line until the desired level is reached.
4. When the desired level is reached, pull up on the plunger line and allow the sampler to fill before releasing the plunger line to seal off the sampler.
5. Retrieve the sampler by the sample line, being careful not to pull up on the plunger line and thereby prevent accidental opening of the bottom valve.
6. Rinse or wipe off the exterior of the sampler body.
7. Position the sampler over the sample container and release its contents by pulling up on the plunger line.
8. Thoroughly decontaminate the sampler prior to next use.

ATTACHMENT C
METHODS OF SAMPLING STRATIFIED CONTENTS OF TANKS
PAGE TWO

2. Sampling using the Weighted Bottle Sampler

Discussion

The weighted bottle sampler consists of a glass bottle, a weight sinker, a bottle stopper, and a line for opening the bottle and lowering and raising the sampler during sampling (Figure C-2). There are variations of this sampler, as illustrated in the American Society of Testing and Materials (ASTM) Methods D0270 and E-300. This sampler can be either fabricated or purchased commercially.

Uses

Weighted bottle samplers are used to sample liquids at a particular depth. These samplers are difficult to use in very viscous liquids. In addition, the outside of the bottle is exposed to the waste. This is undesirable if the bottle is used as the sample container. An alternative to the weighted bottle sampler is the Kemmerer bottle.

Sampling Method

1. Gently lower the sampler into the liquid to the desired depth so as not to remove the stopper prematurely.
2. Pull out the stopper with a sharp jerk of the sampler line.
3. Allow the bottle to fill completely, as evidenced by the cessation of air bubbles.
4. Raise the sampler and cap the bottle.
5. The bottle can be used as the sample container, but it must be thoroughly decontaminated.

ATTACHMENT C
METHODS OF SAMPLING STRATIFIED CONTENTS OF TANKS
PAGE THREE

3. Collection of Samples from Depth with a Kemmerer Bottle

Discussion

The Kemmerer bottle is a messenger-activated sampling device (see Figure C-3). In the open position, liquid flows easily through the device. Once lowered to the desired depth, a messenger is dropped down the sample line, tripping the release mechanism and closing the bottle. In the closed position, the bottle is sealed, both on top and bottom, from any additional contact with the liquid column and the sample can be retrieved. Most commercially-available Kemmerer bottles are of brass or plastic construction.

Uses

The Kemmerer bottle is currently the most practical method of collecting discrete, at-depth samples from vessels. The application is limited, however, by the incompatibility of various construction materials with some analytical techniques. Proper selection, i.e., all metal assemblies for organic analysis, or all plastic assemblies for trace element analysis, will overcome this deficiency.

Sampling Method

1. Inspect Kemmerer bottle for thorough cleaning and ensure that sample drain valve is closed (if bottle is so equipped).

2. Measure and then mark sample line at desired sampling length.

3. Open bottle by lifting top stopper-trip head assembly.

4. Gradually lower bottle until desired level is reached (predesignated mark from Step 2).

5. Place messenger on sample line and release.

6. Retrieve sampler; hold sampler by center stem to prevent accidental opening of bottle stopper.

7. Rinse or wipe off exterior of sampler body (wear proper gloves and protective clothing).

8. Recover sample by grasping lower stopper and sampler body with one hand (gloved), and transfer sample by either (a) lifting top stopper with other hand and carefully pouring contents into sample bottles, or (b) holding drain valve (if present) over sample bottle and opening valve.

9. Thoroughly decontaminate the sampler prior to next use.

1 **FIGURE C-1**
BACON BOMB SAMPLER

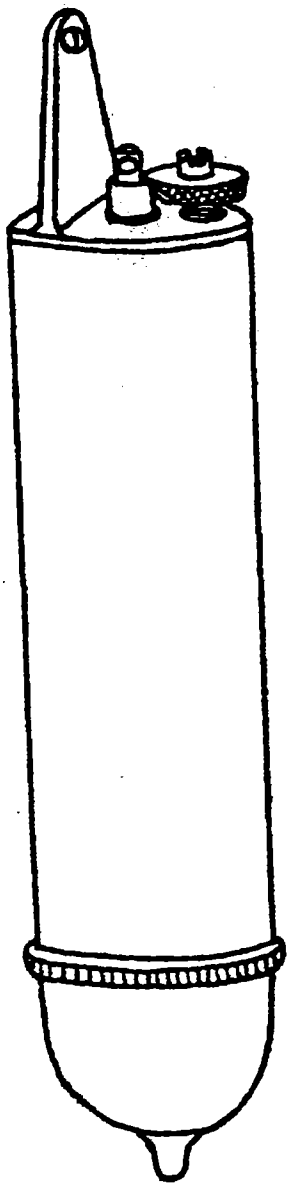
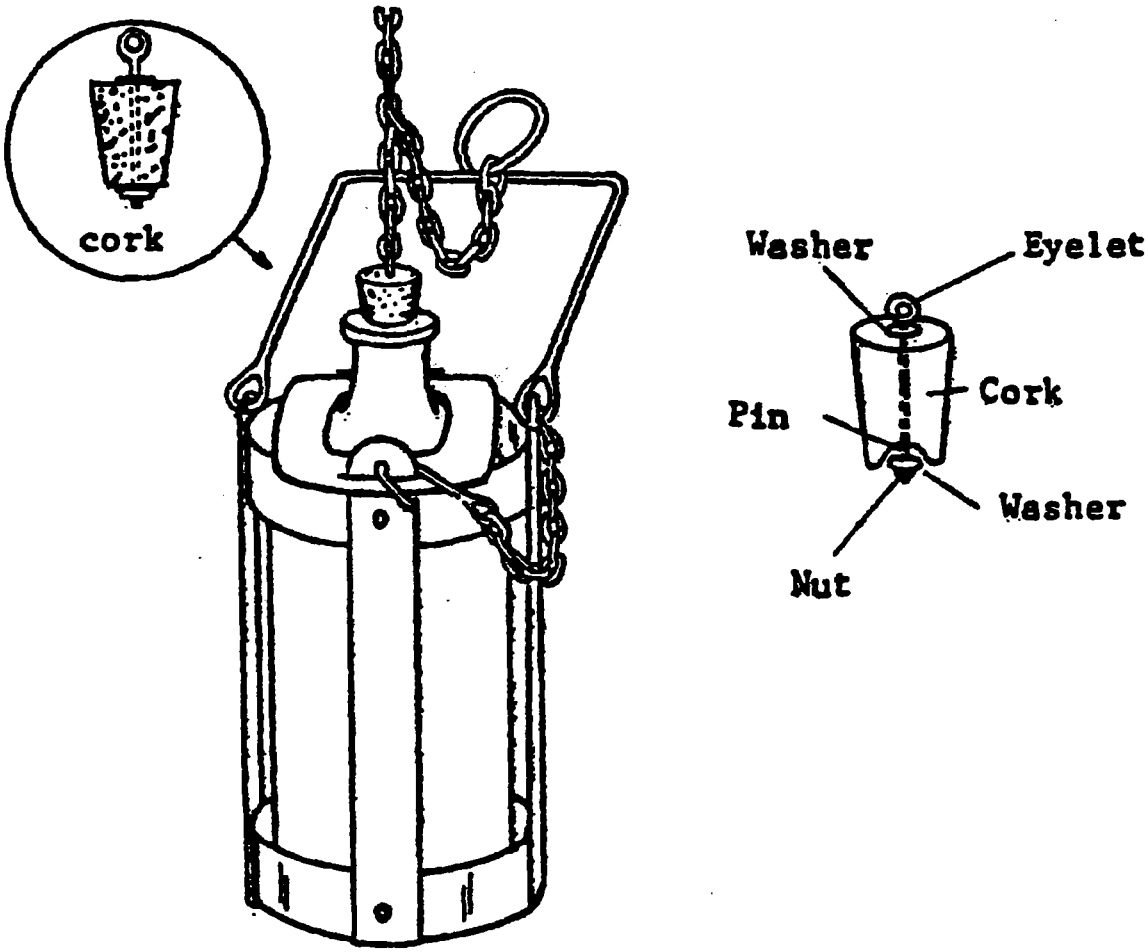
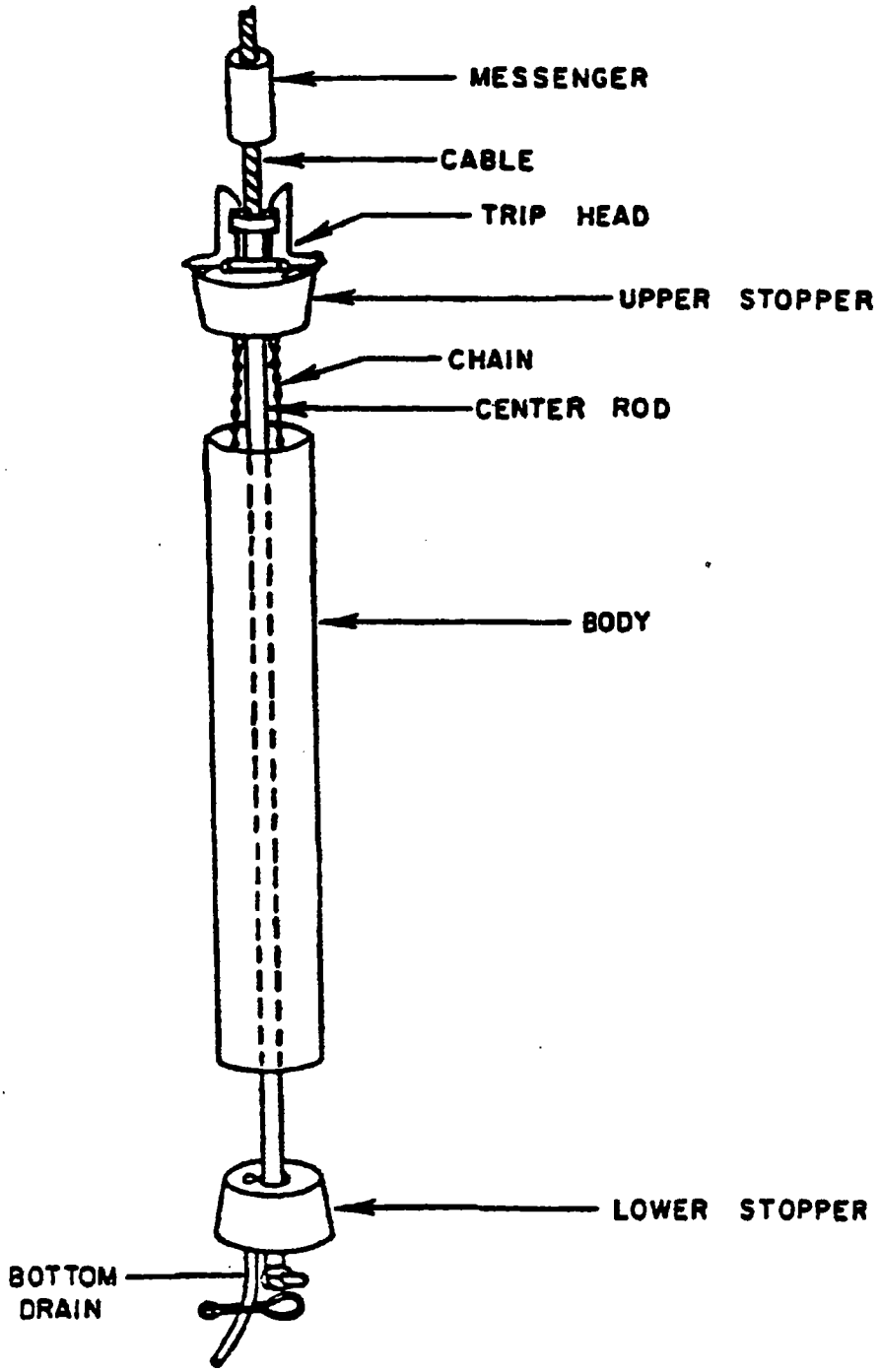


FIGURE C-2
WEIGHTED BOTTLE SAMPLER



1000-ml (1-quart) weighted bottle catcher

FIGURE C-3
MODIFIED KEMMERER SAMPLER



ATTACHMENT D
COLLECTION OF LIQUID CONTAINERIZED WASTES USING GLASS TUBES

Description

Liquid samples from opened containers are collected using lengths of glass tubing. The glass tubes are normally 122 centimeters in length and 6 to 16 millimeters inside diameters. Longer tubes may be used but larger diameter tubing is not effective. The tubing allows inspection of the tank contents for stratification. This method should not be attempted with less than a two-person sampling team.

Uses

This method provides a quick, relatively inexpensive means of collecting containerized wastes. The major disadvantage is from potential sample loss, which is especially prevalent when sampling low viscosity fluids. Splashing can also be a problem, and proper protective clothing should always be worn.

Sampling Method

1. Remove cover from sample container opening.
2. Insert glass tubing almost to the bottom of the container. Try to keep at least 30 centimeters of tubing above the top of the container.
3. Allow the waste in the tank to reach its natural level in the tube, then cap the top of the tube with a rubber stopper or cover tightly with gloved thumb.
4. Carefully remove the capped tube from the tank and insert the uncapped end in the sample container.
5. Release the thumb or stopper on the tube and allow the sample container to fill to approximately 90 percent of its capacity.
6. Repeat Steps 2 through 6 if more volume is needed to fill the sample container.

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		Effective Date 08/13/01	Revision 0
		Applicability Tetra Tech NUS, Inc.	
		Prepared Risk Assessment Department	
Subject DATA VALIDATION - POLYCHLORINATED DIBENZODIOXINS AND POLYCHLORINATED DIBENZOFURANS FOR SOLID AND AQUEOUS MATRICES		Approved D. Senovich	

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1.0 CLP DFLM 1.1/SW-846 METHODS 8280/8290

1.1 Applicability

Methods 8280, 8290 and CLP SOW DFLM1.1 are applicable for the determination of the tetra-, penta-, hexa-, hepta-, and octachlorinated congeners of dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) (by Gas Chromatography/Mass Spectrometry (GC/MS) via selective ion monitoring) in chemical wastes including fuel oils, sludges, fly ash, still bottoms, reactor residues, soil, and water. Methods 8280 and DFLM1.1 are low resolution GC/MS techniques while Method 8290 is a high resolution GC/MS technique.

1.2 Dioxin Data Package Deliverable Minimum Requirements

The following information must be present in data package prior to the validation effort:

- Appropriate Chain-of-Custody (COC) Form(s)
- Laboratory Case Narrative documenting any particular analytical anomalies encountered and sample description information (i.e., sample cross-reference identifications)
- Calibration Summaries
- Laboratory Control Sample and Duplicate forms
- Single Control Samples and Method Blank Results
- Matrix Spike/Matrix Spike Duplicates
- Retention Time Marker Solutions
- Internal and Recovery Standard Area Summaries

The appropriate laboratory liaison must be contacted immediately if any of the above items have been omitted from the data package.

1.3 Technical Data Evaluation

NOTE: Analysis of a fortified standard and blank may be submitted as evidence of compliant Performance Evaluation (PE) analyses as per region-specific requirements. The fortified standard will contain 2,3,7,8-TCDD at a known quantity while the fortified blank will contain 1,2,3,4-TCDD plus other known interferents. The recovery for 2,3,7,8-TCDD recognition must be within the EPA's 99% confidence interval.

1.4 Quality Control

1.4.1 Holding Times and Sample Preservation

All samples are to be extracted within 30 days of sample collection, and all subsequent analyses are to be conducted within 45 days from the date of collection. **NOTE:** Data qualification based upon holding time noncompliances is rare due to the minor effect of extended storage time on PCDD/PCDF quantitation resulting from the inherent persistence and known stability of these compounds. However, estimation of associated sample data based on holding time shall be subject to the professional judgment of the data validator.

Sample preservation shall be checked by referencing the appropriate Chain-of-Custody (COC) form(s) and verifying that all samples receiving PCDD/PCDF analysis were cooled to and stored at 4 C.

1.4.2 Initial Calibration Verification

Review the average Relative Response Factors (RRFs) for all dioxin congeners by recalculating approximately 10% of the reported RRFs while also verifying proper use of quantitation ions. The following ions are specified for selective ion monitoring for PCDDs and PCDFs:

Analyte		Quantitation Ion	Confirmation Ions
PCDDs	Tetra	322	320
	Penta	356	354; 358
	Hexa	390	388; 392
	Hepta	424	422; 426
	Octa	460	458
PCDFs	Tetra	306	304
	Penta	340	338; 342
	Hexa	374	372; 376
	Hepta	408	406; 410
	Octa	444	442

Internal Standards

Analyte	Quantitation Ion	Confirmation Ion
13C12-2,3,7,8-TCDD	334	332
13C12-1,2,3,6,7,8-H_xCDD	404	402
13C12-OCDD	472	470
13C12-2,3,7,8-TCDF	318	316
13C12-1,2,3,4,6,7,8-H_pCDF	420	422

Recovery Standards

Analyte	Quantitation Ion	Confirmation Ion
13C12-1,2,3,4-TCDD	334	332
13C12-1,2,3,7,8,9-H_xCDD	404	402

Next verify the acceptability of isotopic ratios as outlined in the following table:

Analyte		Selected Ions	Relative m/z
PCDDs	Tetra	320/322	0.65-0.89
	Penta	356/358	1.24-1.86
	Hexa	390/392	1.05-1.43
	Hepta	424/426	0.88-1.20
	Octa	458/460	0.76-1.02
PCDFs	Tetra	304/306	0.65-0.89
	Penta	340/342	1.24-1.86
	Hexa	374/376	1.05-1.43
	Hepta	408/410	0.88-1.20
	Octa	442/444	0.76-1.02

Internal Standards

Analyte	Selected Ions	Relative m/z
13C12-2,3,7,8-TCDD	332/334	0.65-0.89
13C12-1,2,3,6,7,8-H_xCDD	402/404	1.05-1.43
13C12-OCDD	470/472	0.76-1.02
13C12-2,3,7,8-TCDF	316/318	0.65-0.89
13C12-1,2,3,4,6,7,8-H_pCDF	420/422	0.88-1.20

Recovery Standards

Analyte	Selected Ions	Relative m/z
13C12-1,2,3,4-TCDD	332/334	0.65-0.89
13C12-1,2,3,7,8,9-H_xCDD	402/404	1.05-1.43

Typically, the data reviewer can expect to associate the following congeners with their associated internal standards as follows:

Internal Standard #1 (13C12-2,3,7,8-TCDD)	TCDD, PeCDD
Internal Standard #2 (13C12-1,2,3,6,7,8-HxCDD)	HxCDD, HpCDD
Internal Standard #3 (13C-OCDD)	OCDD, OCDF
Internal Standard #4 (13C12-TCDF)	TCDF, PeCDF
Internal Standard #5 (13C12-HpCDF)	HxCDF, HpCDF

Additionally, verify that the Relative Standard Deviation (%RSD) for all target compounds and internal standards is 15%.

Actions - Qualify as estimated, (J) positive results and (UJ) nondetects in affected samples if RSD is >15%.

Window Defining Mix

This is a retention time check which must be run prior to the continuing calibration. The composition of the window defining mix may or may not be known. Review the following criteria:

- Peak separation must be 25% valley criterion for TCDD isomers
- Peak separation must be the 50% valley criterion for HxCDD isomers
- Multiple ion detection mass chromatograms and reconstructed ion chromatograms should be present for the window defining mix

Actions - Professional judgment (weighted primarily upon chromatographic expertise) must be employed when assigning data qualifications.

1.4.3 Continuing Calibration Verification

Evaluation of the CCV involves evaluating the Daily Standard (which is a standard that contains the required target compounds plus internal standards), versus the initial standard.

Verify that a Continuing Calibration Verification (CCV) was analyzed prior to sample analysis and at the beginning of each subsequent 12-hour period. A CCV must also be analyzed at the end of the final analysis period.

The Signal-to-Noise ratio (S/N) for all internal standards must be >10:1. No quality control criteria exist to govern internal standard recovery; however, internal standard advisory recovery limits of 40-120% were established in earlier EPA validation protocol.

Verify that the internal standard area count in the sample is -50% to +100% of the internal standard area count in the associated daily standard.

Complete one Percent Recovery ($\%R_{is}$) calculation for an internal standard as outlined in **equation A** below:

$$\text{Equation A:} \quad \%R_{is} = \frac{(A_{is})(Q_{rs})}{(A_{rs})(RRF_{is})(Q_{is})} \times 100$$

where:
- A_{is} = area of the quantitation ion of the internal standard
- A_{rs} = area of the quantitation ion of the recovery standard
- Q_{is} = ng of internal standard
- Q_{rs} = ng of recovery standard
- RRF_{is} = Relative Response Factor for the internal standard as determined from the associated continuing calibration

An RRF shall be calculated for each congener in the CCV solution. A Percent Difference (%D) of 30% from the average RRF must be accomplished for the CCV. **NOTE**: Recalculate some (approximately 10%) of the continuing calibration RRFs for thoroughness.

Actions - Qualify associated sample data as estimated, i.e., (J) positive results and (UJ) nondetects in affected samples in instances where CCV %D >30%. Qualify as rejected (R) all associated sample data in instances where the internal standard S/N ratio <10:1.

1.4.4 Laboratory Method Blank Evaluations

Verify that a laboratory generated method blank was analyzed prior to sample analysis and for each matrix and extraction batch for all samples within an SDG. The laboratory method blanks should be free from contamination and/or interferences stemming from glassware involved in sample preparation and subsequent analytical procedures, associated reagents and solvents, etc. The following criteria shall be employed for evaluation of contaminant levels present in laboratory method blanks:

- The signal of any confirmed analyte present in a method blank must be <2% of the signal of the associated internal standard (based on peak height or peak area). Comparison of contaminants present in the blanks at levels below the calibration range (i.e., contaminants present at levels which constitute <2% of the respective internal standard) shall not require reanalyses as stipulated by the method.
- An action level of 5X the maximum contaminant level shall be used in instances of positive detections.
- The data reviewer should complete a detection limit verification calculation.
- Detection limits are sample-specific dependent upon the concentration of a given analyte to produce a signal with a peak height 2.5 X the background signal.
- The data reviewer shall consider all applicable sample weight, moisture content, and dilution factors prior to application of the aforementioned action level.

- The data reviewer shall recalculate at least one Detection Limit (DL) using **equation B** as follows:

Equation B: $$DL = \frac{(2.5)(H_x)(Q_{is})}{(A_{is})(RRF_A)(W)}$$

where: A_{is} = area of the quantitation ion of the internal standard
Q_{is} = ng of internal standard
H_x = peak height of noise for the analyte's quantitation ion
RRF_{is} = Relative Response Factor for the analyte as determined from the associated continuing calibration
W = dry weight of the sample (g)

Actions - Effects on sample data and subsequent data qualifications shall be upon the professional judgment of the data reviewer, but the following general qualifying guidance shall be employed; Qualify as nondetected (U) any positive result less than the corresponding action level.

1.4.5 Duplicate Control Samples

The Duplicate Control Sample (DCS) is a well-characterized matrix which is spiked and analyzed at approximately 10% of the sample load in order to establish method-specific quality control limits. The DCS spike recovery quality control limits of 60-140% shall be employed. Additionally, the RPDs between control sample and duplicate shall be below 50%.

Actions - Qualify as estimated (J) positive results in affected samples when DCS spike recoveries are >140%. Qualify as estimated (J) positive results and (UJ) nondetects in affected samples when DCS spike recoveries are <60%. Qualify as estimated (J) positive results and (UJ) nondetects in affected samples when %RPD between control and duplicate sample exceeds 50%.

1.4.6 Matrix Spike/Matrix Spike Duplicate Review

Verify that a matrix spike has been analyzed for each matrix and batch of samples within an SDG.

Verify that the %RSD between matrix spike and duplicate injections is 50%. Additionally, the following recovery limits shall be employed for the respective congeners:

Congener	Recovery Limits
TCDD	50-150%
PCDD	50-150%
HxCDD	50-150%
HpCDD	50-150%
OCDD	50-150%
TCDF	50-150%
PeCDF	50-150%
HxCDF	50-150%
HpCDF	50-150%
OCDF	50-150%

Actions - Qualify as estimated (J) only positive results in affected samples when the recovery exceeds the upper quality control limit. Qualify as estimated, (J) positive results and (UJ) nondetects in affected samples when the recovery is below the lower quality control limit.

1.4.7 Chromatographic Performance and Evaluation

Verify that the recovery standard area counts are within -50% to +100% of the area counts in the respective daily check standard.

Examine chromatographic acceptability by checking the chromatographic base-line for fluctuation (i.e., raising or lowering), peak shape and resolution. Proper peak resolution between 13C-2,3,7,8-TCDD and 13C-1,2,3,4-TCDD (or 13C-2,3,7,8-TCDD and its closest eluting isomer), shall be attained at a threshold acceptability level of <25%.

Actions - Data qualification shall be based upon the professional judgment of the data reviewer.

1.4.8 Sample Quantitation

Confirm the quantitation of at least one Estimated Maximum Positive Concentration (EMPC). The laboratory will report an EMPC as opposed to a confirmed, definite positive hit in instances where the S/N 2.5 for both the quantitation ion and confirmation ion for a given target isomer/analyte. The following equation shall be used to verify at least one EMPC calculation:

$$EMPC = \frac{(A_x)(Q_{is})}{(A_{is})(RRF_A)(W)}$$

where: A_x = area of the quantitation or confirmation ion, whichever is lower
Q_{is}, A_{is}, RRF_A, and W are defined in the previous equation.

The data reviewer will also confirm at least one positive detection using the following equation:

$$C_A = \frac{(A_A)(Q_{is})}{(A_{is})(RRF_A)(W)}$$

where: A_{is}, Q_{is}, RRF_A, and W are defined in previous equations
C_A = analyte concentration (ng/g or ug/kg)
A_A = analyte quantitation ion area

NOTE: EMPC values are estimates by definition. If these values are used for risk assessment, it must be understood that an EMPC value is "less certain" that positive results which are qualified (J), since the qualified results meet identification criteria while EMPCs do not.

1.5 Deliverables

In addition to any work-request requirements (e.g., data validation memorandum), all laboratory data package quality control summary forms, laboratory summaries of sample results and laboratory method blanks, and COCs must be provided to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct, and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

Final
Quality Assurance Project Plan
for
Site 8 – Herbicide Orange Storage Areas B and C

Naval Construction Battalion Center

Gulfport, Mississippi

NAVFAC
Naval Facilities Engineering Command

Southern Division
Naval Facilities Engineering Command

Contract Number N62467-94-D-0888

Contract Task Order 0327

March 2005

060304/P

FINAL
QUALITY ASSURANCE PROJECT PLAN
FOR
SITE 8 – HERBICIDE ORANGE STORAGE AREA
AREAS B AND C

NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

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ACRONYM LIST

AOC	Area of Contamination
%R	percent recovery
CLEAN	Comprehensive Long-Term Environmental Action, Navy
COC	Contaminant of Concern
CTO	Contract Task Order
CVAA	Cold Vapor Atomic Absorption
DQO	Data Quality Objective
EISOPQAM	Environmental Investigations Standard Operation Procedure and Quality Assurance Manual
EMPC	Estimated Maximum Potential Concentration
FFS	Focused Feasibility Study
FOL	Field Operations Leader
FTMR	Field Task Modification Request
GC	Gas Chromatograph
GFAA	Graphite Furnace Atomic Absorption
HASP	Health and Safety Plan
HO	Herbicide Orange
HR	High Resolution
HPLC	High Performance Liquid Chromatograph
HSM	Health and Safety Manager
ICP	Inductively-Coupled Plasma Atomic-Emission Spectrometer
LCS	Laboratory Control Sample
MCL	Maximum Contamination Level
MDEQ	Mississippi Department of Environmental Quality
MDL	Method Detection Limit
MS	Mass Spectrometer
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NCBC	Naval Construction Battalion Center
NELAC	National Environmental Laboratory Accreditation Conference
NFESC	Naval Facilities Engineering Service Center
NIST	National Institute of Science and Technology
ng/kg	nanograms per kilogram
NTU	Nephelometric Turbidity Unit
ORP	Oxidation-Reduction Potential
PARCC	Precision, Accuracy, Representativeness, Comparability, Completeness

pg/L	picograms per liter
PM	Program Manager
PRG	Preliminary Remediation Goal
ppt	parts per trillion
QA	Quality Assurance
QAM	Quality Assurance Manager
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Control
RA	Remedial Action
RBC	Risk-Based Concentration
RD	Remedial Design
RDL	Required Detection Limit
RL	Reporting Limit
RPD	Relative Percent Difference
RPM	Remedial Project Manager
RQL	Required Quantitation Limit
SAP	Sampling and Analysis Plan
SDG	Sample Delivery Group
SOP	Standard Operating Procedure
TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
TCL	Target Compound List
TRG	Target Remediation Goal (MDEQ's)
TOM	Task Order Manager
TtNUS	Tetra Tech NUS, Inc.
USEPA	United States Environmental Protection Agency

1.0 PROJECT DESCRIPTION

1.1 INTRODUCTION

This Quality Assurance Project Plan (QAPP) has been prepared by Tetra Tech NUS, Inc. (TtNUS) on behalf of the United States Navy Southern Division Naval Facilities Engineering Command and the Naval Construction Battalion Center (NCBC) Gulfport, Gulfport, Mississippi, under the Comprehensive Long-Term Environmental Action Navy (CLEAN) III Contract Number N62467-94-D-0888, Contract Task Order (CTO) 327. The QAPP and other associated documents, including the United States Environmental Protection Agency (USEPA) Region IV Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), Sampling and Analysis Plan (SAP) dated May 2003 prepared by TtNUS, and the Health and Safety Plan (HASP), constitute the project planning documents for the SAP program to be performed to support the Remedial Design (RD)/Remedial Action (RA) for Site 8, Herbicide Orange Storage Area, and on-base and off-base areas that have been impacted by the storage of Herbicide Orange (HO) at Site 8 at the NCBC Gulfport, Gulfport, Mississippi.

This QAPP presents the organization, objectives, planned activities, and specific quality assurance/quality control (QA/QC) procedures associated with the sampling program. Specific protocols for sampling, sample handling and storage, chain-of-custody, and laboratory and field analyses are described within this document. All QA/QC procedures are structured in accordance with applicable technical standards, the Naval Facilities Engineering Service Center (NFESC) guidance document Navy Installation Restoration Chemical Data Quality Manual (1999), and USEPA Region 4 and Mississippi Department of Environmental Quality (MDEQ) requirements, regulations, guidances, and technical standards.

1.2 FACILITY DESCRIPTION

A description of the NCBC Gulfport, Mississippi is provided in Section 2.0 of the SAP.

1.3 SITE HISTORY

A description of Site 8 and on-base and off-base areas impacted by the past storage of HO at Site 8 is provided in Section 2.0 of the SAP.

1.4 PROJECT OBJECTIVES

This section discusses the overall project objectives, the anticipated target parameters, and intended data uses for both field and laboratory analytical data.

1.4.1 Overall Project Objectives

During the upcoming RA, dioxin-contaminated media from areas impacted by the past storage of HO at Site 8 will be excavated, blended, stabilized, and consolidated/landfilled at Site 8A. A protective cap will be placed over the stabilized material. The overall purpose of this_sampling is to confirm that remedial objectives for the RA are sufficiently achieved_at Areas B and C as well. Specifically, sampling will provide modern low parts per trillion (PPT) verification of surface soil conditions, by:

- Verification that surface soil at Areas B and C have dioxin concentrations less than 38.2 ng/kg.
- If concentrations are discovered above that level, then delineation of the extent of the contamination.
- While primarily a formality, congener analysis will be performed to confirm the source of the dioxins at Site 8.
- Use of a new analytical technique, Method 4025m, as confirmed by 8290 to rapidly determine site conditions.

Project objectives are discussed in further detail in Section 3.0 of the SAP.

1.4.2 Project Target Parameters and Intended Data Uses

This section discusses the field and laboratory analytical information to be generated during the course of the investigation. Field parameters and intended data uses are discussed in Section 1.4.2.1. Laboratory parameters and intended data uses are discussed in Section 1.4.2.2.

1.4.2.1 Field Parameters

No field sampling parameters are planned for this investigation.

1.4.2.2 Laboratory Parameters

Dioxins and furans are the only chemicals of concern (COCs) established in areas affected by the past storage of HO at Site 8. Analytical data will be used to determine whether remedial objectives for the RA have been achieved.

All soil and sediment samples will also be analyzed for toxicity equivalent dioxin/furan via Method 4025m and confirmed by selecting 10% confirmation using TCL dioxins/furans (Method 8290). Table 1-1

provides a summary of all target compounds associated RQLs for dioxins/furans. The RQLs listed in the tables meet the required MDEQ Tier 1 Target Remediation Goals (TRGs) for unrestricted use.

1.5 SAMPLE NETWORK DESIGN AND RATIONALE

The sample network design and rationale are discussed in Section 3.0 of the SAP.

1.6 PROJECT SCHEDULE

The project schedule is to be determined.

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TABLE 1-1

METHOD SW-846 8290 ANALYTICAL QUANTITATION LIMITS
DIOXIN/FURAN LIST
NCBC GULFPORT SITE 8 QAPP

	RQL[1]	
	Solid Samples 8290	Solid Samples 4025
Dioxins/Furans	ppt	ppt[2]
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	1.0	4.0
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	1.0	NA
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	2.5	NA
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	2.5	NA
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	2.5	NA
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HPCDD)	2.5	NA
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD)	5.0	NA
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	1.0	NA
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	1.0	NA
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	1.0	NA
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	2.5	NA
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	2.5	NA
1,2,3,7,8,9 -Hexachlorodibenzofuran (HxCDF)	2.5	NA
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	2.5	NA
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	2.5	NA
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	2.5	NA
1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF)	5.0	NA

1 RQL Required Quantitation Limit
ppt = part per trillion
2 Method 4025, a bioassay technique provides a single number equivalency of TCDD with a RQL set at a project specific requirement of 4.0 ppt.

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The overall QA objective for this project is to develop and implement procedures for field sampling, chain-of-custody, laboratory analysis, and reporting that will provide results that support the attainment of project data quality objectives. Intended data uses are described in Section 1.4 of this QAPP. Specific procedures for sampling, chain-of-custody, laboratory instrument calibration, laboratory analysis, reporting of data, internal QC, audits, preventive maintenance of field and laboratory equipment, and corrective action are described in other sections of this QAPP.

The PARCC parameters (precision, accuracy, representativeness, comparability, and completeness) are qualitative and/or quantitative statements regarding the quality characteristics of the data used to support project data quality objectives and ultimately, environmental decisions. These parameters are discussed in the remainder of this section. Specific routine procedures used to assess the quantitative parameters (precision, accuracy, and completeness) are provided in Section 12.0.

3.1 PRECISION

Precision is a measure of the amount of variability and bias inherent in a data set. Precision describes the reproducibility of measurements of the same parameter for samples under similar conditions. The equation for determining precision is provided in Section 12.2.

3.1.1 Field Precision Objectives

No field sampling parameters will be collected as part of this field program.

3.1.2 Laboratory Precision Objectives

Laboratory precision QC samples are analyzed at a frequency of 5 percent (i.e., one quality control sample per 20 environmental samples). Laboratory precision is measured via comparison of calculated Relative Percent Difference (RPD) values and precision control limits specified in the analytical method or by the laboratory's QA/QC Program.

Precision for organic analyses will be measured via the RPDs for MS/matrix spike duplicate (MS/MSD) samples. Table 3-1 presents precision control limits for MS/MSD RPDs for dioxin/furan analyses. Both Method 4025 and 8290 will use the same frequency for precision sampling and analysis.

3.2 ACCURACY

Accuracy is the degree of agreement between the observed value and an accepted reference value. The equation for determining accuracy is provided in Section 12.1.

3.2.1 Field Accuracy Objectives

No field sampling parameters will be collected as part of this field program.

3.2.2 Laboratory Accuracy Objectives

Accuracy in the laboratory is measured through the comparison of a spiked sample result against a known or calculated value expressed as a percent recovery (%R). Percent recoveries are derived from the analysis of known amounts of compounds spiked into deionized water [i.e., laboratory control sample (LCS) analysis] or into actual samples (i.e., surrogate or MS analysis). LCS analyses measure the accuracy of laboratory operations. Surrogate and MS analyses also measure the accuracy of laboratory operations but as affected by the sample matrix. LCS and/or MS analyses are performed with a frequency of one per 20 associated samples of like matrix. Surrogate spike analysis is performed for all chromatographic organic analyses. Laboratory accuracy is assessed via comparison of calculated %Rs with accuracy control limits specified in the analytical method or by the laboratory's QA/QC Program.

Accuracy will be measured via the %Rs for surrogate spikes and MS/MSDs. Table 3-2 presents control limits for LCS spike recoveries for dioxins/furans. Tables 3-3 and 3-4 present control limits for matrix and surrogate spike recoveries, respectively, for Dioxins/Furans.

3.3 COMPLETENESS

Completeness is a measure of the amount of usable, valid analytical data obtained, compared to the amount expected. Completeness is typically expressed as a percentage. The equation for completeness is presented in Section 12.3.

The ideal objective for completeness is 100 percent (i.e., every sample planned to be collected is collected; every sample submitted for analysis yields valid data). However, samples can be rendered unusable during shipping or preparation (e.g., bottles broken or extracts accidentally destroyed), errors can be introduced during analysis (e.g., loss of instrument sensitivity, introduction of ambient laboratory contamination), or strong matrix effects can skew analytical results (e.g., extremely low MS recovery).

These instances may result in data that do not meet QC criteria. Based on these considerations, 95 percent is considered an acceptable target for the data completeness objective. If critical data points are lost, resampling and/or reanalysis might be required.

As further discussed in Section 11.2.2, 100 percent of the laboratory data for the NCBC Gulfport investigation program will undergo a full validation review. Data rejected as a result of the review process will be treated as unusable data unless additional review shows that the data are usable.

3.4 REPRESENTATIVENESS

Representativeness is an expression of the degree to which the data accurately and precisely depict the actual characteristics of a population or environmental condition existing at an individual sampling point. Use of standardized sampling, handling, analytical, and reporting procedures ensures that the final data accurately represent actual site conditions.

3.4.1 Measures to Ensure Representativeness of Field Data

Representativeness depends on the proper design of the sampling program and it will be achieved by ensuring that the SAP is followed and that proper sampling techniques are used. The sampling network for the SAP was designed to provide data representative of site conditions. During development of this network, consideration was given to the baseline condition determined from prior sampling and analytical data. The rationale of the sampling network is discussed in detail in Section 3.0 of the SAP.

3.4.2 Measures to Ensure Representativeness of Laboratory Data

Representativeness in the laboratory data is ensured by using the proper analytical procedures, meeting sample holding times, and analyzing and assessing duplicate samples.

3.5 COMPARABILITY

Comparability is defined as the confidence with which one data set can be compared to another (e.g., between sampling points; between sampling events). Comparability is achieved by using standardized sampling and analysis methods and data reporting formats (including use of consistent units of measure). Additionally, consideration is given to seasonal conditions and other environmental variations that could influence data results.

3.5.1 Measures to Ensure Comparability of Field Data

Comparability is dependent upon the proper design of the sampling program and will be achieved by ensuring that the SAP is followed. It also depends on recording field measurements using the correct units. Field measurement units are further discussed in Section 11.1.1.

3.5.2 Measures to Ensure Comparability of Laboratory Data

Analytical data will be comparable when similar sampling and analytical methods are used and documented. Results will be reported in units that ensure comparability with previous data and with current State and federal standards and guidelines. Laboratory measurement units are further discussed in Section 11.1.2.

3.6 LEVEL OF QUALITY CONTROL EFFORT

Rinsate blank, method blank, field and laboratory duplicate, laboratory control, and MS samples will be analyzed to assess the quality of the data resulting from the field sampling and analytical programs.

External QC measures to be collected as part of verification sampling activities consist of field duplicates and equipment rinsate blanks. Volatile organic compounds will not be collected as part of SAP activities; consequently, trip blanks will not be collected. Information gained from these analyses further characterizes the level of data quality obtained to support project goals. Each of these types of field QC samples undergo the same preservation, analysis, and reporting procedures as the related environmental samples. Each type of field QC sample is discussed below.

Field duplicates are two samples collected independently at a sampling location (e.g., sediment). Field duplicates are collected and analyzed by the laboratory for all chemical constituents to measure the precision of the sampling and analysis methods employed. The level of the QC effort will be one field duplicate for every 5 to 9 samples and then 10 percent of the number of additional investigative samples.

Equipment rinsate blanks are obtained under representative field conditions by collecting the rinse water generated by running analyte-free water through sample collection equipment after decontamination and prior to use. At least one equipment blank will be collected per day per matrix. If pre-cleaned, dedicated, or disposable sampling equipment is used, one rinsate blank per type of equipment used must be collected as a "batch blank." Rinsate blanks are analyzed by the laboratory for the same chemical constituents as the associated environmental samples. Equipment blanks are further discussed in Sections 5.2 and 5.13.10 of the EISOPQAM (USEPA, 2001).

Method blank samples are generated within the laboratory and used to assess contamination resulting from laboratory procedures. Samples with positive results corresponding to positive results in the method blank will be designated with a qualifier by the laboratory. Method blanks are further discussed in Section 10.2 of this QAPP.

MS/MSD samples are investigative samples spiked with known quantities of target analytes. MS/MSDs provide information about the effect of the sample matrix on the measurement methodology. One MS/MSD sample will be collected/designated for every 20 or fewer investigative samples per sample matrix.

The level of QC effort for analytical testing will conform to the appropriate analytical method, as specified in Table 8-1.

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TABLE 3-1

PRECISION CONTROL LIMITS (RPDs)[1]
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES
SITE 8 QAPP
NCBC GULFPORT, MISSISSIPPI

Chemical	Soil Samples
Dioxins/Furans [2]	**RPD**
All dioxins/furans	25

1 RPD Relative Percent Difference as described in Section 12.2
2 USEPA Method SW-846 8290.

TABLE 3-2

ACCURACY CONTROL LIMITS (%R)[1]
LABORATORY CONTROL SAMPLE
SITE 8 QAPP
NCBC GULFPORT, MISSISSIPPI

Chemical	Soil Samples
Dioxins/Furans [2]	**%R**
All dioxins/furans	25

1 %R Percent Recovery
2 USEPA Method SW-846 8290.
NA Not Applicable

TABLE 3-3

ACCURACY CONTROL LIMITS (%R)[1]
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES
SITE 8 QAPP
NCBC GULFPORT, MISSISSIPPI

Chemical	Soil Samples
Dioxins/Furans [2]	%R
All dioxins/furans	25

1 %R Percent Recovery
2 USEPA Method SW-846 8290.
NA Not Applicable

TABLE 3-4

ACCURACY CONTROL LIMITS (%R)[1]
SURROGATE SPIKES
NCBC GULFPORT, MISSISSIPPI
SITE 8 QAPP

Chemical	Soil Samples
Dioxins/Furans [2]	%R
1,2,3,4-TCDD	75 - 125
1,2,3,7,8,9-HxCDD	75 - 125

1 %R Percent Recovery
2 USEPA Method SW-846 8290.
NA Not Applicable

4.0 DATA QUALITY OBJECTIVES

4.1 INTRODUCTION

The Data Quality Objective (DQO) Process is a planning approach used to determine the appropriate environmental data collection activities for a specific project. The DQOs, generated by the DQO Process define the criteria that a data collection design should satisfy: purpose of the data collection; what the data should represent; the requirements for the quality of the data; and when, where, and how to collect samples or measurements. Satisfying the DQOs will result in a data collection design that meets all performance criteria and any other requirements. The DQO Process has been conducted by all involved parties on an informal basis throughout the investigation of Site 8 and contiguous areas affected by past HO storage at Site 8. This section of the QAPP will address the DQOs generated through the informal DQO Process.

4.2 PROJECT AND DATA OBJECTIVES

A detailed description of the project objectives are provided in Section 2.0 of the SAP. The primary objective of this sampling effort is to characterize the levels and distribution of the remaining HO-related dioxins in the surface soil at Site 8 Areas B and C to determine if these areas meet the current PRG of 38.2 ng/kg or if additional remedial activities are necessary.

4.3 ANALYTICAL OBJECTIVE

Analytical parameters were chosen based on the previous investigations conducted at NCBC Gulfport. All soil samples will be analyzed using the high-resolution USEPA SW-846 4025 bioassay analytical method with 10% confirmation sampling using USEPA SW-846 8290 method. These results will allow for a comparison of the results to Tier 1 TRG restricted levels.

4.4 DATA QUALITY OBJECTIVE

Data quality is discussed in Sections 11.0 and 12.0 of this QAPP. These sections specifically address data reduction, validation, reporting, precision, accuracy, completeness, and usability.

4.5 SAMPLING AND MEASUREMENT PROCEDURES

Sampling and measurement procedures are specifically discussed in Section 5.0 of this QAPP.

5.0 SAMPLING PROCEDURES

The specific types of field activities associated with NCBC Gulfport Site 8 verification sampling are discussed in the SAP and will follow the EISOPQAM. In addition, the EISOPQAM and the SAP address the following field investigation tasks:

- Sample containers, preservatives, and volume requirements – Appendix A, EISOPQAM
- Decontamination procedures – Appendix B, EISOPQAM; Section 4.0, SAP
- Sample identification system – Section 5, Subsection 5.3.2, TtNUS CompQAP
- Sample packaging and shipping procedures – Appendix D, EISOPQAM
- Recordkeeping – TtNUS Corporate Standard Operating Procedure (SOP) SA-6.3 (Attachment 1)
- Sample container, preservation, and laboratory holding time requirements for sample collection – Section 5.0, SAP.

6.0 CUSTODY PROCEDURES

Custody is one of several factors necessary for the admissibility of environmental data as evidence in a court of law. Custody procedures help to satisfy the two major requirements for admissibility: relevance and authenticity. Sample custody is addressed in three parts: field sample collection, laboratory analysis, and final evidence files. Final evidence files, including all originals of laboratory reports and purge files, are maintained under document control in a secure area. A sample or evidence file is under custody if:

- The item is in the actual physical possession of an authorized person, or;
- The item is in view of the person after being in his or her possession, or;
- The item was placed in a secure area to prevent tampering; or
- The item is in a designated and identified secure area with access restricted to authorized personnel only.

The chain-of-custody report is a multi-part, standardized form used to summarize and document pertinent sample information such as sample identification and type, matrix, date and time of collection, preservation, and requested analyses. Furthermore, through the sequential signatures of various sample custodians (e.g., sampler, airbill number, laboratory sample custodian), the chain-of-custody report documents sample custody and tracking. A "cradle-to-grave" sample tracking system will be employed. Custody procedures apply to all environmental and associated field QC samples obtained as part of the data collection system.

6.1 FIELD CUSTODY PROCEDURES

The FOL (or designee) is responsible for the care and custody of the samples collected until they are relinquished to the analyzing laboratory or entrusted to a commercial overnight courier. Chain-of-custody reports are completed for each sample shipment. The reports are filled out in a legible manner, using waterproof ink, and are signed and dated by the sampler. Pertinent notes, such as whether the sample was field filtered or whether the sample is suspected to be high in contaminant concentration, are also indicated on the chain-of-custody report. Information similar to that contained in the chain-of-custody report is also provided on the sample label, which is securely attached to the sample bottle. Chain-of-custody report forms and sample labels will be supplied by the laboratory subcontractor. In accordance with NFESC guidelines, samples for chemical constituent analysis must be sent (for next-day receipt) to the laboratory within 24 hours of collection.

Full details regarding sample chain-of-custody (including use of custody seals and sample shipment protocols) are contained in TtNUS Corporate SOP SA-6.1, which is provided as Attachment 1. TtNUS

Corporate SOP SA-6.3, also provided in Attachment 1, discusses maintenance of site logbooks, site notebooks, and other field records. All sample records are eventually docketed into the TtNUS project central file.

6.2 LABORATORY CUSTODY PROCEDURES

When samples are received by the laboratory subcontractor, the laboratory's sample custodian examines each cooler's custody seals to verify that they are intact and that the integrity of the environmental samples has been maintained. The sample custodian then signs the chain-of-custody report. The custodian then opens the cooler and measures its internal temperature. The temperature reading is noted on the accompanying chain-of-custody report. The sample custodian then examines the contents of the cooler. Sample container breakages or discrepancies between the chain-of-custody report and sample label documentation are recorded. With the exception of samples for volatile analysis, the pH of chemically preserved samples is checked using pH paper and recorded. All problems or discrepancies noted during this process are to be promptly reported to the TOM (or designee). Inter-laboratory chain-of-custody procedures and specific procedures for sample handling, storage, disbursement for analysis, and remnant disposal will be followed as specified by the subcontract laboratory's SOPs and/or QA Plan.

The laboratory will maintain a hardcopy file of all analytical data associated with this project in a secure area. Access to the data will be limited to laboratory, TtNUS, and Navy personnel. The hardcopy files will be maintained by the laboratory for a minimum of 7 years.

6.3 FINAL EVIDENCE FILES

The TtNUS central file will be the repository for all documents that constitute evidence relevant to sampling and analysis activities as described in this QAPP. TtNUS is the custodian of the evidence file and maintains the contents of these files, including all relevant records, reports, logs, field notebooks, photographs, subcontractor reports and data reviews in a secure, limited-access location and under custody of the TtNUS facility manager. The control file will include at a minimum:

- Field logbooks
- Field data and data deliverables
- Photographs
- Drawings
- Soil boring logs
- Laboratory data deliverables
- Data validation reports
- Data assessment reports

- Progress reports, QA reports, interim project reports, etc.
- All custody documentation (chain-of-custody forms, airbills, etc.)

Upon completion of the contract, all pertinent files will be relinquished to the custody of the United States Navy.

7.0 CALIBRATION PROCEDURES AND FREQUENCY

All instrumentation used to perform chemical measurements must be properly calibrated prior to use in order to obtain valid and usable results. The requirement to properly calibrate instruments prior to use applies equally to field instruments and fixed laboratory instruments.

7.1 FIELD INSTRUMENT CALIBRATION

Field instrument calibration will not be required as part of this sampling program.

7.2 LABORATORY INSTRUMENT CALIBRATION

Calibration procedures for a specific laboratory instrument will consist of initial calibration (typically 3 to 5 calibration points) and continuing calibration verification. In all cases, the initial calibration will be verified using an independently prepared calibration verification solution. The frequency of calibration will be performed according to the requirements of the specific methods.

All standards used to calibrate analytical instruments must be obtained from the National Institute of Standards and Technology (NIST) or through a reliable commercial supplier with a proven record for quality standards. All commercially supplied standards must be traceable to NIST reference standards, where possible, and appropriate documentation will be obtained from the supplier. In cases where documentation is not available, the laboratory will analyze the standard and compare the results to a USEPA-supplied known or previous NIST-traceable standard.

The calibration procedures and frequencies used by the subcontract laboratory will comply with the applicable analytical method. Brief descriptions of calibration procedures for major instrument types follow.

For dioxin/furan compounds, the high resolution gas chromatograph/high resolution mass spectrometer (HRGC/HRMS) and bioassay photometer systems will be tuned and calibrated in accordance with the appropriate analytical method. A PFK instrument performance check (tuning check) must be run prior to the initial calibration and each continuing calibration and must meet all method-specified criteria before analysis may continue. Initial calibration is required before any samples are analyzed and must include a blank and a minimum of five different concentrations as specified in the method. A PFK tuning check and a continuing calibration check, including the mid-range standard and a blank, must be performed at the beginning of each 12-hour period during which analyses are performed.

8.0 ANALYTICAL AND MEASUREMENT PROCEDURES

Samples will be subjected to field and laboratory parameter measurement as necessary based on the sample matrix and location under investigation. The analytical program for environmental samples collected at each anticipated location is provided in Section 3.0 of the SAP.

The analytical laboratory responsible for the chemical analyses will be NFESC-approved, certified by the National Environmental Laboratory Accreditation Conference (NELAC) for all analyses requested by TtNUS. Documentation of the certifications will be provided to TtNUS as described in the TtNUS analytical Statement of Work for the contracted laboratory.

All environmental samples for dioxin/furan analysis will be analyzed in accordance with current SW-846 methods. All groundwater samples for miscellaneous parameter analyses will be analyzed in accordance with current USEPA approved methods. Table 8-1 provides a summary of the laboratory analytical methods for the NCBC Gulfport Site 8 Areas B and C sampling effort.

A complete list of the target compounds/analytes and RQLs is provided in Table 1-1 of this QAPP. Data generated through use of the SW-846 method protocols will be reported to the RQL for nondetected compounds from organics analysis. Compounds that are positively identified and that can be quantitated at concentrations less than the RQL but greater than the calculated method detection limit (MDL) will be reported as specified in the appropriate analytical method.

Quantitation and detection limits will also be adjusted, as necessary, based on dilutions and sample volume.

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TABLE 8-1

SUMMARY OF ANALYTICAL PROCEDURES
NCBC GULFPORT, MISSISSIPPI
SITE 8 QAPP

Analytical Parameter	Analytical Methods
Dioxins/Furans	SW-846 8290 SW-846 4025m

9.0 PREVENTIVE MAINTENANCE PROCEDURES

Measuring equipment used in environmental monitoring or analysis for the Site 8 verification sampling shall be maintained in accordance with the manufacturer's operation and maintenance manuals. Equipment and instruments shall be calibrated in accordance with the procedures and at the frequency discussed in Section 7.0 (Calibration Procedures and Frequency). Preventive maintenance for field and laboratory equipment is discussed in the remainder of this section.

9.1 FIELD EQUIPMENT PREVENTIVE MAINTENANCE

Field data collection will not be performed as part of this sampling program.

9.2 LABORATORY INSTRUMENT PREVENTIVE MAINTENANCE

Proper maintenance of laboratory instruments and equipment is essential to ensuring their readiness when needed. Dependent on manufacturer's recommendations, maintenance intervals are established for each instrument. All major instruments must be labeled with a model number and serial number, and a maintenance logbook must be maintained for each major instrument. Personnel must be alert to the maintenance status of the equipment they are using at all times.

9.2.1 Major Instruments

Table 9-1 provides a summary of preventive maintenance procedures typically performed for key analytical instruments. Maintenance of key instruments is sometimes covered under service contracts with external firms. These contracts provide for periodic routine maintenance to help guard against unexpected instrument downtime. The contracts also provide for quick response for unscheduled service calls when malfunctions are observed by the operator.

The use of manufacturer recommended grades or better of supporting supplies and reagents is also a form of preventive maintenance. For example, gases used in the various gas chromatographs and metals instruments should be of sufficient grade to minimize fouling of the instrument. The routine use of septa, chromatographic columns, ferrules, atomic adsorption furnace tubes, and other supporting supplies from reputable manufacturers will assist in averting unnecessary periods of instrument downtime.

9.2.2 Refrigerators/Ovens

The temperatures of refrigerators used for sample storage and drying ovens will be monitored a minimum of once daily. The acceptable range for refrigerator temperatures is 4°C ±2°C. Required temperatures of

ovens will vary based on the analytical methods for which the ovens are used. The temperatures will be recorded on temperature logs. The logs will contain the following information at a minimum:

- Date
- Temperature
- Initials of person performing the check

Maintenance of the logs is typically the responsibility of the sample custodian. However, assignment of responsibilities for temperature monitoring to specific personnel does not preclude the participation of other laboratory personnel. If unusual temperature fluctuations are noted, it is the responsibility of the observer to immediately notify the person in charge of the discrepancy before the condition of the samples is compromised.

Unstable or fluctuating temperatures may be indicative of malfunctions in the cooling or heating system. On the other hand, the instability may be due to frequent opening of the door. Regardless of the cause, such an observation must be investigated, and modifications must be made to access procedures, or repairs to equipment must be made to prevent jeopardizing the integrity of the samples.

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TABLE 9-1

TYPICAL PREVENTIVE MAINTENANCE FOR KEY ANALYTICAL INSTRUMENTS
NCBC GULFPORT SITE 8 QAPP, GULFPORT, MISSISSIPPI

Instrument	Preventive Maintenance	Maintenance Frequency
HRGC/HRMS	Bake oven, replace septum, check carrier gas, clip column, clean injection port.	As required.
	Replace solvent washes and clean syringe.	Daily.
Photometer	Clean contact cylinders, replace/clean tube, check lamp alignment.	As required

10.0 INTERNAL QUALITY CONTROL CHECKS

Field-related QC checks were discussed in Section 3.0 of this QAPP. This section provides additional information regarding internal QC checks for the field and the laboratory.

10.1 FIELD QUALITY CONTROL CHECKS

Field analytical parameters and analysis will not be performed as part of this sampling program.

10.2 LABORATORY QUALITY CONTROL CHECKS

The subcontract laboratory will have a QC program that ensures the reliability and validity of the analyses performed at the laboratory. Internal QC procedures for analyses will comply with the applicable analytical method requirements.

Several internal laboratory QC checks are briefly discussed in the remainder of this section.

Laboratory method blanks are prepared and analyzed in accordance with the analytical method employed to indicate whether contaminants originating from laboratory sources have been introduced and may have affected environmental sample analyses. A method blank generally consists of an aliquot of analyte-free water that is subjected to the same preparation and analysis procedures as the environmental samples undergoing analysis. With the exception of recognized volatile and semivolatile common laboratory contaminants (e.g., methylene chloride, acetone, 2-butanone, and phthalates) detected, method blanks must not contain levels of target analytes greater than the reported quantitation limits (greater than 2.5 times the RQL for methylene chloride and greater than 5 times the RQL for acetone, and 2-butanone). Under no circumstances are laboratory method blank contaminant values subtracted from environmental sample analysis results.

Matrix spike analysis for organic fraction analyses is performed in duplicate as a measure of laboratory precision. For dioxin/furan analyses, laboratory duplicates are prepared by thoroughly mixing and splitting a sample aliquot into two portions and analyzing each portion following the same analytical procedures that are used for the environmental sample analyses. The field crew provides extra volumes of sample matrices designated for laboratory quality control analyses, as required. Control limits for MS and laboratory duplicate analyses are discussed in Section 3.0 of this QAPP and are listed in Tables 3-1 through 3-4.

Surrogates are organic compounds (typically brominated, fluorinated, or isotopically labeled) that are similar in nature to the compounds of concern and that are not likely to be present in environmental media. Surrogates are spiked into each sample, standard, and method blank prior to analysis and are used only in organic chromatographic analysis procedures as a check of method effectiveness and extraction efficiency. As discussed in Section 3.0 of this QAPP, surrogate recoveries are evaluated against control limits specified in the associated method, where applicable, or laboratory-derived control limits.

LCSs monitor the overall performance of each step during the analysis, including the sample preparation. LCS analysis will be performed as required by the applicable analytical method. Aqueous LCS results must fall within the control limits specified in the analytical method, where applicable, or established by the laboratory. Aqueous LCSs shall be analyzed utilizing the same sample preparations, analytical methods, and QA/QC procedures as employed for the samples.

Internal standard performance criteria ensure that organic GC/MS and HPLC analysis sensitivity and response are stable during every analytical run. Internal standard area counts for samples and blanks must not vary by more than a factor of two (- 50 percent to + 100 percent) from the associated calibration standard. The retention time of the internal standards in samples and blanks must not vary by more than ±30 seconds from the retention time of the associated calibration standard.

11.0 DATA REDUCTION, VALIDATION, AND REPORTING

This section describes the procedures to be used for data reduction, review, and reporting for the NCBC Gulfport Site 8 verification sampling program. All data generated during the course of the investigation will be maintained in hardcopy format by TtNUS in the Naval Facilities Engineering Command Southern Division designated central files located in TtNUS' Pittsburgh, Pennsylvania office.

In addition to the central files, photocopies of all hardcopy data (as well as electronic data) will be maintained in the Chemistry/Toxicology/Risk Assessment Department database records files located in TtNUS' Pittsburgh, Pennsylvania office. Upon completion of the contract, all files will be relinquished to the Navy.

11.1 DATA REDUCTION

Data reduction will be completed for both field measurements and laboratory-generated analytical data. Field data reduction will be relatively limited compared to the degree of laboratory data reduction required for the project. Reduction of both field and laboratory data are discussed in the remainder of this section.

11.1.1 Field Data Reduction

Field data collection will not be performed as part of this sampling program.

11.1.2 Laboratory Data Reduction

Laboratory analytical data will be reported using standard concentration units to ensure comparability with regulatory standards/guidelines and previous analytical results. Reporting units for aqueous matrices for the classes of chemicals under consideration are as follows:

Soil Samples:

- Dioxins/furans – ng/kg

Field QC sample results will be included in the database for the NCBC Gulfport Site 8 verification sampling program. Specifically, the analytical results for field duplicates and rinsate blanks will be provided. The results for field QC samples will be considered during the course of data review (in concert with laboratory method blanks) to eliminate false positive results according to the 5- and 10-times rules specified in the National Functional Guidelines for Organic Review. The results for laboratory QC samples

such as method blanks will not be presented in the database. In addition, only the original (unspiked) sample results for MS/MSD samples will be provided in the database.

11.2 DATA VALIDATION

Validation of field measurements and laboratory analytical data are discussed in this section. Validation of field data will be limited to real-time checks as discussed in Section 11.2.1. Laboratory analytical data will be reviewed against data validation rules as discussed in Section 11.2.2.

11.2.1 Field Measurement Data Validation

Field data collection will not be performed as part of this sampling program

11.2.2 Laboratory Data Review

One hundred percent of the laboratory data will undergo a full data validation. A full data validation evaluates items including, but not limited to the following: sample holding times, method blank analyses, initial and continuing calibration standards, data completeness, reported detection limits, LCS analysis, MS/MSD analysis, and duplicate sample analyses. Review of analytical data will be completed by the TtNUS Chemistry Department located in TtNUS' Pittsburgh, Pennsylvania office. Final review and approval of reviewed deliverables will be completed by the Department's Data Validation Manager. The TOM will maintain contact with the Data Validation Manager to ensure that management of the acquired data proceeds in an organized and expeditious manner.

Organic data analytical results will be reviewed versus the applicable analytical method. Data will be accepted, rejected, or qualified based on the results of the limited review items. Guidelines established in the USEPA National Functional Guidelines for Chlorinated Dioxin/Furan Data Review (August 2002) and the NFESC Navy Installation Restoration Chemical Data Quality Manual (September 1999) will be used as guidance to define the criteria for the full data validation items.

11.3 DATA REPORTING

11.3.1 Field Measurement Data Reporting

Field data collection will not be performed as part of this sampling program.

11.3.2 Laboratory Data Reporting

Data reported by the laboratory will be in accordance with the reporting format described in TtNUS' analytical Statement of Work for the contracted laboratory. All pertinent QC data including method blanks, standards analysis, calibration information, etc. will be provided for the non-SW-846 method analyses. Case narratives and a certificate of analysis will be provided for each Sample Delivery Group (SDG).

All environmental and field QC sample results (field duplicates and rinsate blanks) will be included in the report as an appendix. The database will include pertinent sampling information such as sample number, sampling date, general location, depth, and survey coordinates (if applicable). Sample-specific detection limits will be reported for nondetected analytes. Units will be clearly summarized in the database and will conform to those identified in Section 11.1.2. The analytical data may also be reported in summary fashion within the body of the report text in tabular and graphic fashion.

Data will be handled electronically pursuant to the electronic deliverable requirements specified in TtNUS' purchase order with analytical laboratories. This agreement requires the analytical laboratories to provide data in both hardcopy and electronic form. The laboratory will provide a 28-calendar-day turnaround time for the delivery of the SDG in both hardcopy and electronic format. The original electronic diskettes and the original hardcopy analytical data are maintained in TtNUS' Southern Division central files as received.

Data review will be completed using the hard copy data. Upon completion of the review of a SDG and review by the Data Validation Manager, review qualifiers will be entered in the electronic database and will be subjected to independent review for accuracy. During this review process, the electronic database printout will also be contrasted with the hard copy data to ensure that the hard copy data and electronic data are consistent.

In addition, a summary of the data qualifiers for all project samples will be prepared. This summary will include a list of chemicals identified as laboratory and/or field QC blank contaminants, holding time exceedences, samples exhibiting field duplicate/replicate imprecision as well as affected chemicals, rejected results and associated specific causes, and general causes of estimated results. This summary will facilitate the preparation of a summary of the data review results and completeness assessment for inclusion in the report.

12.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, COMPLETENESS, FIELD DUPLICATES, AND DATA USABILITY

Compliance with the QC objectives outlined in Section 3.0 will be monitored via two separate mechanisms. Precision and accuracy will be assessed through data, while compliance with the completeness objectives for field and laboratory data/measurement will be calculated by hand (field measurements) and electronically via a database subroutine (laboratory data). Information necessary to complete the precision and accuracy calculations will be provided in electronic and hardcopy form by the subcontract laboratory. Equations to be used for the precision, accuracy, and completeness assessment are outlined in the remainder of this section.

12.1 ACCURACY ASSESSMENT

To assure the accuracy of the analytical procedures, a minimum of one of every 20 samples is spiked with a known amount of the analyte or analytes to be evaluated. The spiked sample is then analyzed. The increase in concentration of the analyte observed in the spiked sample, because of the addition of a known quantity of the analyte, compared to the reported value of the same analyte in the unspiked sample determines the %R. Control charts are plotted for each commonly analyzed compound and kept on matrix-specific and analyte-specific bases. The %R for a spiked sample is calculated according to the following formula:

$$\%R = \frac{\text{Amount in Spiked Sample} - \text{Amount in Sample}}{\text{Known Amount Added}} \times 100\%$$

12.2 PRECISION ASSESSMENT

Duplicate and MS/MSD samples are prepared and analyzed at a minimum frequency of one per 20 environmental samples. Duplicate samples are provided by the field crew.

MS/MSD samples are prepared by spiking each of the aliquots with a known amount of analyte. The duplicate samples are handled in the same manner as the other environmental samples included in the analytical sample set. The RPD between the sample (or MS) and duplicate sample (or MSD) is calculated and plotted. The RPD is calculated according to the following formula:

$$RPD = \frac{\text{Amount in Sample} - \text{Amount in Duplicate}}{0.5\,(\text{Amount in Sample} + \text{Amount in Duplicate})} \times 100\%$$

12.3 COMPLETENESS ASSESSMENT

Completeness is the ratio of the number of valid sample results to the total number of sample results expected to be obtained for the project as a whole. Following the completion of the analytical testing and data validation, the percent completeness will be calculated by the following equation:

$$\text{Completeness} = \frac{\text{(number of valid measurements)}}{\text{(number of measurements planned)}} \times 100\ \%$$

The results of the data validation process and the completeness assessment will be summarized in the report using the summary format discussed in Section 11.3.2 and an electronic database subroutine.

12.4 FIELD DUPLICATE ASSESSMENT

Field duplicate sample results and their associated sample results will be assessed using the calculated average of the two results when performing risk and ecological assessments.

$$\text{Average} = \text{(sample result + duplicate result)} \times 0.5$$

12.5 DATA USABILITY ASSESSMENT

Data validation, accuracy, precision, completeness, and duplicate assessments are completed with regards to specific criteria. The results of the validation and assessments are applied to project-specific standards that determine the usability of the data. The impact of any rejected data must be addressed to determine if the overall project objective has been compromised. This section details the technical criteria on which the validation and assessments are based, the project-specific standards applied to the "qualified data", and the impact of rejected data on the overall project objective.

Technical Criteria

Accuracy, precision, and duplicate assessments (the calculations are detailed in Sections 12.1, 12.2, and 12.4, respectively) are based on the technical criteria listed in Section 3 of this QAPP. A completeness assessment if also performed. The data must be a 95 percent complete (the calculation is detailed in Section 12.3) to fulfill the completeness standard as stated in Section 3.3 of this QAPP. Guidelines established in the USEPA National Functional Guidelines for Chlorinated Dioxin/Furan Data Review (August 2002) and the NFESC Navy Installation Restoration Chemical Data Quality Manual (September 1999) will be used as guidances to define the criteria for the data validation. The results of the assessments and the validation provide the data user with "qualified data".

Standards

Project-specific standards addressed in this section are used to determine the usability of the qualified data. The following list details the standards to be used when determining the usability of the data:

- Any data collected using procedures not specified in the SAP and without prior approval from the TOM will be rejected.

- If the completeness assessment returns a value of less than 95 percent complete, all data will be rejected.

- Any data point rejected during the data validation or assessments will not be used.

- If a data point is qualified as estimated during the validation or assessments the following tests will be implemented:

  1. Will the qualified result affect any decisions for the project or site?

     - No – then the result is rejected and not included.
     - Yes – continue to Test #2.

  2. Could the result be biased high?

     - No – continue to Test #3.
     - Yes – continue to Test #4.

  3. Could the result be biased low?

     - No – then the result is accepted and included.
     - Yes – continue to Test #4.

  4. If the result is biased high or low, how will the result affect the decisions for the project or site?

     - If a biased high contamination result will result in the exceedence of MCLs, the result will be rejected and the original sample location will be resampled.
     - If a biased high contamination result will result in no exceedence of MCLs, the result will be accepted and included.
     - If a biased low contamination result will result in no exceedence of MCLs, the result will be rejected and the original sample location will be resampled.
     - If a biased low contamination result will result in the exceedence of MCLs, the result will be accepted and included.

- For any 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) result that is classified as an estimated maximum possible concentration (EMPC), the result will either be reported as a positive detection or the original sample location will be resampled and the new TCDD result will be accepted as the new sample result.

- For a dioxin or furan congener other than TCDD that is classified as an EMPC, the result will be reported as a non-detected value.

Using these standards to determine the usability of the data will ensure that the integrity of the project objective is maintained. Maintaining the project objective will ensure accurate decisions are made when determining the most appropriate action for the project or site. Rejected data must be considered to determine its impact on project decisions.

Rejected Data

Rejected data can have significant impact on the decisions that will determine the status of the project or site. Specific questions about the rejected data must be addressed and answered before making any final decisions. Question to be addressed about rejected data is:

Is it possible that MCLs will not be exceeded when the rejected data is not included?

- Yes – Additional data will be collected to determine if non-rejected data will or will not exceed MCLs.
- No – Additional data will not be collected. Final decisions will be made without the rejected data.

Answers to this question will determine if and how the project objective will be met.

Using technical criteria to determined the validity of the collected data, project-specific standards to determine the usability of the qualified data, and determining the impact of rejected data on project objectives will ensure that quality data and informed decisions are made with respect to the project objective and future studies at the site.

13.0 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits will be performed periodically to ensure that work is being implemented in accordance with the approved project plans and in an overall satisfactory manner. Such audits will be performed by various personnel and will include evaluation of field, laboratory, data review, and data reporting processes. Examples of pertinent audits are as follows:

- The FOL will supervise and check daily that the field measurements are made accurately, equipment is thoroughly decontaminated, samples are collected and handled properly, and fieldwork is documented accurately and neatly.

- Performance and system audits of the laboratory will be performed regularly (every 18 months) by a Navy Contractor (internal) and in accordance with the Laboratory Quality Assurance Plan (internal).

- Data reviewers will evaluate (on a timely basis) the chemical analytical data packages submitted by the laboratory. The data reviewers will check that the data were obtained through use of an approved methodology, that the appropriate level of QC effort and reporting was conducted, and whether or not the results are in conformance with QC criteria. Based on these factors, the data reviewer will generate a report describing data limitations, which will be reviewed internally by the Data Validation Manager prior to submittal to the TOM.

- A formal audit of the field sampling procedures may be conducted by the TtNUS QAM or designee in addition to the auditing that is an inherent part of the daily project activities. The purpose of this audit is to ensure that sample collection, handling, and shipping protocols and equipment decontamination and field documentation procedures are being performed in accordance with the approved project plans and SOPs. An audit will be performed if the TtNUS TOM, TtNUS QAM, Navy Remedial Project Manager, or USEPA or MDEQ Regulator develops concerns with regards to the field sampling effort.

14.0 CORRECTIVE ACTION

Under TtNUS' QA/QC program, it is required that any and all personnel noting conditions adverse to quality report these conditions immediately to the TOM and the QAO. These parties, in turn, are charged with performing root-cause analyses and implementing appropriate corrective action in a timely manner. It is ultimately the responsibility of the QAO to document all findings and corrective actions taken and to monitor the effectiveness of the corrective measures performed.

14.1 FIELD CORRECTIVE ACTION

Field nonconformances or conditions adverse to quality must be identified and corrected as quickly as possible so that work integrity or quality of product is not compromised. The need for corrective action may arise based on deviations from project plans and procedures, adverse field conditions, or other unforeseen circumstances. Corrective action needs may become apparent during the performance of daily work tasks or as a consequence of internal or external field audits.

Corrective action may include resampling and may involve amending previously approved field procedures. If warranted by the severity of the problem (e.g., if a change in the approved project plan documents or SOPs is required), the Navy will be notified in writing via a Field Task Modification Request (FTMR), and Navy (in conjunction with USEPA Region IV) approvals will be obtained. The FOL is responsible for initiating FTMRs; an FTMR will be initiated for all deviations from the project plan documents, as applicable. An example of an FTMR is provided as Figure 14-1. Copies of all FTMRs will be maintained with the on-site project planning documents and will be placed in the final evidence file.

Minor modifications to field activities such as a slight offset of a boring location will be initiated at the discretion of the FOL, subject to on-site approval by NCBC Gulfport personnel. Approval for major modifications (e.g., elimination of a sampling point) must be obtained via an FTMR.

14.2 LABORATORY CORRECTIVE ACTION

In general, laboratory corrective actions are warranted whenever an out-of-control event or potential out-of-control event is noted. The specific corrective action taken depends on the specific analysis and the nature of the event. Generally, the following occurrences alert laboratory personnel that corrective action may be necessary:

- QC data are outside established warning or control limits.
- Method blank analyses yield concentrations of target analytes greater than acceptable levels.

- Undesirable trends are detected in spike recoveries or in duplicate RPDs.
- There is an unexplained change in compound detection capability.
- Inquiries concerning data quality are received.
- Deficiencies are detected by laboratory QA staff audits or from performance evaluation sample test results.

Corrective actions are typically documented for out-of-control situations on a corrective action form. Using a corrective action form, any employee may notify the QAO of a problem. The QAO generally initiates the corrective action by relating the problem to the appropriate Laboratory Manager and/or Internal Coordinator who then investigates or assigns responsibility for investigating the problem and its cause. After an appropriate corrective action is determined, it is approved by the QAO. Its implementation is verified and documented on the corrective action form and is further documented through audits.

14.3 CORRECTIVE ACTION DURING DATA REVIEW AND DATA ASSESSMENT

The need for corrective action may become apparent during data review and assessment. Data is sometimes qualified or rejected due to deviances from project SOPs or project-specific control limits. Section 12.5 details the technical criteria and project-specific standards used when determining the usability of the data. The impact of rejected data and corrective actions to be used when data is rejected is also discussed in Section 12.5. The performance of rework or instituting a change in work procedures are possible corrective actions relevant to data evaluation activities. The TOM will be responsible for approving the implementation of corrective action.

FIGURE 14-1

TETRA TECH NUS, INC.
FIELD TASK MODIFICATION REQUEST FORM

_____ Client Identification

_____ Project Number

_____ FTMR Number

To_____ Location_____ Date_____

Description:

_____
_____
_____
_____

Reason for Change:

_____
_____
_____
_____

Recommended Disposition:

_____
_____
_____
_____

_____
Field Operations Leader (Signature, if applicable) Date

Disposition:

_____
_____
_____
_____

_____
Task Order Manager (Signature, if required) Date

_____
Distribution:
Program Manager
Quality Assurance Officer
Task Order Manager
Field Operations Leader

Others as required_____
_____
_____
_____

15.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

QA reports to management will be provided in three primary formats during the course of the NCBC Gulfport Site 8 verification sampling program. Data review letter reports will be prepared on a SDG-specific basis and will summarize QA issues for the subcontract laboratory data. In addition, written weekly reports summarizing accomplishments and QA/QC issues during the field investigation will be provided by the FOL. Finally, monthly progress reports are provided by the TOM. In addition, a summary of data review qualifiers and a completeness assessment for all project samples will be prepared.

15.1 CONTENTS OF PROJECT QUALITY ASSURANCE REPORTS

The contents of the specific QA reports are as follows. The data review reports address major and minor laboratory noncompliances as well as noted sample matrix effects. In the event that major problems occur with the analytical laboratory (e.g., holding time exceedences or calibration noncompliances, etc.) the Data Validation Manager will notify the TOM and the Laboratory Services Coordinator. Such notifications (if necessary) are typically provided via internal memoranda and are placed in the project file. Such reports contain a summary of the noncompliance, a synopsis of the impact on individual projects, and recommendations regarding corrective action and compensational adjustments. Corrective actions are initiated at the program level.

The FOL will provide the TOM with weekly reports regarding accomplishments, deviations from the SAP, upcoming activities, and a QA summary during the course of the field investigation. In addition, monthly project review meetings are held for all active Navy CLEAN III projects. Issues discussed at the project review meeting include all aspects of budget and schedule compliance and QA/QC problems. The TOM provides a monthly progress report to the Navy, which addresses the project budget, schedule, accomplishments, planned activities, required revisions of the QAPP, and QA/QC issues and intended corrective actions.

15.2 INDIVIDUALS RECEIVING/REVIEWING QUALITY ASSURANCE REPORTS

Data review QA Reports are provided to the TOM for inclusion in the project files. In the event that major problems are observed for a given laboratory, the Program Manager, Deputy Program Manager, QAM, TOM, QAO, and Laboratory Services Coordinator are provided with copies of the QA report. Weekly field progress reports are provided to the TOM. Monthly progress reports are provided to the Navy CLEAN III Program Manager and the Navy CLEAN III Contracting Officer's Technical Representative.

GUIDANCE DOCUMENT

VERIFICATION OF SOIL REMEDIATION

DNR

ENVIRONMENTAL RESPONSE DIVISION

WASTE MANAGEMENT DIVISION

APRIL 1994, Revision 1

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DNR--GUIDANCE DOCUMENT, PART 1

SMALL SITE SOIL CLEANUP VERIFICATION (LESS THAN 10,890 SQUARE FEET)

Part 1 of this document is a guide for a biased sampling strategy to verify that soil contamination has been remediated at sites no greater than 0.25 acres (small sites). Soil sampling and analyses to verify that a site remediation is complete can result in two basic errors.

- Declaring a site clean when it is contaminated
- Declaring a site contaminated when it is clean

A soil sampling plan submitted to the DNR must minimize these errors. Part 1 presents a biased sampling method of verifying soil remediation at small sites. The biased sampling approach specified in this guidance recommends soil sampling from areas most likely to still exceed cleanup criteria. The location of the soil sample points relies on a site specific analysis of the released or contaminant distribution and the soil types encountered. The remediation is verified using a point by point comparison of sample values with the appropriate cleanup criteria. If the cleanup criteria are exceeded at any sampled point, the biased sampling methodology may require additional remediation at that point until the criteria are met. Verification of cleanup utilizing the biased approach should generally require fewer samples to demonstrate attainment than by using the unbiased approach. DNR will evaluate other sampling and statistical strategies on a case-by-case basis.

Any biased sampling plan, whether presented in the guidance document or some other geostatistical approach, requires professional judgment. Therefore, documentation and the rationale used to select sample locations are extremely important. The report section (page 9) of this guidance document should be carefully followed.

Compositing samples for verifying soil remediation is not acceptable without prior DNR approval. When verifying a soil remediation is complete, contaminant concentrations will be low. Compositing may result in the contaminant concentrations not being representative of what remains in the soil. If concentrations are low, compositing may dilute the concentrations of a contaminant to below its threshold detection limit. Additionally, if contamination is indicated in a composited sample, the location of the contamination remains unknown.

Part 1 is divided into five main sections: Verifying Excavation Remedies, Verifying In-Situ and Ex-Situ Soil Remedies, Sample Analysis, Background Soil Samples, and Reports. The excavation and in-situ remediations require different strategies for verification. Guidance is presented for statistically determining background concentrations of compounds/contaminants. Guidance for reporting all appropriate information is presented to facilitate remediation approval.

VERIFYING EXCAVATION REMEDIES

Verifying that contaminated soil is remediated by means of excavation requires samples from the excavation bottom and sidewalls. Tables and formulas presented provide the minimum number of samples necessary to verify cleanup for various size excavations. The biased approach specified in this guidance recommends soil sampling from areas most likely to still exceed cleanup criteria. The location of the sample collection points relies on site specific analysis of the release or contaminant distribution and the soil types encountered in the excavation. The minimum number of excavation floor and sidewall samples required to demonstrate verification using a point by point comparison with the cleanup criteria are specified. If the cleanup criteria are exceeded at any point, this verification methodology may require additional excavation at that point until the criteria are attained.

Sampling and analyzing the locations most likely to have contaminants can minimize the number of samples needed to verify remediation is complete. Since professional judgment and site specific knowledge are required for selecting sampling locations, the rationale used to select these locations must be documented in the verification report.

SAMPLE LOCATIONS

Using a biased sampling approach, samples must be collected where they will most likely encounter contamination which could exceed the cleanup criteria. This will minimize the number of samples needed to verify a site is remediated. A sampling strategy that uses bias to choose sample locations is recommended. While it is inappropriate for this guidance document to dictate exact locations for sample collection in this strategy, site specific information (e.g., the location of leaks in an underground storage tank or its piping) from the remedial investigation concerning the release and soil conditions should be used along with professional judgment and the general guidance provided here to select appropriate soil sampling locations.

EXAMPLE: It would be incorrect to sample the north side of an excavation pit as extensively as the south side when the leak was confirmed on the south side of the tank.

Because a site must be remediated to a certain degree before approval can be considered, an analysis of data generated by a prior investigation should yield information for the verification analysis. The field personnel present during remediation should be sufficiently familiar with the conditions on-site to implement an appropriate verification strategy. A soil verification strategy should incorporate all pertinent biases of a site which may include, but are not limited to, those listed below.

- preferential pathways of contaminant migration
- source areas
- stained soils
- other site specific "clues" (e.g., fractures in clays)
- changes in soil characteristics (e.g., sand/clay interfaces)
- soil types and characteristics

NUMBER OF SAMPLES

The following tables are used to determine the minimum number of samples necessary from the floor and sidewalls of an excavation no greater than 0.25 acres using a biased sampling approach. If the area of the excavation floor exceeds 10,890 square feet, use Part 2 of this guidance document. A site may have an appropriate number of samples collected for verification, but, if the samples are not collected from the appropriate locations (discussed previously) and adequately reported, remediation may not be considered adequate. All sample locations must be accurately located, described, and reported. It should be noted that "excavation" as used here refers only to that area excavated for remediation purposes and being verified to meet Type A/Type B cleanup criteria.

Number of Excavation Floor Samples

Determine the minimum number of excavation floor samples from the table below.

TABLE 1
EXCAVATION FLOOR SAMPLES

Area of Floor (sq ft)	*Number of Samples*
< 500	2
500 < 1,000	3
1,000 < 1,500	4
1,500 < 2,500	5
2,500 < 4,000	6
4,000 < 6,000	7
6,000 < 8,500	8
8,500 <10,890	9

Number of Excavation Sidewall Samples

Sidewall samples are required to verify that the horizontal extent of contamination has been remediated. Use Table 2 to determine the minimum number of required sidewall samples. In no case is less than one sample on each sidewall (i.e., four) acceptable. In the case of irregularly shaped excavations, where four walls are not readily discernible, divide the total wall area into four segments of approximately equal size. Sidewall samples should be located in accordance with "biases" outlined earlier in Part 1.

TABLE 2

EXCAVATION SIDEWALL SAMPLES

Total Area of Sidewalls (sq ft)	*Number of Samples*
< 500	4
500 < 1,000	5
1,000 < 1,500	6
1,500 < 2,000	7
2,000 < 3,000	8
3,000 < 4,000	9
> 4,000	1 sample per 45 lineal feet of sidewall

VERIFYING IN-SITU AND EX-SITU SOIL REMEDIES

The effectiveness of in-situ soil remedies must be verified by three-dimensional random soil sampling. Refer to Attachment 2 for approved statistical sampling strategies. Certain ex-situ remedies, such as bio-piles or above-ground vapor extraction, may be amenable to statistical sampling strategies or batch sampling. Any proposed sampling strategy for in-situ or ex-situ remedies should be pre-approved by the DNR.

SAMPLE ANALYSIS

All test methods and associated target detection levels for cleanup verification must be consistent with those specified in MERA Operational Memorandum #6. Also, MERA Operational Memorandum #13 may be reviewed to evaluate appropriate QA/QC procedures. Generally, constituents in soil will be measured on a total, dry weight basis.

BACKGROUND SOIL SAMPLES

ESTABLISHING SOIL BACKGROUND

Establishing soil background, as required by Act 307 PA 1982, as amended, Michigan Environmental Response Act (MERA), can be accomplished by utilizing Operational Memorandum #15 or using the following guidance.

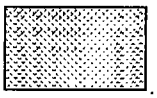
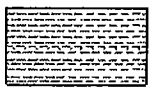
Background should be established as appropriate for site specific waste constituents, specific chemicals used in various processes, facility operations, or remedial investigation results. Sample analyses may include metals, organic constituents, or other site specific waste constituents. Analyses should be in accordance with MERA Operational Memorandum #6

Many factors can play a part in the background concentrations of a chemical in soil.

EXAMPLE: The geologic origin (e.g., the parent rock) of glacial drift may have been high in copper, lead, or other metals that may be potential contaminants. Additionally, the hydrogeologic situation can alter the quantity of these elements. Groundwater recharge areas (e.g., highlands) are frequently leached of metals while groundwater discharge areas (e.g., swamps, floodplain) are the recipients of leached metals. Thus, sites in low areas will usually have higher background concentrations than upland areas. Other conditions, such as precipitation and atmospheric fallout from widely dispersed human and natural activities, also affect soil concentrations.

A minimum of four samples must be used to establish "background" in soils. This will help account for natural constituent occurrences and inherent variability within each distinctive soil horizon. Background samples must be collected in an area which has not been impacted by environmental contamination from the site and representative of natural background conditions. Based on waste type, contaminant mobility, operation practices, and soil type (sand, silty sand, clay), an estimate of contamination depth should be made and background samples taken at comparable depths for the particular soil type. Multiple soil horizons should have "background" established separately (e.g., minimum of four samples per each soil unit).

EXAMPLE:

	Ground Surface	
Brown medium-coarse SAND		4 samples
Lt. brown silty fine SAND		4 samples
Gray silty CLAY w/trace of fine-med sand		4 samples

STATISTICAL ANALYSIS FOR ESTABLISHING BACKGROUND CONCENTRATIONS

The recommended statistical method for establishing background concentrations at small sites is (1) establishing the upper limit of background concentration of a constituent at the mean plus 3 standard deviations or (2) other statistical methods submitted to DNR for approval.

1. *Mean Plus 3 Standard Deviation Approach*

Calculate the "upper limit" of background concentration by using the following 5 step process.

A. Calculate the background mean ($\overline{X_b}$) by dividing the sum of the total background readings by the total number of background readings:

$$\overline{X_b} = \frac{X_1 + X_2 + \ldots X_n}{n}$$

B. Calculate the background variance (S_b^2) by taking the sum of the squares of each reading minus the mean and dividing by the degrees of freedom (the total number of background samples minus one):

$$S_b^2 = \frac{(X_1 - \overline{X}_b)^2 + (X_2 - \overline{X}_b)^2 + \ldots + (X_n - \overline{X}_b)^2}{n-1}$$

NOTE: Any sample populations less than (n<30 samples) must use n - 1 for degrees of freedom

C. Calculate the background standard deviation (S_b) by taking the square root of the variance:

$$Sb = \sqrt{S_b^2}$$

D. The Coefficient of Variation Test (CV) where

$$CV = \frac{S_b}{\overline{X}_b}$$

is used to evaluate data distribution. The background data should generally have a CV of less than 0.5 for granular soils, less than 0.75 for cohesive soils, or an explanation accounting for higher CV values. The maximum recommended CV is 1. If the data distribution exceeds a CV of 1.0, then a thorough evaluation will need to be made to account for this variability (e.g., lab QA/QC, typographical errors, soil classification, sample location, data not normally distributed, etc.). If the CV exceeds 1.0 and there is sufficient evidence to suggest a data point does not accurately represent background conditions or if QA/QC problems exist which invalidate that data point, the outlier data may be dropped or additional samples collected and analyzed to ensure a sufficient representative data population (n) is achieved. A high concentration in and of itself is not sufficient justification to exclude the data point.

E. Use the $\overline{X_b} + 3*S_b$ of "background" data as the maximum allowable limit or upper limit. Where $3*S_b$ equals three times the standard deviation and $\overline{X_b}$ equals the background mean (this statistical method only requires one sample per station). Compare each sample point to the calculated maximum allowable limit or upper limit analyzed from background data.

EXAMPLE: Four sand samples from a site were analyzed for background concentrations for lead. Concentrations of lead from the sample analyses returned from the lab were 56, 25, 18, and 35 ppb. Now, the investigator wants to examine the data set to discover whether the 56 ppb sample is an outlier:

$$\overline{X}_b \; mean = \frac{56+25+18+35}{4} = 33.5$$

$$S_b^2 = \frac{[56-33.5]^2 + [25-33.5]^2 + [18-33.5]^2 + [35-33.5]^2}{3} = 273.67$$

$$S_b = (standard\ deviation) = \sqrt{S_b^2} = 16.5$$

$$CV = \frac{16.5}{33.5} = 0.49$$

Because 0.49 is less than 0.5, no further evaluation of the background data set is necessary.

Therefore, the background upper limit value for this site is:

$$background\ upper\ limit = \overline{X}_b + (3*S_b) = 33.5 + (3 * 16.5) = 83.0\ ppb$$

If a value is found to be an outlier which is not representative of background conditions, it may be replaced by another sample that is not an outlier to maintain at least four samples for background determination.

2. *Other statistical procedures for establishing background.* Refer to a statistical reference book or US EPA's Interim Final Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities (April 1989) and Addendum (July 1992).

PROCEDURES FOR NON-DETECT VALUES

The following provides some guidelines in incorporating non-detectable sample results into the procedure to calculate background concentrations.

1. If less than 50% of the background data is below the detection limit (DL), use ½ of the detection limit as the value.

2. If more than 50% of the background data is below the detection limit, use one of the following procedures.

   - Alternate "0" and the detection limit (DL) resulting in a net value of of the detection limit with a variance.

EXAMPLE:	Actual Value	Substitute Value
	<DL	DL
	<DL	0
	<DL	DL
	<DL	0

   - The Continuity Correction procedure with the t-test, Cohen's method, or other approved methods.

Line/Col.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
101	13284	16834	74151	92027	24670	36665	00770	22878	02179	51602	07270	76517	97275	45960
102	21224	00370	30420	03883	96648	89428	41583	17564	27395	63904	41548	49197	82277	24120
103	99052	47887	81085	64933	66279	80432	65793	83287	34142	13241	30590	97760	35848	91983
104	00199	50993	98603	38452	87890	94624	69721	57484	67501	77638	44331	11257	71131	11059
105	60578	06483	28733	37867	07936	98710	98539	27186	31237	80612	44488	97819	70401	95419
106	91240	18312	17441	01929	18163	69201	31211	54288	39296	37318	65724	90401	79017	62077
107	97458	14229	12063	59611	32249	90466	33216	19358	02591	54263	88449	01912	07436	50813
108	35249	38646	34475	72417	60514	69257	12489	51924	86871	92446	36607	11458	30440	52639
109	38980	46600	11759	11900	46743	27860	77940	39298	97838	95145	32378	68038	89351	37005
110	10750	52745	38749	87365	58959	53731	89295	59062	39404	13198	59960	70408	29812	83126
111	36247	27850	73958	20673	37800	63835	71051	84724	52492	22342	78071	17456	96104	18327
112	70994	66986	99744	72438	01174	42159	11392	20724	54322	36923	70009	23233	65438	59685
113	99638	94702	11463	18148	81386	80431	90628	52506	02016	85151	88598	47821	00265	82525
114	72055	15774	43857	99805	10419	76939	25993	03544	21560	83471	43989	90770	22965	44247
115	24038	65541	85788	55835	38835	59399	13790	35112	01324	39520	76210	22467	83275	32286
116	74976	14631	35908	28221	39470	91548	12854	30166	09073	75887	36782	00268	97121	57676
117	35553	71628	70189	26436	63407	91178	90348	55359	80392	41012	36270	77786	89578	21059
118	35676	12797	51434	82976	42010	26344	92920	92155	58807	54644	58581	95331	78629	73344
119	74815	67523	72985	23183	02446	63594	98924	20633	58842	85961	07648	70164	34994	67662
120	45246	88048	65173	50989	91060	89894	36063	32819	68559	99221	49475	50558	34698	71800
121	76509	47069	86378	41797	11910	49672	88575	97966	32466	10083	54728	81972	58975	30761
122	19689	90332	04315	21358	97248	11188	39062	63312	52496	07349	79178	33692	57352	72862
123	42751	35318	97513	61537	54955	08159	00337	80778	27507	95478	21252	12746	37554	97775
124	11946	22681	45045	13964	57517	59419	58045	44067	58716	58840	45557	96345	33271	53464
125	96518	48688	20996	11090	48396	57177	83867	86464	14342	21545	46717	72364	86954	55580

SAMPLING GRIDS

1. A grid system should be established over the specified area (sidewalls and base). Grid point representation should be proportioned to the size of the area. It is recommended that one of the following equations be used to determine grid intervals for stationing.

$$\text{small site: } \frac{\sqrt{A/\pi}}{2} = \text{GI}$$

$$\text{medium site: } \frac{\sqrt{A/\pi}}{4} = \text{GI}$$

$$\text{large site: } \sqrt{\frac{A\pi}{SF}} = \text{GI}$$

where: A = area to be grid (square feet)
GI = grid interval
SF = Site Factor, length of area to be grid (unitless)
π = 3.14159

It appears that there are logical size ranges of sites to which the grid equations apply:

A) small: up to 0.25 acre

B) medium: 0.25 3.0 acres

C) large: 3.0 acres and greater

To simplify this application, use the following chart based on an average size range of sites (1 acre = 43,560 square feet). The approximate grid ranges are provided as a quick check on numbers generated for specific sites using the above formulas.

*Site Acreage**	*Square Feet**	*~Grid Interval Ranges*
up to 0.25 (small)	up to 10,890	See Part 1
0.25-3.00 (medium)	10,890-130,680	15-50 feet
3.0 and over (large)	130,680 +	30 feet plus

* Site acreage, square footage, is total area of sidewalls and base of excavation.

2. After the grid interval is calculated, it is recommended that a scaled grid overlay be made to superimpose on a map of the remediated area (this area includes both sidewalls and base). Some specified point (usually the southwest corner) should be designated as the 0,0 coordinate. The grid can then be adjusted to maximize sampling coverage. Some grid adjustment may be necessary for unusually shaped areas.

STATISTICAL EVALUATION
WASTE/TREATMENT CHARACTERIZATION SAMPLINGS

Following is a step by step description of the approach used to calculate confidence limits based on the analytical data derived from the preliminary samples.

1. Calculate a preliminary estimate of the mean, $\overline{X}$

$$\overline{X} = \frac{\sum_{i=1}^{n} X_i}{n}$$

where: n = number of measurements
X = variable concentration
X_i = individual measurements

2. Calculate a preliminary estimate of the variance (S^2) and the standard deviation (S). Standard deviation is a function of both sampling variability and measurement variability.

$$S^2 = \frac{\sum_{i=1}^{n} X_i^2 - \frac{(\sum_{i=1}^{n} X_i)^2}{n}}{n-1}$$

$$S = \sqrt{S^2}$$

3. Calculate the standard error of the mean (S_x). Standard error is inversely proportional to the square root of the number of samples (increasing n from 4 to 16 reduces S_x by 50%).

$$S_x = \frac{S}{\sqrt{n}}$$

4. Since the concern is only whether the upper limit of a confidence interval is below or above the regulatory threshold, the lower confidence limit (LCL) need not be considered. The upper confidence limit (UCL) can be calculated using the onetailed (onesided) t values with n1 degrees of freedom derived from a table of the Student's t distribution. Where only small sized statistical samples are involved (n<30), the normal or Gaussian distribution is not accurate, and the t distribution must be used.

5. The 95% UCL is calculated by using the following formula and substituting the values determined above plus the appropriate t value obtained from the t table.

$$\text{UCL} = \overline{X} + [t_{0.95}(n-1)]S_x$$

The term in brackets indicates a one-tailed t-test at n-1 degrees of freedom. See the t-distribution table in Attachment 2.

The UCL number resulting from this formula will indicate with a 95% probability that it is either above or below the regulatory threshold (RT) developed for the constituent being subjected to the test. If a compound does not have a specified RT, then the UCL is compared to whatever concentration is of concern (i.e., a clean up level, action level, etc). Other confidence levels can be used, based on the specific sampling situation.

If the preliminary data indicate that more samples are needed to make a hazard determination, the Lambda relationship should be used. A step by step approach to calculating the appropriate sample size follows:

1. The appropriate number of samples to be collected can be estimated by use of the Lambda (λ) relationship and then consulting a table of values and their corresponding sample size number.

$$\lambda = \frac{RT - \overline{X}}{S}$$

The lower the calculated value, the more samples are required to maintain a certain level of confidence. Also, as $\overline{X}$ approaches RT, λ becomes smaller, and therefore a greater sample size is indicated for a certain level of confidence.

2. To obtain the appropriate sample size from the table of values, use the single sided value for to test at the desired significance level (for 5%, = 0.05).

3. Randomly collect any additional samples that may be needed using the same grid and random numbers sequence as the first sampling. All field and laboratory procedures should be kept as consistent as possible to lower the amount of variability in the data.

4. Use all data values to calculate new $\overline{X}$, S, and S_x.

5. If the new $\overline{X} \geq$ RT, then the contaminant is present at an unacceptable concentration and the study would be complete.

6. If $\overline{X}$ < RT and $\overline{X} > S^2$, calculate C (the criterion for determining if contamination is present at hazardous concentration). If $\overline{X} = S^2$ or $\overline{X} < S^2$, the data must be transformed prior to calculating C.

Using the new data, C is calculated by the formula:

$$C = \frac{RT - \overline{X}}{S_x}$$

7. Compare the calculated C value to the twotailed t value for the level of significance desired. The two-tailed t-value is used because both the possibility that C is > t or that C is < t must be checked.

   Use $t_{0.95}$ and df (degrees of freedom) = n-1.

8. If C > t value, the contaminant is present at unacceptable concentrations and the study would be over. If C < t value, reestimate the total number of additional samples to be collected by deriving a new Lambda. Use the newly calculated values of X and S.

9. If this new number of samples is not more than 20% greater than the last set collected, there is little chance that additional samples would decrease Sx and result in the material being considered unacceptable. Therefore, the study would be complete.

EXAMPLE

CALCULATION OF CONFIDENCE LIMITS AND LAMDA CALCULATION

Problem 1: STATISTICAL SAMPLING

A metal plating factory has been discharging process wastewaters into a large nearby swampy area for several years. This swampy area drains into a small river. The discharged wastewaters are known to be contaminated with very low levels of cadmium and chromium (i.e., the levels in the wastewater are below the facilities NPDES permit limitations). However, it has been suspected that the sediments in this swampy area may contain high levels of cadmium and chromium. Three preliminary sediment samples were taken with a Ponar dredge and analyzed to determine whether or not these sediments were contaminated with hazardous levels of these two metals. In 40 CFR 261.24, it states that a waste is hazardous under the characteristic of EP toxicity if it contains cadmium at a level $\geq$1.0 mg/l or chromium at a level $\geq$5.0 mg/l. The analysis of the three preliminary samples indicated a mean cadmium concentration of 0.37 mg/l (3 samples at 0.25, 0.51, and 0.35 mg/l) and a mean chromium concentration of 4.66 mg/l (3 samples at 4.93, 4.21, and 4.84 mg/l). Based on this analytical data, the cadmium level is well below the regulatory threshold (RT), but the chromium level closely approaches its RT. Because large legal or monetary losses may be incurred if the sediments are declared hazardous, the analytical data must be sound and a high degree of confidence is necessary in any decision made.

QUESTIONS: Given the above scenario, answer the following questions and calculate the appropriate answers.

1. Based on the chromium data supplied

   Calculate S^2, S, Sx

   Calculate the 95% UCL

   With what degree of confidence can it be stated that the chromium concentration does not exceed the RT?

2. If more samples are deemed necessary, determine how many

   Calculate the Lambda value

   Calculate the appropriate number of additional samples using $\alpha = 0.05$ and $\beta = 0.05$

PROBLEM 1 ANSWER SHEET

Given three samples with chromium concentrations of 4.93, 4.21, and 4.84 mg/l and

$$\overline{X} = 4.66\ mg/l$$

(1a) Calculate S^2

$$S^2 = \frac{\sum_{i=1}^{n} X_i^2 - \frac{(\sum_{i=1}^{n} X_i)^2}{n}}{n-1}$$

$$= \frac{4.93^2 + 4.21^2 + 4.84^2 - (4.93 + 4.21 + 4.84)^2 / 3}{2}$$

$$= 0.15$$

Calculate S

$$S = \sqrt{S} = \sqrt{0.15} = 0.39$$

Calculate S_x

$$S_x = \frac{S}{\sqrt{n}} = \frac{0.39}{\sqrt{3}} = 0.23$$

(1b) Calculate the 95% UCL

$$\text{UCL} = \overline{X} + [t_{0.95}(n-1)]S_x$$

$$= 4.66 + (2.920)*(0.23)$$

$$= 5.33$$

(1c)

$$90\%\ \text{UCL} = \overline{X} + [t_{0.90}(n-1)]S_x$$

$$= 4.66 + (1.886)*(0.23)$$

$$= 5.09$$

$$80\%\ \text{UCL} = \overline{X} + [t_{0.80}(n-1)]S_x$$

$$= 4.66 + (1.061)*(0.23)$$

$$= 4.90$$

The preceding two calculations indicate that it can be stated with somewhere between 80% and 90% confidence that the chromium concentration does not exceed the RT. This degree of confidence may not be sufficient to meet the needs of the sampling plan. Therefore, more samples may need to be taken.

2a. Calculate the Lambda value

$$\lambda = \frac{RT - \overline{X}}{S} = \frac{5.0 - 4.66}{0.39} = 0.87$$

2b. Calculate the number of additional samples

Using Attachment 2, Number of Observations for t Test of Mean, page 36 of this Guidance Document, using a single-sided test with alpha=0.05 and ß=0.05, approximately 15 to 17 total samples need to be collected. Therefore, based on the three preliminary samples that were collected, an additional 13 samples need to be taken.

Cumulative t Distribution

	one-tailed	0.550	0.750	0.080	0.900	0.950	0.975	0.990	0.995
	two-tailed	0.100	0.500	0.600	0.800	0.900	0.950	0.980	0.990
					p				
	1	0.158	1.000	1.376	3.078	6.314	12.706	31.821	63.657
	2	0.142	0.816	1.061	1.886	2.920	4.303	6.925	9.925
	3	0.137	0.765	0.978	1.638	2.353	3.182	4.541	5.841
	4	0.134	0.741	0.941	1.533	2.132	2.776	3.747	4.604
	5	0.132	0.727	0.920	1.476	2.015	2.571	3.365	4.032
	6	0.131	0.718	0.906	1.440	1.943	2.447	3.143	3.707
	7	0.130	0.711	0.896	1.415	1.895	2.365	2.998	3.499
	8	0.130	0.706	0.889	1.397	1.860	2.306	2.896	3.355
	9	0.129	0.703	0.883	1.383	1.833	2.262	2.821	3.250
	10	0.129	0.700	0.879	1.372	1.812	2.228	2.764	3.169
	11	0.129	0.697	0.876	1.363	1.796	2.201	2.718	3.106
	12	0.128	0.695	0.873	1.356	1.782	2.179	2.681	3.055
	13	0.128	0.694	0.870	1.350	1.771	2.160	2.650	3.012
	14	0.128	0.692	0.868	1.345	1.761	2.145	2.624	2.977
	15	0.128	0.691	0.866	1.341	1.753	2.131	2.602	2.947
	16	0.128	0.690	0.865	1.337	1.746	2.120	2.583	2.921
	17	0.128	0.689	0.863	1.333	1.740	2.110	2.567	2.898
	18	0.127	0.688	0.862	1.330	1.734	2.101	2.552	2.878
df	19	0.127	0.688	0.861	1.328	1.729	2.093	2.539	2.861
(n-1)	20	0.127	0.687	0.860	1.325	1.725	2.086	2.528	2.845
	21	0.127	0.686	0.859	1.323	1.721	2.080	2.518	2.831
	22	0.127	0.686	0.858	1.321	1.717	2.074	2.508	2.819
	23	0.127	0.685	0.858	1.319	1.714	2.069	2.500	2.807
	24	0.127	0.685	0.857	1.318	1.711	2.064	2.492	2.797
	25	0.127	0.684	0.856	1.316	1.708	2.060	2.485	2.787
	26	0.127	0.684	0.856	1.315	1.706	2.056	2.479	2.779
	27	0.127	0.684	0.855	1.314	1.703	2.052	2.473	2.771
	28	0.127	0.683	0.855	1.313	1.701	2.048	2.467	2.763
	29	0.127	0.683	0.854	1.311	1.699	2.045	2.462	2.756
	30	0.127	0.683	0.854	1.310	1.697	2.042	2.457	2.750
	40	0.126	0.681	0.851	1.303	1.684	2.021	2.423	2.704
	60	0.126	0.679	0.848	1.296	1.671	2.000	2.390	2.660
	120	0.126	0.677	0.845	1.289	1.658	1.980	2.358	2.617
		0.126	0.674	0.842	1.282	1.645	1.960	2.326	2.576

NOTE: For one-tailed distributions $\alpha/2 = 1\text{-}p$
For two-tailed distributions $\alpha = 1\text{-}p$

NUMBER OF OBSERVATIONS FOR t TEST OF MEAN
Level for t Test

Single-sided	α=0.005	α=0.01	α=0.025	α=0.05
Double-sided	α=0.01	α=0.02	α=0.05	α=0.1

λ	β=0.01	0.05	0.1	0.2	0.5	0.01	0.05	0.1	0.2	0.5	0.01	0.05	0.1	0.2	0.5	0.01	0.05	0.1	0.2	0.5
0.05																				
0.10																				
0.15																				122
0.20										139					99					70
0.25					110					90				128	64			139	101	45
0.30				134	78				115	63			119	90	45		122	97	71	32
0.35			125	99	58			109	85	47		109	88	67	34		90	72	52	24
0.40		115	97	77	45		101	85	66	37	117	84	68	51	26	101	70	55	40	19
0.45		92	77	62	37	110	81	68	53	30	93	67	54	41	21	80	55	44	33	15
0.50	100	75	63	51	30	90	66	55	43	25	76	54	44	34	18	65	45	36	27	13
0.55	83	63	53	42	26	75	55	46	36	21	63	45	37	28	15	54	38	30	22	11
0.60	71	53	45	36	22	63	47	39	31	18	53	38	32	24	13	46	32	26	19	9
0.65	61	46	39	31	20	55	41	34	27	16	46	33	27	21	12	39	28	22	17	8
0.70	53	40	34	28	17	47	35	30	24	14	40	29	24	19	10	34	24	19	15	8
0.75	47	36	30	25	16	42	31	27	21	13	35	26	21	16	9	30	21	17	13	7
0.80	41	32	27	22	14	37	28	24	19	12	31	22	19	15	9	27	19	15	12	6
0.85	37	29	24	20	13	33	25	21	17	11	28	21	17	13	8	24	17	14	11	6
0.90	34	26	22	18	12	29	23	19	16	10	25	19	16	12	7	21	15	13	10	5
0.95	31	24	20	17	11	27	21	18	14	9	23	17	14	11	7	19	14	11	9	5
1.00	28	22	19	16	10	25	19	16	13	9	21	16	13	10	6	18	13	11	8	5
1.1	24	19	16	14	9	21	16	14	12	8	18	13	11	9	6	15	11	9	7	
1.2	21	16	14	12	8	18	14	12	10	7	15	12	10	8	5	13	10	8	6	
1.3	18	15	13	11	8	16	13	11	9	6	14	10	9	7		11	8	7	6	
1.4	16	13	12	10	8	14	11	10	9	6	12	9	8	7		10	8	7	5	
1.5	15	12	11	9	7	13	10	9	8	6	11	8	7	6		9	7	6		
1.6	13	11	10	8	6	12	10	9	7	5	10	8	7	6		8	6	6		
1.7	12	10	9	8	6	11	9	8	7		9	7	6	5		8	6	5		
1.8	12	10	9	8	6	10	8	7	7		8	7	6			7	6			
1.9	11	9	8	7	6	10	8	7	6		8	6	6			7	5			
2.0	10	8	8	7	5	9	7	7	6		7	6	5			6				
2.1	10	8	7	7		8	7	6	6		7	6				6				
2.2	9	8	7	6		8	7	6	5		7	6				6				
2.3	9	7	7	6		8	6	6			6	5				5				
2.4	8	7	7	6		7	6	6			6									
2.5	8	7	6	6		7	6	6			6									
3.0	7	6	6	5		6	5	5			5									
3.5	6	5	5			5														
4.0	6																			

99% confidence

95% confidence

SAMPLING PROCESS STREAMS

Although sampling is generally thought to occur on a pile of material or over an area of treated soil, other schemes are possible. The most common instance is when the material is to be sampled at the point of generation. This is the preferred method, since it is most representative of the material under study. The lack of exposure to elements that might cause chemical degradation and/or leaching will result in material most indicative of actual conditions.

A sampling point along the material conveyor that can be fairly easily and safely reached should be chosen. It should be in an area where the entire belt can be accessed for sampling. Under this scenario, a temporal, rather than a spatial, approach needs to be used.

Time stratum should be established over the course of the process day. Ideally, the entire active time of the line should be included in the sampling scheme. Once time strata are chosen, the random numbers table can be used to establish sampling times. For a four hour period, a point somewhere on the table would be chosen and every number greater than 0 but less than 240 would be selected until the number of samples for that strata were obtained. The number would relate to time in minutes. This would be added to the starting time for that strata to determine the time of sampling.

If the time strata chosen are of unequal lengths, the number of samples chosen from any one strata should reflect the percentage contribution that strata makes to the time frame as a whole. For example, if for a 24 hour operating time, strata 1 is 4 hours and strata 2 is 8 hours, strata 2 should have twice as many samples as strata 1.

When the appropriate sampling time arrives, the material from the conveyor belt point that had been identified would be removed. This material should be well mixed and a subsample taken for inclusion in the jar for lab analysis. An example of the use of this protocol is attached.

RANDOM TIME WASTE SAMPLING EXAMPLE

	Sampling Point	Random Minute	Time
Stratum #1			
6:00 to 8:00 hours	1	28	6:28
	2	62	7:02
	3	99	7:39
	4	112	7:52
Stratum #2			
8:00 to 20:00 hours	1	11	8:11
	2	107	9:47
	3	156	10:36
	4	173	10:53
	5	296	12:56
	6	313	13:13
	7	398	14:38
	8	497	16:17
	9	555	17:15
	10	600	18:00
	11	637	18:37
	12	706	19:46
Stratum #3			
20:00 to 22:00 hours	1	13	20:13
	2	52	20:52
	3	88	21:28
	4	108	21:48
Stratum #4			
8:00 to 20:00 hours	1	48	22:48
	2	113	23:53
	3	153	24:33
	4	189	1:09
	5	290	2:49
	7	314	3:14
	8	474	5:44

ATTACHMENT 3
TOLERANCE FACTORS (*K*)
TOLERANCE FACTORS (*K*) FOR ONE-SIDED NORMAL TOLERANCE INTERVALS WITH PROBABILITY LEVEL (CONFIDENCE FACTOR)
Y = 0.95 AND COVERAGE P = 95%

n	*K*	n	*K*
3	7.655	75	1.972
4	5.145	100	1.924
5	4.202	125	1.891
6	3.707	150	1.868
7	3.399	175	1.850
8	3.188	200	1.836
9	3.031	225	1.824
10	2.911	250	1.814
11	2.815	275	1.806
12	2.736	300	1.799
13	2.670	325	1.792
14	2.614	350	1.787
15	2.566	375	1.782
16	2.523	400	1.777
17	2.486	425	1.773
18	2.453	450	1.769
19	2.423	475	1.766
20	2.396	500	1.763
21	2.371	525	1.760
22	2.350	550	1.757
23	2.329	575	1.754
24	2.309	600	1.752
25	2.292	625	1.750
30	2.220	650	1.748
35	2.166	675	1.746
40	2.126	700	1.744
45	2.092	725	1.742
50	2.065	750	1.740
55	2.036	775	1.739
60	2.017	800	1.737
65	2.000	825	0.736
70	1.986	850	1.734
		875	1.733
		900	1.732
		925	1.731
		950	1.729
		975	1.728
		1000	1.727

SOURCE: FOR SAMPLE SIZES < 50: Lieberman, Gerald F. 1958. "Tables for One-sided Statistical Tolerance Limits." Industrial Quality Control. Vol. XIV, No. 10.

FOR SAMPLE SIZES > 50: K values were calculated from large sample approximation.

NTIS Document PB-89-151-047

ATTACHMENT 4

WASTE MANAGEMENT DIVISION'S

CLEAN CLOSURE CERTIFICATION CHECKLIST

This checklist was developed to review RCRA clean closures. Due to direct reference to 40 CFR, Part 264, Subpart G, by Act 64, Rule 613; Act 64 closures should also be evaluated by this checklist.

Documentation supporting the owners/operators and the independent registered professional engineer's certification can be requested under 40 CFR, 264.115 and 265.115 (as of October 29, 1986). The owner/operator must submit at least four copies of certification documentation.

The checklist identifies items recommended to properly evaluate a closure certification. These items are not "absolutes." Other information or substitutions may be provided which technically justify and certify a "clean closure."

This checklist can be used for land disposal, storage, and treatment facilities. Several of the items would not be required for storage and/or treatment facilities where testing was minimal. Items 1 through 5 would be required for all closures. Items 6 through 11 would be optional for storage and/or treatment facilities, dependent on extent of testing required. Land disposal facilities would require all items listed.

1. Manifests (or some type of manifest/waste removal summary) of where and how much waste was shipped.

2. Certification statement is needed by the owner/operator AND an independent registered engineer. All independent registered professional engineer certificates must have an original stamp on at least one copy.

3. Summary of decontamination procedures (pressure wash, Steam clean, etc.) and how the resultant waste water was disposed.

4. Summary analysis (include conditions of haul roads, time table, soil and groundwater results, weather conditions, runoff controls, equipment decontamination, etc.).

5. Results of all tests used to determine clean closure (charts, tables, lab sheets).

6. Statistical comparisons on sampling results compared to cleanup criteria (this should include full computations on background and statistical analysis).

7. Sampling and analysis procedures (specify references).

8. Final depth and elevations of excavations of wastes and soils.

9. Properly labeled and easily identified sampling locations and grid stations (map) including background stations.

10. Groundwater data (and statistical evaluation) used to determine if groundwater degradation has occurred (usually four sets of replicate analysis compared to sampling event after closure activities). Monitor well construction details and sampling and analysis procedures may be required if documentation is not in the file.

11. Summary of final restoration of excavated area...
information on fill material used and/or future land use outline. If clean closure cannot be achieved (e.g., contaminated soils to water table and groundwater results show contamination). This summary item should be used to address the need for any post closure program and/or corrective action.

12. A copy of all field notes pertaining to these closure activities.

13. A copy of the approved closure plan and letter of closure plan approval.

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