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WORK PLAN PILOT-SCALE SOIL/SEDIMENT TREATABILITY STUDY FOR SITE 8 HERBICIDE ORANGE STUDY AREA NCBC GULFPORT MS

12/1/2000

TETRA TECH

Work Plan
Pilot-Scale Soil/Sediment Treatability Study

Site 8
Herbicide Orange Study Area

at

Naval Construction Battalion Center

Gulfport, Mississippi

Southern Division
Naval Facilities Engineering Command

Contract Number N62467-94-D-0888
Contract Task Order 0143

December 2000

100024/P

WORK PLAN
FOR
PILOT-SCALE SOIL/SEDIMENT TREATABILITY STUDY

SITE 8
HERBICIDE ORANGE STUDY AREA

NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29406

Submitted by:
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CONTRACT NUMBER N62467-94-D-0888
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DECEMBER 2000

PREPARED UNDER THE SUPERVISION OF:	APPROVED FOR SUBMITTAL BY:
FOR	
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TETRA TECH NUS, INC.	TETRA TECH NUS, INC.
TALLAHASSEE, FLORIDA	PITTSBURGH, PENNSYLVANIA

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LIST OF ACRONYMS AND ABBREVIATIONS

AASHTO	American Association of State Highway Officials
ASTM	American Society for Testing and Materials
CBR	California Bearing Ratio
CKD	cement kiln dust
CLEAN	Comprehensive Long-Term Environmental Action Navy
CTO	Contract Task Order
ft^2	square foot/feet
ft^3	cubic foot/feet
HASP	Health and Safety Plan
HO	Herbicide Orange
H20	Highway 20
MSDEQ	Mississippi Department of Environmental Quality
µg/kg	microgram(s) per kilogram
NCBC	Naval Construction Battalion Center
ng/kg	nanogram(s) per kilogram
pcf	pound(s) per cubic foot
psi	pound(s) per square inch
PVC	polyvinyl chloride
SOUTHDIVNAVFACENGCOM	Southern Division Naval Facility Engineering Command
SPLP	Synthetic Precipitation Leaching Procedure
SRT	sediment recovery trap
TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
TCLP	Toxicity Characteristics Leaching Procedure (USEPA's)
TtNUS	Tetra Tech NUS, Inc.
UCS	unconfined compressive strength
USAF	United States Air Force
USEPA	United States Environmental Protection Agency
yd^3	cubic yard(s)

1.0 INTRODUCTION

1.1 SCOPE AND PURPOSE

This Pilot-Scale Treatability Study Work Plan for Naval Construction Battalion Center (NCBC) Gulfport, Site 8, Herbicide Orange Study Area has been prepared by Tetra Tech NUS, Inc. (TtNUS) for the Southern Division Naval Facilities Engineering Command (SOUTHDIVNAVFACENGCOM) under the Navy Comprehensive Long-Term Environmental Action Navy (CLEAN) Program, Contract Number N62467-94-D-0888, Contract Task Order (CTO) 0143. The purpose of this Work Plan is to define the objectives of the soil and sediment pilot-scale treatability study and provide a description of planned testing activities.

1.2 SITE HISTORY AND PROJECT BACKGROUND

Site 8 occupies approximately 30 acres in the north central section of NCBC Gulfport. From 1968 to 1977, the site was used by the United States Air Force (USAF) for the storage of approximately 850,000 gallons of Herbicide Orange (HO) in 55-gallon drums. It was originally believed that only 12 acres of the site, designated as Site 8A, had been used for HO storage, but two additional storage areas were later identified, including 17-acre Site 8B and 1-acre Site 8C. Figure 1-1 shows the location of Sites 8A, 8B, and 8C.

The main chemical of concern at the site is 2,3,7,8-tetrachlorodibenzo-p-dioxin, or TCDD, which is a manufacturing impurity of the HO. In this document, TCDD and the other dioxins found in HO will be collectively referred to as "dioxin."

In 1977, the USAF disposed of the entire HO inventory by high-temperature incineration at sea. From 1987 to 1988, a quantity of dioxin-contaminated soil was treated on-site by high-temperature incineration and the resulting ash were stored on Site 8A. This ash meets the dioxin delisting concentration criterion of 1.0 microgram per kilogram (µg/kg) set by the Mississippi Department of Environmental Quality (MSDEQ, 1997).

As a result of the spills and leaks that occurred during the years of HO storage, dioxin has migrated from Site 8 to the system of on-base ditches that drain surface runoff from the site and to the off-base swampland located across 28th Street from Outfall 3. Since dioxin has an affinity for soil and is not readily water soluble, this migration has primarily occurred through the erosion and transportation of

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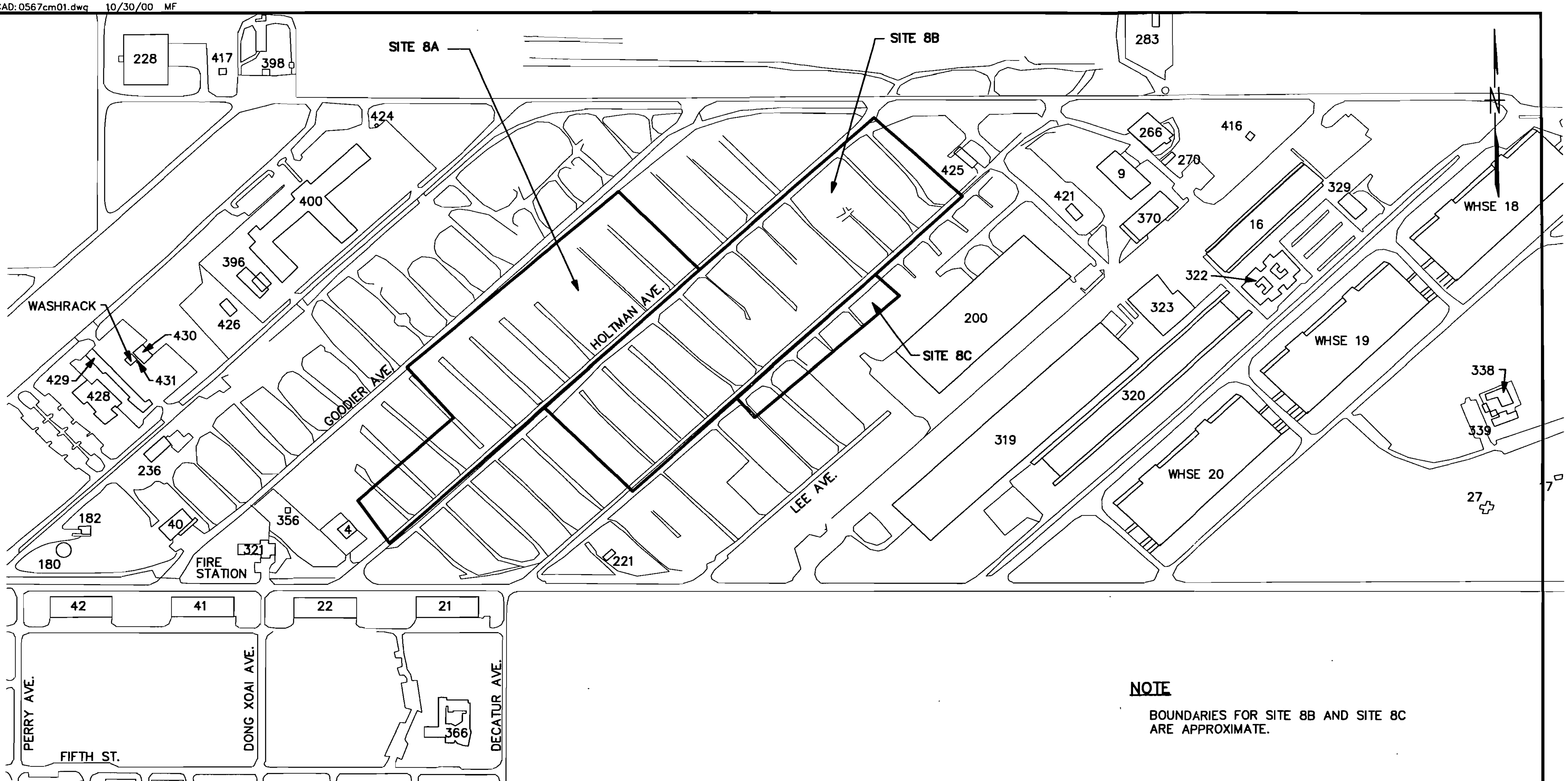

NOTE

BOUNDARIES FOR SITE 8B AND SITE 8C ARE APPROXIMATE.

0 200 400

APPROXIMATE SCALE IN FEET

DRAWN BY HJP DATE 8/7/00	DEPARTMENT OF THE NAVY SOUTHERN DIV FACILITIES ENGINEERING COMD	SITES 8A, 8B, AND 8C LOCATION MAP NAVAL CONSTRUCTION BATTALION CENTER GULFPORT, MISSISSIPPI	CONTRACT NO. 0567
CHECKED BY SWH DATE 10/4/00			APPROVED BY JLG DATE 10/4/00
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 1-1 REV. 1

SOURCE: REMEDIATION GUIDANCE DOCUMENT, HARDING LAWSON ASSOCIATES, MARCH 2000.

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contaminated soil from the site and the deposition of that soil in the sediment of the on-base ditches and off-base swampland.

Site 8 is also currently used to store construction debris and dioxin-contaminated sediment excavated from ditches as part of removal actions conducted during the widening of 28th Street in 1995 and the 1997 upgrading of the sediment recovery trap (SRT) system located in the on-base drainage ditches.

The currently proposed remedial approach for the contaminated soil and sediment is to excavate dioxin-contaminated sediment from on-base drainage ditches and off-base swampland and to consolidate the excavated material on Site 8A with the soil incineration ash and construction debris. The consolidated material would then be capped and the capped area used as a parking and storage area for heavy construction equipment. Based on an agreed-upon soil/sediment cleanup criterion of 50 nanograms per kilogram (ng/kg) dioxin, it is estimated that a total of approximately 58,600 cubic yards (yd^3) of contaminated media will have to be excavated and consolidated at Site 8A, including the following:

Material	Estimated Volume (cubic yards)
Site 8A Incinerated Soil Ash	21,000
Site 8A Construction Debris	600
On-Base Ditches Contaminated Sediment	24,000
Off-Base Swampland Contaminated Sediment	13,000
Total	**58,600**

For the purpose of this work plan, the mixture of the above-listed media in proportion to their estimated volumes is referred to as the Material Blend. Figures 1-2 and 1-3 show the approximate areal extent of the on-base and off-base contaminated media, respectively.

A bench-scale treatability study was conducted (TtNUS, 2000a) to determine the geotechnical characteristics of the Material Blend and its suitability to support a Highway 20 (H20) loading, as defined by the American Association of State Highway Officials (AASHTO, 1973). The evaluation criteria used for the bench-scale treatability study to determine the suitability of the Material Blend are a minimum California Bearing Ratio (CBR) of 20 and a minimum 28-day unconfined compressive strength (UCS) of 50 pounds per square inch (psi).

The bench-scale treatability test results indicate that the Material Blend is not suitable to support H20 loading (TtNUS, 2000b). The preliminary results also indicate that addition of a relatively small amount (i.e., 5 to 10 %, by weight) of cement kiln dust (CKD) to the Material Blend improves its load bearing capacity so that it satisfies the H20 criteria.

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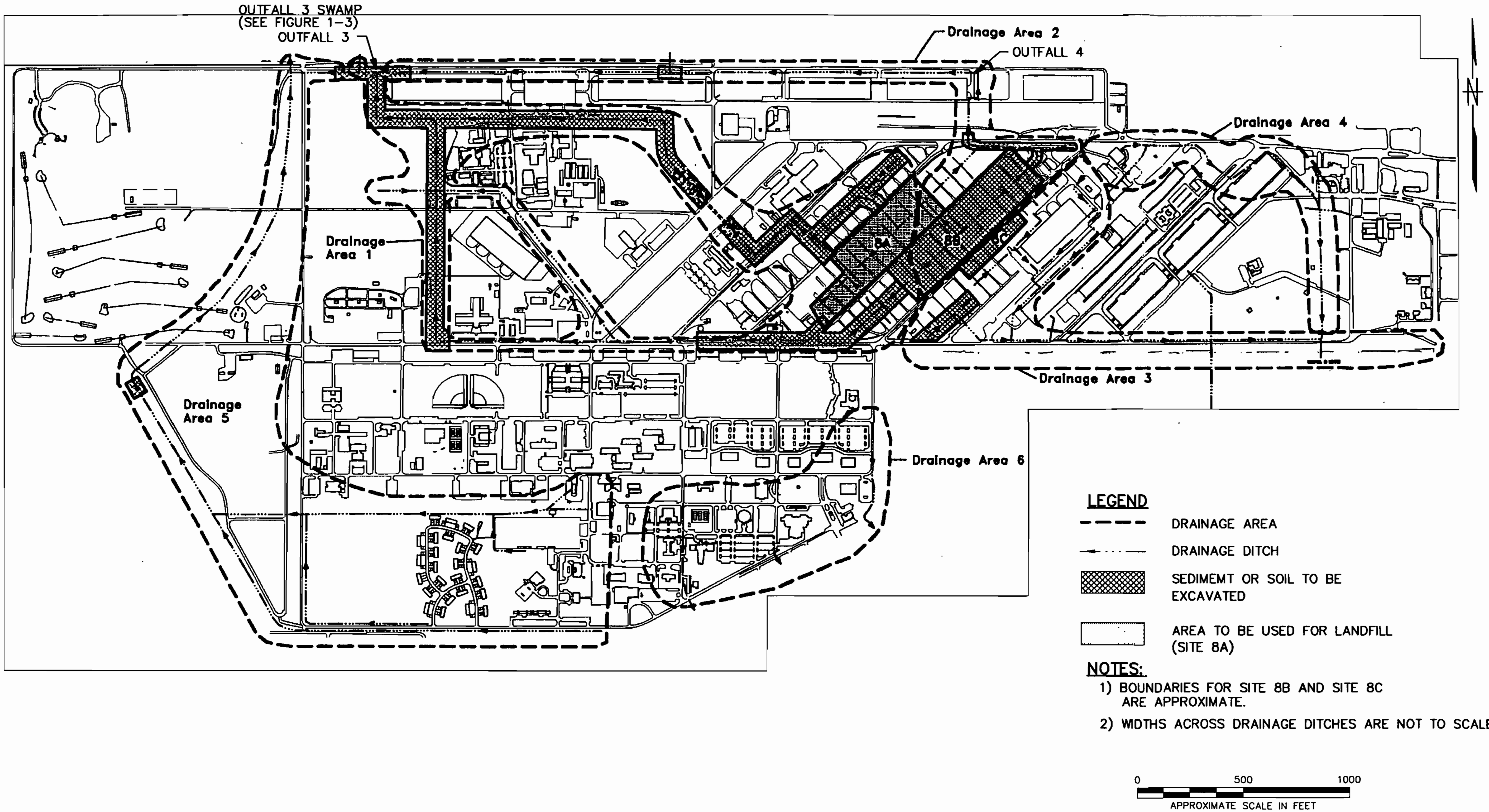

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COST/SCHED-AREA		APPROVED BY JLG DATE 10/4/00
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SOURCE: REMEDIATION GUIDANCE DOCUMENT, HARDING LAWSON ASSOCIATES, MARCH 2000.

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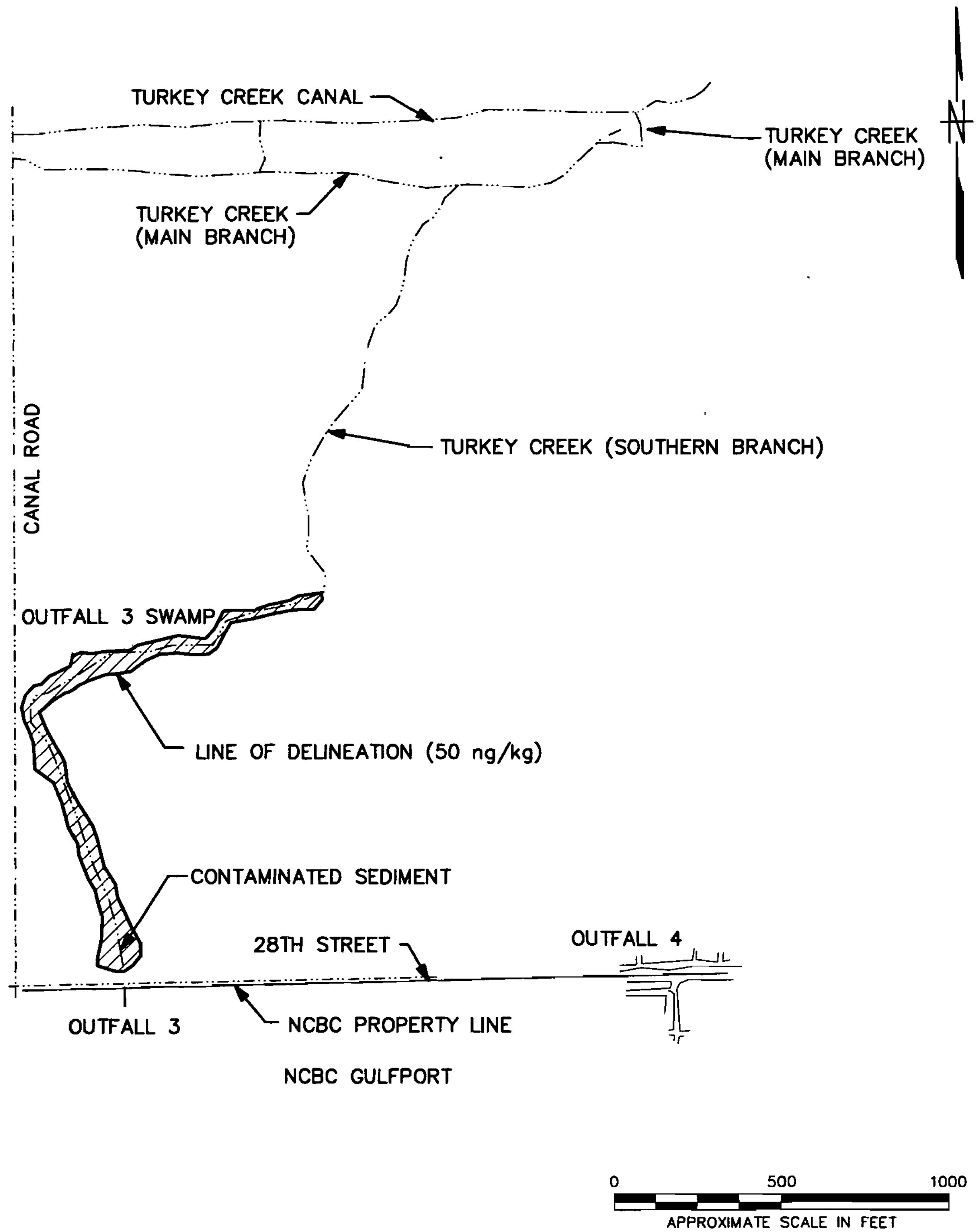

SOURCE: REMEDIATION GUIDANCE DOCUMENT, HARDING LAWSON ASSOCIATES, MARCH 2000.

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SCALE AS NOTED			DRAWING NO. FIGURE 1-3	REV. 1

FORM CADD NO. SDIV_AV.DWG - REV 0 - 1/20/98

1.3 STUDY OBJECTIVES

The purpose of this pilot-scale treatability study is to determine the technical feasibility and practicality of implementing the findings of the bench-scale treatability study on a scale representative of actual remedial operations. The objectives of this pilot-scale treatability study are as follows:

- Determine the most effective method of removing the various contaminated media (incinerated soil ash and on-base ditch and off-base swampland sediment) from their current locations.

- Determine the most effective method of removing excess free water from the sediment excavated from the on-base ditches and off-base swampland.

- Verify the effectiveness of a mechanical vibrating screen for the removal of oversized particles from the off-base swampland sediment (optional).

- Determine the most effective method for mixing the various contaminated media into an homogeneous Material Blend as well as for mixing this Material Blend with the required CKD additive.

- Determine the most effective method of landfilling the amended Material Blend.

- Verify the load bearing characteristics and dioxin leachability of the landfilled amended Material Blend.

1.4 DOCUMENT ORGANIZATION

This Work Plan has three sections. Section 1.0 provides this brief introduction. Section 2.0 describes the pilot-scale testing procedures. Section 3.0 describes test reporting procedures and provides a project schedule.

2.0 TREATABILITY TESTING

2.1 INTRODUCTION

This pilot-scale treatability study will include the following activities:

- Excavation Tests
- Free Water Removal Tests
- Mixing and Spreading Tests
- Compaction Tests
- Leachability Tests
- Excavation of Sites 8B and 8C Drainage Ditches Sediment

All field activities will be performed in accordance with the Health and Safety Plan (HASP) provided in Appendix A.

During the pilot-scale treatability study, the following equipment will be utilized:

- Mud Pumps (Bladder-type)
- Gradall-type Excavator
- 20 cubic yard (yd^3) capacity Lined Dump Truck or Lined Roll-off Box
- 10,000-gallon Above-ground Storage Tank
- 4 foot (ft) by 10 ft Vibrating Screen with 6-inch (in) square openings (optional)
- Front End Loader
- Bulldozer
- Mechanical Spreader
- Single-shaft Traverse Mixer
- Water Truck with Rear Spray Header
- Sheepsfoot Roller

2.2 EXCAVATION TESTS

Excavation tests will consist of determining the most effective method for removing the contaminated media identified in Section 1.2 from their current locations (i.e., the Site 8A ash piles, the on-base ditches, and the off-base swampland).

Since the composition of the piles of incinerated soil ash stored at Site 8A is fairly homogeneous, location of the ash excavation tests will be selected mainly based upon ease of access to the many soil ash piles scattered across the site.

The locations of the sediment excavation tests were selected because they have representative levels of known contamination and represent current site conditions. The location of the off-base swampland sediment excavation tests were also selected based upon reasonable accessibility. The locations of the off-base swampland sediment and on-base sediment excavation areas are shown on Figures 2-1 and 2-2, respectively. It is anticipated that excavation will be accomplished with the use of a Gradall-type excavator. The excavated sediment will then be transported to the appropriate sediment staging/dewatering cell at Site 8A in a lined dump truck or roll-off box.

As shown on Figure 2-1, the off-base swampland sediment excavation tests will take place in the main area of dioxin contamination along the unnamed ephemeral creek which extends northwest from Outfall 3 (at 28th Street) to the south branch of Turkey Creek (at Canal Road). The off-base excavation area occupies approximately 4,500 square feet (ft^2). Approximately 6 inches of sediment will be excavated from the 4,500 ft^2 area and transported to Site 8A. Dewatering of the off-base swampland excavation area is not anticipated, but may be necessary depending on weather/site conditions.

During excavation activities, if it is determined that the excavated off-base swampland sediment contains significant organic debris (e.g., roots, grass, etc.), then the off-base sediment will be screened with the 4 ft by 10 ft vibrating screen. The screening activities will be performed at Site 8A. The screen will be evaluated with the sediment both before and after the free water has been removed to determine the most efficient method of removing the oversized organic debris. All organic debris retained on the screen will be stockpiled on Site 8A.

The on-base sediment excavation tests will take place in the ditches of Drainage Area 1 immediately upstream and downstream of the SRT located adjacent to Outfall 3 as shown on Figure 2-2. It is anticipated that the excavation of the on-base sediment will be conducted in two stages. The first stage will consist of dewatering and excavating the portion of the ditch to the east of the site access road that is oriented north-south. This will be accomplished with the use of marine-grade polyvinyl chloride (PVC) sheet piling and mud pumps (bladder-type) to remove water from the excavation areas and bypass upstream flow. The water from this area will be pumped to the portion of the ditch to the west of the site access road. Once the area is sufficiently dewatered, an area of approximately 4,850 ft^2 will be excavated to a depth of 6 inches and the material transported to Site 8A.

Upon completion of the excavation in the upgradient portion of the ditch, the downgradient area near Outfall 3 will then be excavated. Again, the excavation area will be dewatered using marine-grade PVC

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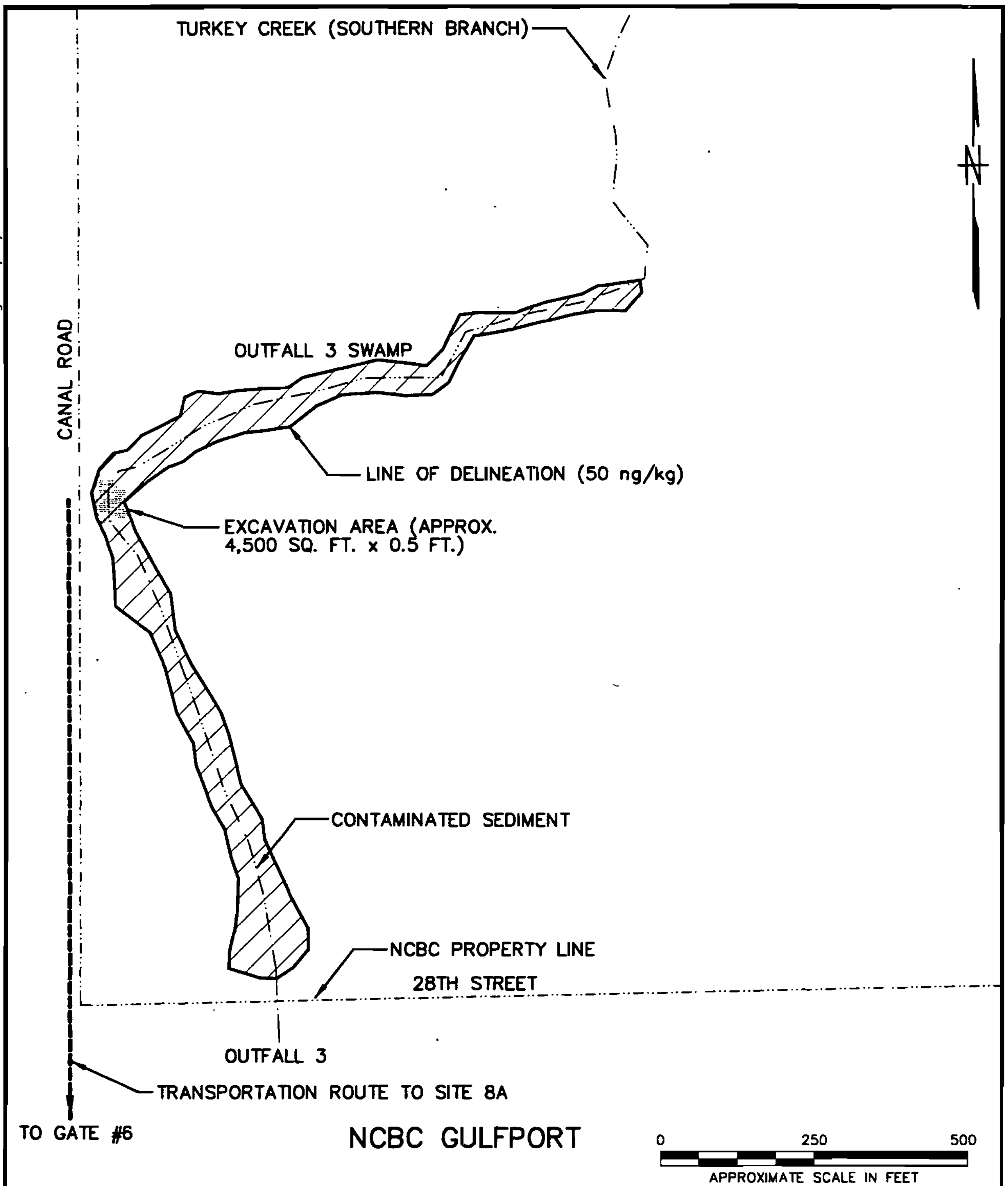

SOURCE: REMEDIATION GUIDANCE DOCUMENT, HARDING LAWSON ASSOCIATES, MARCH 2000.

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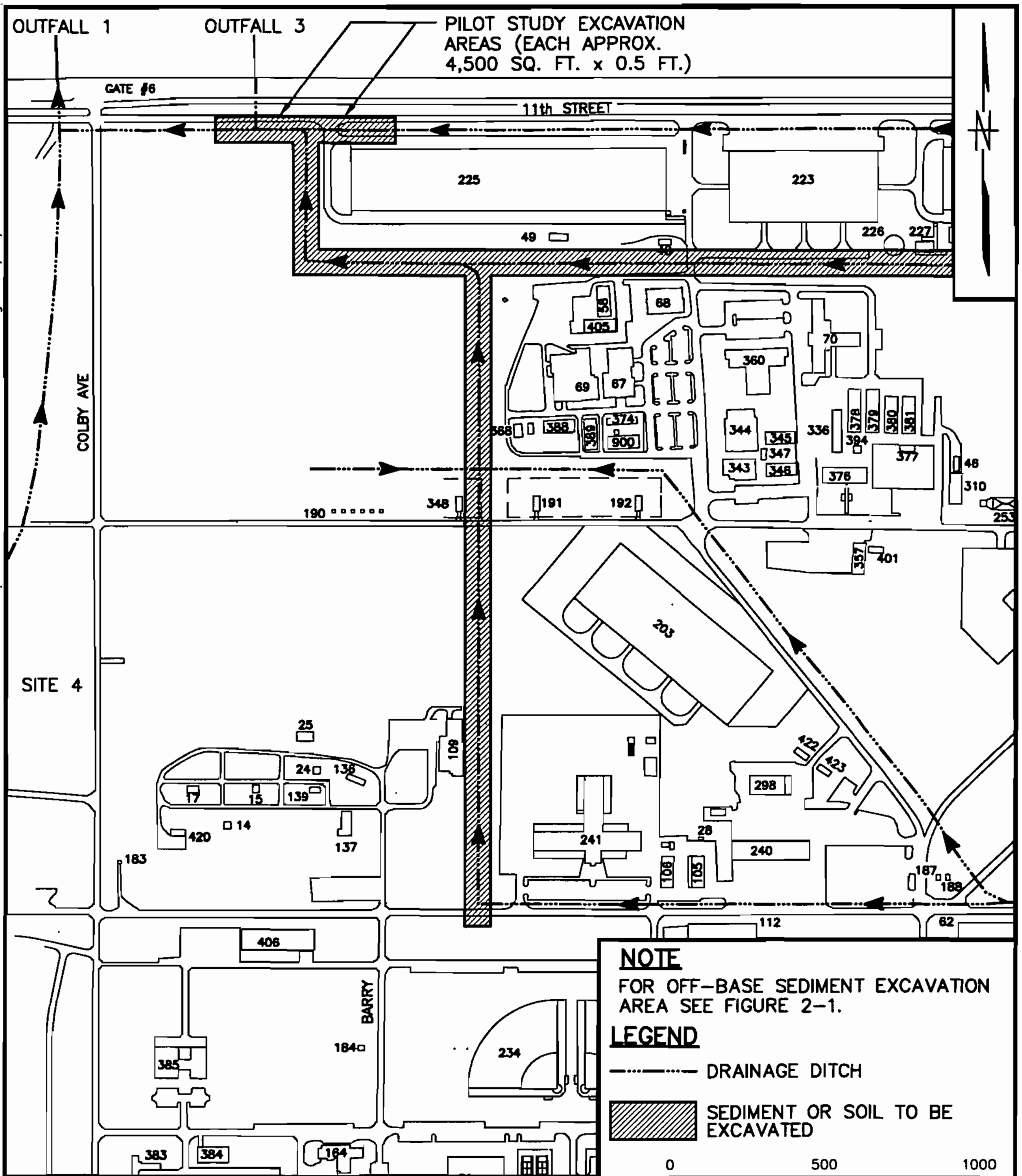

SOURCE: REMEDIATION GUIDANCE DOCUMENT, HARDING LAWSON ASSOCIATES, MARCH 2000.

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FORM CADD NO. SDIV_AV.DWG – REV 0 – 1/20/98 sheet piling and mud pumps (bladder-type). The water from this portion of the excavation will be pumped to the area east of the SRT. Once the area is sufficiently dewatered, an area of approximately 4,850 ft^2 will be excavated to a depth of 6 in and the material transported to Site 8A.

If site conditions and/or water levels are deemed to be unsuitable for a Gradall-type excavator to excavate the on-base or off-base sediment, alternate means of mechanical removal, such as a dragline, will be considered and tested.

The following table presents estimates of the volumes of contaminated media that will be excavated and transported to Site 8A for the pilot-scale treatability study:

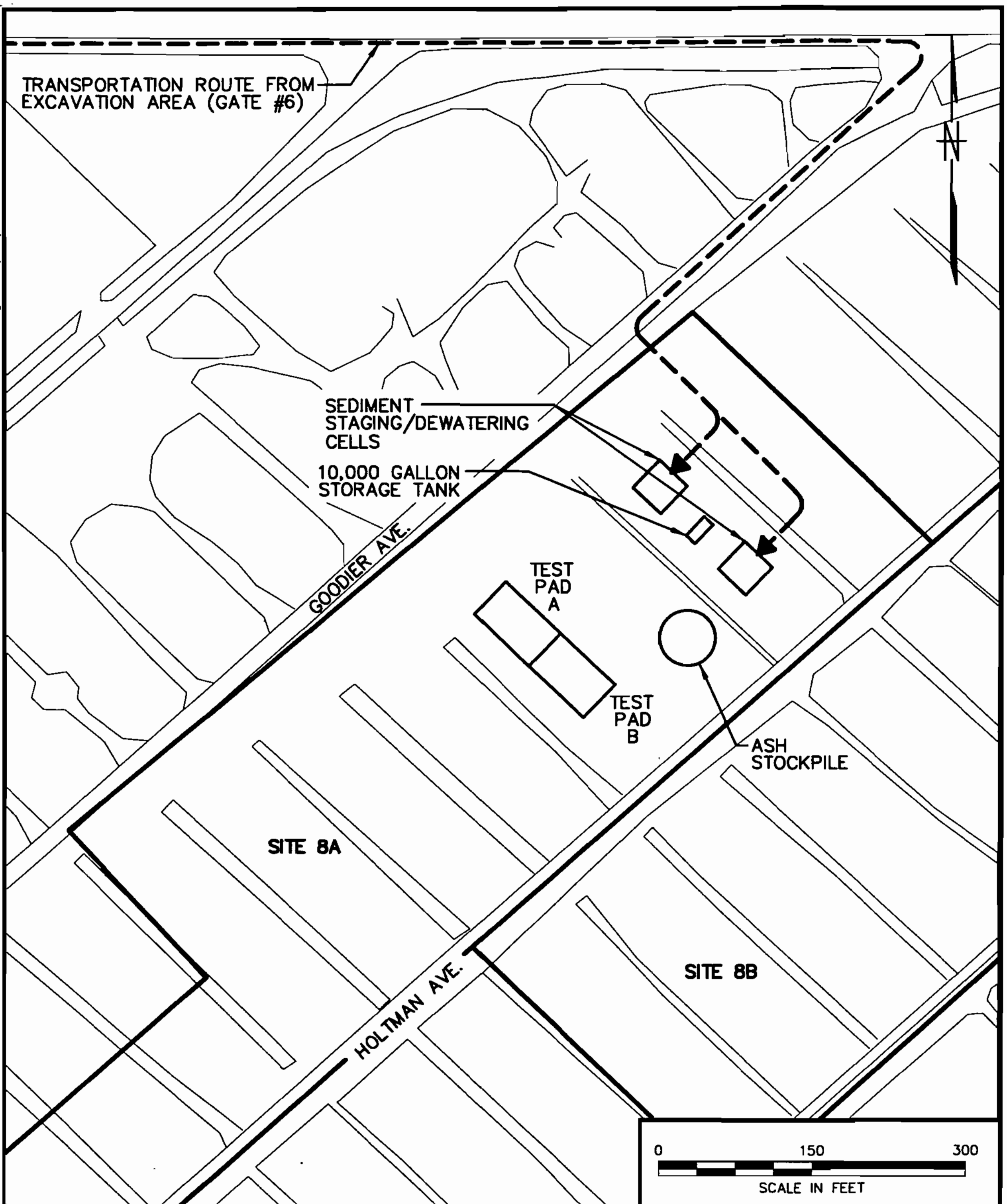
Material	Excavated Volume (cubic yards)
Site 8A Incinerated Soil Ash	134
Site 8A Construction Debris	3
On-base Ditches Contaminated Sediment	180
Off-base Swampland Contaminated Sediment	83
Total	**400**

The above volumes have been calculated to provide sufficient contaminated media to perform all of the subsequently described pilot tests. The above volumes have also been calculated to provide contaminated media in proportion to the volumes identified for these media in Section 1.2, adjusted for the loss of the free water removed from the on-base ditch sediment, as estimated in Section 2.3.

2.3 FREE WATER REMOVAL TESTS

As shown on Figure 2-3, two sediment staging/dewatering cells will be constructed at Site 8A; one for the temporary staging of off-base swampland sediment, and the other for temporary staging of on-base sediment. The staging/dewatering cells, each approximately 50 ft by 50 ft, will be constructed using an earthen berm around the perimeter and lined with a geomembrane liner, as shown on to Figure 2-4. The cells will be sufficiently sloped to allow free water to drain by gravity to the lined collection sumps located near the 10,000-gallon above-ground storage tank.

The purpose of the free water removal tests is to evaluate the quantity of free water that will be release from the water during the staging period and not to actually dewater the sediment. Free water removal tests will consist of stockpiling the excavated sediment in the sediment staging/dewatering cells and letting the free water drain by gravity to the lined collection sumps. Free water will then be pumped from the collection sumps to the 10,000-gallon storage tank.



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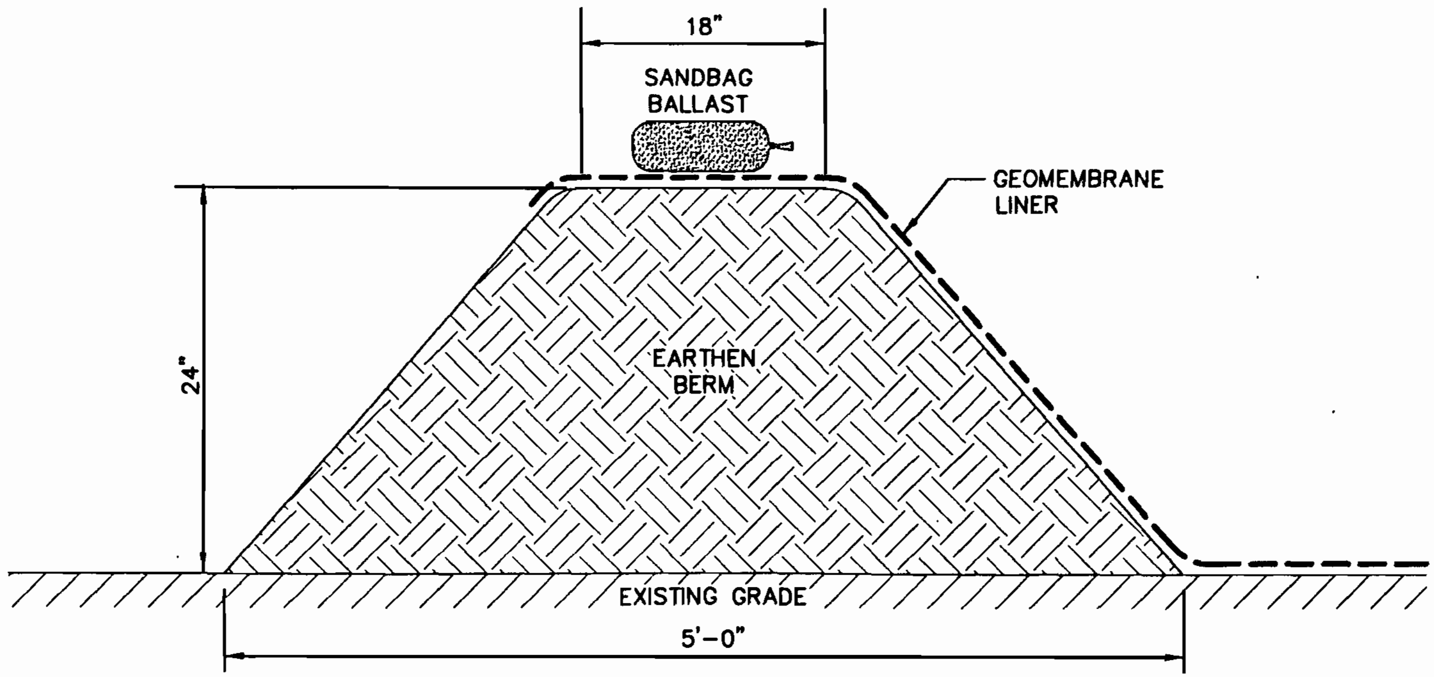

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To evaluate the potential need for treatment of the removed free water during full-scale remediation, a sample of the water will be collected and submitted to an analytical testing laboratory for measurement of its dioxin concentration before and after filtration.

The effectiveness of the free water removal process will be evaluated through visual estimation of the volume percentage of free water removed and field-measurement of the sediment moisture content before and after removal of free water. Moisture content will be determined in accordance with the American Society for Testing and Material (ASTM) Method D2216-98, copy of which is provided in Appendix B. For planning purposes, it is estimated that approximately 15 percent (by volume) of free water will be removed from the sediment excavated from the on-base ditches and that no significant free water will be removed from sediment excavated from the off-base swampland sediment.

2.4 MIXING AND SPREADING TESTS

The mixing and spreading tests will be conducted to verifying that the various contaminated media identified in Section 1.2 can be mixed into a homogeneous Material Blend with the appropriate amount of CKD as established by the bench-scale treatability study. Two separate test pads, which are shown on Figure 2-3, will be constructed during the pilot test. Each of the test pads will be approximately 40 ft wide by 100 ft long and will be comprised of two compacted lifts, each approximately 8 in in depth. Prior to construction of the pads, the area will be cleared and graded with the bulldozer to level the area and remove any vegetation. The vegetative material removed from the test pad area will be stockpiled at Site 8A.

2.4.1 Test Pad A

The first mixing, spreading, and compaction test will be performed at Test Pad A. The incinerated soil ash, on-base sediment, and off-base swampland sediment will be excavated from the stockpiles using a front end loader and placed into a dump truck at a volume ratio of approximately 2:2:1, respectively. The various materials will be placed into the dump truck by alternating from the three stockpiles until the truck is full. The purpose of alternating from each stockpile as the truck is being loaded is to pre-blend the stockpiled materials as much as possible before transporting the material to the test pad area. The resulting 2:2:1 volume ratio will approximate the desired Material Blend. The Material Blend will then be transported to the test pad area, dumped, and spread with the bulldozer to create a loose lift approximately 10 inches in depth. Approximately 100 yd^3 of loose (i.e., uncompacted) Material Blend (i.e., 40 yd^3 of incinerated soil ash, 40 yd^3 of on-base sediment, and 20 yd^3 of off-base swampland sediment) will be required for each 10 in uncompacted lift over the 40 ft by 100 ft test pad area.

After a 10-inch uncompacted lift of Material Blend has been spread over the entire 40 ft by 100 ft test pad area, an lift of approximately 2 inches CKD will be placed over the entire test pad area with the mechanical spreader. The 2-inch uncompacted lift of CKD approximates the amount of CKD required to achieve the desired compaction and strength characteristics as determined from the bench-scale treatability study. After the CKD has been placed, the single-shaft traverse mixer will be used to blend the CKD into the previously spread Material Blend. As the CKD is being mixed with the Material Blend, the mixing effectiveness will be field-evaluated by visually checking the homogeneity of the amended Material Blend. Several samples will be collected at various locations and depth to determine the effectiveness of the mixing equipment. If inadequate homogeneity is observed, additional mixing will be performed and the amended Material Blend will be visually inspected again at various locations and depth to determine the effectiveness of the mixing equipment used, and to determine the optimum number of passes with the mixing equipment and mixing time.

Should it be determined that the mixing equipment is not effective or the mixing time is insufficient, two alternative mixing procedures will be evaluated. The first alternative mixing procedure will consist of mixing the Material Blend in-place at the test pad area prior to the addition of the CKD. The second alternative will consist of loading the CKD directly into the dump truck with the front end loader. The incinerated soil ash, on-base sediment, off-base swampland sediment, and CKD will be excavated from the stockpiles using a front end loader and placed into a dump truck at a volume ratio of 2:2:1:1, respectively. The various materials will be placed into the dump truck by alternating from the four stockpiles until the truck is full. The resulting 2:2:1:1 volume ratio will approximate the desired amended Material Blend. The amended Material Blend will then be transported to the test pad area, dumped, and spread with the bulldozer to create an uncompacted lift approximately 12 inches in depth. Approximately 120 yd^3 of uncompacted amended Material Blend (i.e., 40 yd^3 of incinerated soil ash, 40 yd^3 of on-base sediment, 20 yd^3 of off-base swampland sediment, and 20 yd^3 of CKD) will be required for each 12-inch uncompacted lift over the 40 ft by 100 ft test pad area. The material will then be blended and evaluated as described above.

Upon successful mixing of the Material blend and CKD, tests will be performed to evaluate the compaction and strength properties as described in Section 2.5. After the material has been successfully compacted, a second lift of amended Material Blend will be placed and compacted over the area of Test Pad A as described in this section. The second lift will not be placed for a minimum of 72 hours after the initial lift has been completed to allow the original lift to sufficiently cure.

2.4.2 Test Pad B

The second mixing and spreading test will be performed at Test Pad B. The purpose of Test Pad B will be to determine whether the free water collected from the stockpiled sediment can be added to the amended Material Blend and still achieve the desired compaction and strength criteria. The most successful mixing and spreading tests used for Test Pad A, as appropriate, will also be used for Test Pad B. After it is determined that the amended Material Blend has been successfully mixed, a water truck will be used to distribute the collected free water over the lift. After the water has been added to the test pad area, the lift will again be mixed with the mixing equipment to prior to compaction. A determination will be made in the field during construction of the test pad as to the rate and volume of water than can be added to the lift while still achieving the desired compaction and strength criteria.

Upon successful mixing of the Material blend, CKD, and additional water, tests will be performed to evaluate the compaction and strength properties as described in Section 2.5. After the material has been successfully compacted, a second lift of amended Material Blend will be placed and compacted over the area of Test Pad A as described in this section. The second lift will not be placed for a minimum of 72 hours after the initial lift has been completed to allow the original lift to sufficiently cure.

2.5 COMPACTION TESTS

If field observations indicate that the mixing equipment and methods are judged to be successful, the mixing effectiveness of that test will be further evaluated by determining the geotechnical compaction and strength characteristics of the resulting amended Material Blend. To this effect, a sample of the amended Material Blend will be submitted to a specialized geotechnical testing laboratory for measurement of the moisture-density relationship in accordance with ASTM Method D698. After the sample has been collected, the 12-inch uncompacted lift of amended Material Blend will be leveled with the bulldozer, as necessary, and compacted with the sheepsfoot roller. The density of the compacted amended Material Blend will be field-checked in accordance with ASTM Method D2922 (nuclear method). Several density tests will be taken over the test pad area after each pass of the roller. In the absence of actual laboratory-measured density tests, the laboratory-measured density tests from the bench-scale treatability study design mix will be used to determine when the amended Material Blend has been compacted to 90 percent of maximum dry density. The field-checked density tests will be re-evaluated once the results of the laboratory-measured density tests are obtained. During the bench-scale treatability study it was determined that the maximum dry density of the samples containing 10 percent CKD ranged from of 112.0 pounds per cubic foot (pcf) to 114.2 pcf.

After it is determined that the amended Material Blend has been compacted to 90 percent of maximum dry density, the California Bearing Ratio (CBR) will be field-measured in accordance with ASTM Method D4429. The field-measured CBR value will then be compared to that measured for the corresponding bench-scale treatability study design mix. Since the results of the bench-scale treatability study indicated that the strength of the amended Material Blend increased over time, the CBR of the upper lift of each test cell will be field-measured over a one-week period to evaluate the strength of the compacted lift over time. The results of this evaluation will determine the appropriate time between placement of the lifts during full-scale production.

Copies of ASTM Methods D698, D2922, and D4429 are provided in Appendix B. A stand-alone sampling and analysis plan will be prepared that will detail all testing activities that will be performed during the pilot test.

2.6 LEACHABILITY TESTS

Leachability tests will consist of verifying that the dioxin contamination of the amended Material Blend is not likely to migrate from the landfill into the surrounding environment. For this purpose three samples of the amended Material Blend will be collected and submitted to a specialized analytical testing laboratory for performance of the United States Environmental Protection Agency (USEPA) Synthetic Precipitation Leaching Procedure (SPLP) and analysis of the leachate from that procedure for dioxin.

2.7 EXCAVATION OF SITES 8B AND 8C DRAINAGE DITCHES SEDIMENT

As part of the field activities for the pilot-scale treatability study, the contaminated sediment from the drainage ditches of Sites 8B and 8C will be excavated and stockpiled at Site 8A for eventual treatment and disposal under the structural cap during the full-scale remediation effort.

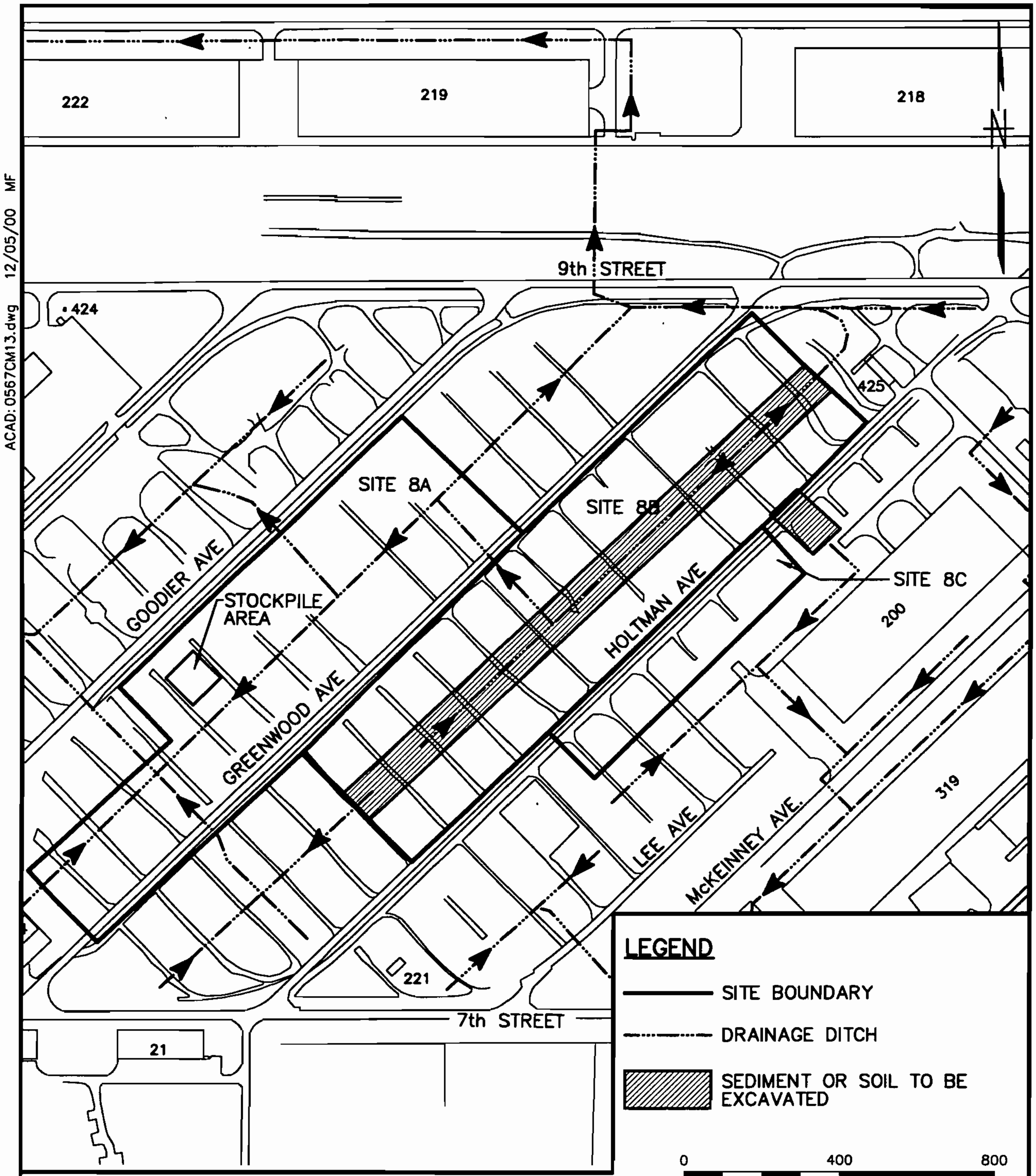
The proposed excavation and stockpiling locations are shown on Figure 2-5. It is estimated that approximately 1,200 cubic yards of contaminated sediment will be excavated from Sites 8B and 8C.

Excavation will be performed with the same equipment and in the same manner as described in Section 2.2 for the pilot-scale excavation tests. The excavated sediment will be transported to Site 8A and stockpiled in a lined storage cell similar to the staging/dewatering cells described in Section 2.3 for the free water removal tests. The estimated size of the storage cell is 100 ft x 100 ft. It is not anticipated that significant free water will initially drain from the excavated sediment since the ditches of Sites 8B and 8C are most often dry. However, an earthen containment berm (see Figure 2-4) and lined collection sump must be provided to capture and collect potentially contaminated runoff water from rainfall events.

2.8 HANDLING OF TEST RESIDUES AND TEMPORARY CLOSURE OF TEST SITE

The free water removed from the excavated on-base ditch sediment will be used during the testing procedures of Test Pad B, as described in Section 2.4.2.

Any amended or non-amended Material Blend that has not been used for the construction of the landfill test pads as described in Section 2.4 will be consolidated in one of the sediment staging/dewatering cells.



SOURCE: REMEDIATION GUIDANCE DOCUMENT, HARDING LAWSON ASSOCIATES, MARCH 2000.

DRAWN BY MF DATE 12/5/00	DEPARTMENT OF THE NAVY ★ SOUTHERN DIV FACILITIES ENGINEERING COMD ★	SITES 8B AND 8C SEDIMENT EXCAVATION AND STOCKPILING AREA NAVAL CONSTRUCTION BATTALION CENTER GULFPORT, MISSISSIPPI	CONTRACT NO. 0567
CHECKED BY SH DATE 12/5/00			APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 2-5 REV. 0

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Following completion and evaluation of the test pads, these test pads will be temporarily closed until construction of the permanent structural cap by placement of a cover, such as a tarpaulin or gravel layer, to prevent erosion of the landfilled material.

3

3.0 REPORTING AND SCHEDULE

3.1 REPORT

Upon completion of field and laboratory testing activities, a letter-type report will be prepared which will include the following elements:

- Description of the pilot-scale testing procedures.
- Presentation of the pilot-scale testing results, including field measurements and observations and geotechnical and leachability laboratory data.
- Treatability study conclusions and recommendations.

3.2 SCHEDULE

It is anticipated that the pilot-scale treatability study will be completed within 29 weeks. Anticipated schedule of project milestones is summarized as follows:

Activity	Start	End
Prepare Draft Work Plan	10/13/00	10/31/00
Submit Draft Work Plan	10/31/00	10/31/00
Navy/Air Force Review of Draft Work Plan	11/01/00	11/08/00
Prepare Final Work Plan	11/09/00	12/11/00
CCI Prepares Work Plan	TBD	TBD
Submit Final Work Plan	12/11/00	12/11/00
Pilot-Scale Testing	01/08/00	03/09/01
Prepare Draft Letter-Report	02/26/01	03/26/01
Submit Draft Letter-Report	03/26/01	03/26/01
Navy/Air Force Review of Draft Letter-Report	03/27/01	04/17/01
Prepare Final Letter-Report	04/18/01	05/04/01
Submit Final Letter-Report	05/04/01	05/04/01

TBD: To be determined

REFERENCES

REFERENCES

AASHTO (American Association of State Highway Officials), 1973. *Standard Specifications for Highway Bridges.* Eleventh Edition.

MSDEQ (Mississippi Department of Environmental Quality), 1997. *Agreed Order No. 3466-97.* November 5.

TtNUS (Tetra Tech NUS, Inc.), 2000a. *Work Plan, Bench-Scale Soil/Sediment Treatability Study, Site 8, Herbicide Orange Study Area at Naval Construction Battalion Center, Gulfport, Mississippi.* Prepared for the Southern Division Naval Facilities Engineering Command (SOUTHDIVNAVFACENGCOM), Charleston, South Carolina. October.

TtNUS, 2000b. *Draft Report, Bench-Scale Soil/Sediment Treatability Study, Site 8, Herbicide Orange Study Area at Naval Construction Battalion Center, Gulfport, Mississippi.* Prepared for SOUTHDIVNAVFACENGCOM, Charleston, South Carolina. November.

A

APPENDIX A

HEALTH AND SAFETY PLAN

HEALTH AND SAFETY PLAN
For
FEASIBILITY STUDY
SITE 8 HERBICIDE ORANGE STUDY AREA

NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT
GULFPORT, MISSISSIPPI

Southern Division
Naval Facilities Engineering Command
Contract Number N62467-94-D-0888
Contract Task Order 0143

October 2000

HEALTH AND SAFETY PLAN
FOR
FEASIBILITY STUDY
SITE 8 HERBICIDE ORANGE STUDY AREA

NAVAL CONSTRUCTION BATTALION CENTER GULFPORT
GULFPORT, MISSISSIPPI

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION-NAVY (CLEAN) CONTRACT

Submitted to:
Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29406

Submitted by:
TETRA TECH NUS
661 Andersen Drive Foster Plaza 7
Pittsburgh, Pennsylvania 15220

CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0143

OCTOBER 2000

PREPARED UNDER THE SUPERVISION OF:

for

ROBERT FISHER
TASK ORDER MANAGER
TETRA TECH NUS
TALLAHASSEE, FLORIDA

APPROVED FOR SUBMITTAL BY:

MATTHEW M. SOLTIS, CIH, CSP
CLEAN HEALTH AND SAFETY MANAGER
TETRA TECH NUS
PITTSBURGH, PENNSYLVANIA

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1.0 INTRODUCTION

Authorization: This Health and Safety Plan (HASP) and the work described within are completed under the authorization of:

Contract: Comprehensive Long-Term Environmental Action Navy (CLEAN III)
Contract Number: N62467-94-D-0888
Contract Task Order: 0143
Statement of Work: #160-Revision 2 – Feasibility Study and Brownfield's Agreement for Site 8, Herbicide Orange Study Area at Naval Construction Battalion Center, Gulfport, Mississippi. Through this activity

- Determine the extent of contamination (horizontal and vertical) to surface and subsurface soils, surface and groundwater, and sediments.
- Establish and develop a suitable treatability method with proven results established through bench and pilot scale testing.

Proposed Dates of Work: September 2000 to September 2002

Application: This Health and Safety Plan (HASP) has been written to encompass site activities that are to be conducted at the Naval Construction Battalion Center (NCBC) located in Gulfport, Mississippi. Activities to be conducted as per this HASP are defined in detail in Section 4.0.

Compliance: The elements of this HASP are intended to be in compliance with the requirements established by:

- OSHA 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response" (HAZWOPER)
- Applicable sections of 29 CFR 1926 "Safety and Health Regulations For Construction."
- Tetra Tech NUS Health and Safety Program

This HASP must be accompanied by the Tetra Tech NUS, Inc. Health and Safety Guidance Manual (TtNUS HSGM). The Guidance Manual provides additional information on program support, standard operating procedures, and safe work practices.

Modifications/Changes: The following conditions are considered sufficient basis review and possible changes to this document

- The addition or modification of activities outside of those specified in Section 4.0, Scope of Work.
- New information becomes available through the course of the investigation or from outside sources.

All changes to this HASP will be requested through the Task Order Manager (TOM) to the Tetra Tech NUS Health and Safety Manager (HSM). It is the responsibility of the TOM to notify all affected personnel of all changes to this HASP. Changes to the HASP will be documented using a Document Review Record.

1.1 KEY PROJECT PERSONNEL AND ORGANIZATION

This section defines responsibility for site safety and health for TtNUS and subcontractor employees engaged in on-site activities. Personnel assigned to these positions will exercise the primary responsibility for all on-site health and safety. These persons will be the primary points of contact for any questions regarding the safety and health procedures and the selected control measures that are to be implemented for on-site activities.

- The TtNUS TOM is responsible for the overall direction of health and safety for this project. This includes but is not limited to, providing
  - I. Prepares background review - Results from past investigation activities at Gulfport (pertinent data - peak concentrations/exceedances by site media for each contaminant at each location of the investigation).
  - II. Specific scope of work that TtNUS will be performing.
  - III. Points of Contact within NCBC Gulfport (i.e., Base Contact, Base Security, Utilities, Emergency notification procedures, closest hospital, Facility Emergency Response capabilities, etc.)
  - IV. Obtains site access, not only to the base, but also to files and records that may have some bearing or pertinence pertaining to this project.

- The Project Health and Safety Officer (PHSO) is responsible for developing this HASP in accordance with applicable OSHA regulations. Specific responsibilities include:

  - i. Providing information regarding site contaminants and physical hazards associated with the site and tasks to be conducted.
  - ii. Establishing air monitoring and decontamination procedures.
  - iii. Assigning personal protective equipment based on task and potential hazards.
  - iv. Determining emergency action/response procedures and emergency contacts.
  - v. Stipulating training and medical surveillance requirements.
  - vi. Providing standard work practices to minimize potential injuries and exposures associated with hazardous waste work.

vii. Modifying this HASP, as it becomes necessary.

- The TtNUS Field Operations Leader (FOL) is responsible for implementation of the HASP with the assistance of an appointed Site Safety Officer (SSO). The FOL manages field activities, executes the work plan, and enforces safety procedures as applicable to the work plan.

- The SSO supports site activities by advising the FOL on all aspects of health and safety on-site. In this capacity the SSO:

  i. Coordinates all health and safety activities with the FOL.
  ii. Selects, applies, inspects, and maintains personal protective equipment.
  iii. Establishes work zones and control points in areas of operation.
  iv. Implements air monitoring program for on-site activities.
  v. Verifies training and medical clearance of on-site personnel status in relation to site activities.
  vi. Implements Hazard Communication, Respiratory Protection Programs, and other associated health and safety programs as they may apply to site activities.
  vii. Coordinates TtNUS emergency actions with the facilities emergency services.
  viii. Provides site-specific training for all on-site personnel.
  ix. Investigates all accidents and injuries (see Attachment I - Illness/Injury Procedure and Report Form)
  x. Provides input to the PHSO regarding the need to modify, this HASP, or applicable health and safety associated documents as per site-specific requirements.

- Compliance with the requirements stipulated in this HASP is monitored by the SSO and coordinated through the TtNUS CLEAN HSM.

Note: In some cases one person may be designated responsibilities for more than one position. For example, at NCBC Gulfport the FOL may also be responsible for the SSO duties. This action will be performed only as credentials, experience, and availability permits.

1.2 SITE INFORMATION AND PERSONNEL ASSIGNMENTS

Site Name: Naval Construction Battalion Center **Address:** Gulfport, Mississippi

Navy Engineer-in-Charge (EIC): Mr. Arthur Conrad **Phone Number:** (843) 820-5520

Facility Contact: Mr. Gordon Crane **Phone Number:** (228) 871-2485
Pager Number: 1(800) 343-3472

Purpose of Site Visit: This activity is divided into a multi-task operation (see Section 3.0).

Project Team:

TtNUS Personnel:	Discipline/Tasks Assigned:	Phone Number:
Robert Fisher	Task Order Manager (TOM)	850/510-2743
Matthew M. Soltis, CIH, CSP	CLEAN Health and Safety Manager (HSM)	412/921-8912
Thomas M. Dickson, CSP	Project Health and Safety Officer (PHSO)	412/921-8457
TBD	Field Operations Leader (FOL)	
TBD	Site Safety Officer (SSO)	
Tom Patton	Equipment Manager	412/262-4583

NCBC Gulfport
Tetra Tech NUS, Inc.
Project Support Staff

Debbie Wroblewski Program Manager Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745	(412) 921-8968 FAX: (412) 921-4040
Joseph Samchuck Data Validation Manager Tetra Tech NUS	Tetra Tech NUS 661 Anderson Drive Pittsburgh, PA 15220	(412) 921-8510 FAX: (412) 921-4040
Brian Lewis Statistician Tetra Tech NUS	Tetra Tech NUS 661 Anderson Drive Pittsburgh, PA 15220	(412) 921-7105 FAX: (412) 921-4040

Non-TtNUS Personnel	Affiliation/Discipline/Tasks Assigned	
TBD	Analytical (Chemical) Laboratory	
TBD	Drilling Contractor	
FedEx	Parcel/Sample Shipment	1(800)463-3339

Hazard Assessments (for purposes of 29 CFR 1910.132) and HASP preparation conducted by:

Thomas M. Dickson, CSP
TBD - To Be Determined

Shipping Address at NCBC Gulfport:
NCBC Gulfport
Building 320, Shipping and Receiving Warehouse
Attention: Mr. Gordon Crane/Tetra Tech NUS, Inc.
5200 CBC 2nd Street
Gulfport, Mississippi 39501-5000

2.0 EMERGENCY ACTION PLAN

2.1 INTRODUCTION

This section has been developed as part of a planning effort to direct and guide field personnel in the event of an incidental or emergency release or occurrence. Tetra Tech NUS will, through necessary services, include incidental response measures for incidents such as:

- Initial stage fire fighting support and prevention
- Initial spill control and containment measures and prevention
- Removal of personnel from emergency situations
- Provide initial medical support for injuries or illnesses requiring only first-aid level support
- Provide site control and security measures as necessary

Incidental response measures will only be provided to the capabilities of on-site personnel and available resources. Incidental response measures are not considered an emergency response as per 29 CFR 1910.120 (b). Incidents and situations that are deemed to be an emergency response as defined by 29 CFR 1910.120 (b) will be handled by outside resources. It has been determined that these off-site response agencies are capable of providing the most effective response and will be designated as the primary responders. These agencies are located within a reasonable distance from the area of site operations, which ensures adequate emergency response time. These agencies will be contacted through NCBC Gulfport Emergency Dispatch. This Emergency Action Plan conforms to the requirements of 29 CFR 1910.38(a), as allowed in 29 CFR 1910.120(l)(1)(ii).

2.2 EMERGENCY PLANNING

Based on planned activities, the potential for field personnel to encounter significant emergency situations is minimal. However, based on the initial hazard/risk assessment effort, some potential exists for injuries or illnesses resulting from exposure to chemical and/or physical hazards or fire could be encountered during site activities. To minimize and eliminate these potential emergency situations, emergency planning activities associated with this project, the following responsibilities are assigned to the FOL and/or the SSO:

- Coordinating response actions with NCBC Gulfport Emergency Services personnel to ensure that TtNUS emergency action activities are compatible with existing facility emergency response procedures. This will serve as the initial review of the Emergency Action Plan.

- Establishing and maintaining information at the project staging area (Support Zone) for easy access in the event of an emergency. This information includes the following:

  - Chemical Inventory (for substances used on-site), with Material Safety Data Sheets.
  - On-site personnel medical records (medical data sheets).
  - A logbook identifying personnel on-site each day.
  - Emergency notification phone numbers in all site vehicles

Note: It is the responsibility of the TtNUS FOL and/or the SSO to ensure that this information is available and present at the site.

- Identifying a chain of command for emergency action.
- Educating site workers to the hazards and control measures associated with planned activities at the site, and providing early recognition and prevention, where possible.
- Preview work areas to remove physical hazards where identified.

2.3 EMERGENCY RECOGNITION AND PREVENTION

The primary focus of this section is the ability to recognize and control factors, which could contribute to an emergency situation/condition. The FOL, and/or the SSO will preview all site work location prior to committing personnel or resources. Their actions will be as follows:

- Identify, remove, and/or barricade physical hazards within the estimated work area.
  - Ensure that approach paths to monitoring wells are maintained (cleared, mowed, etc.)
  - Inspect monitoring well protective casings are cleared of spider and insect nests.
  - Inspect remote sample locations for signs of natural hazards (i.e., heavy brush – ticks; snakes, etc.)

- Provide the necessary equipment to control potential emergencies (i.e., safety cans for flammable liquid storage, spill containment equipment, PPE, and emergency equipment such as portable fire extinguishers).

- Evaluate operations to ensure that necessary measures are taken to control and/or minimize the impact of emergency situations/conditions. This includes actions such as, but not limited to, securing the necessary permits and clearances such as Utility and Excavation Clearances provided by the Base and Mississippi One Call Systems; Ensuring equipment and resources are at the ready for response to incidental measures; All personnel are adequately trained in the provisions of this HASP and this Emergency Action Plan.

- Complete site characterization for all predetermined work contaminated areas to quantify and qualify the hazards associated with those areas. Based on the results obtained the areas will be demarcated and restricted to only approved personnel.

Field Crew shall:

- Identify, remove, or barricade physical hazards within the estimated work area identified by the FOL and/or the SSO.
- Follow the guidelines for control of emergency conditions
- Report any potential emergency situation to the FOL and/or the SSO.

2.4 SAFE DISTANCES AND PLACES OF REFUGE

Upon activation of the on-site emergency alarm system the following actions will occur:

- All operations will cease.
- Field personnel will note the direction of the wind based on the position of wind socks or other wind direction indicator placed at the top of the mast or excavation equipment or other elevated points within the work area (i.e., streamer, flag, etc.).
- Based on the wind direction, personnel will move cross and up wind to either the primary or secondary safe place of refuge as identified in Figure 2-1(To be determined in the field by the FOL and/or the SSO).
- All personnel will remain at this location until directed otherwise by the FOL and/or the SSO.

2.4.1 Safe Place of Refuge Selection

The FOL and/or the SSO shall identify a safe place of refuge (in the event of an emergency) on the Safe Work Permit (Example – See Section 10.2). This location will be selected and conveyed to the Field Crew as part of issuing the Safe Work Permit at the beginning of each field task. Selection will be based on the following considerations:

- A location providing telephone communications and or shelter.
- A location from which the field crews can provide site security restricting access to the emergency area, however, a point from which the field crew may direct emergency crews (i.e., intersection or gate, etc.).

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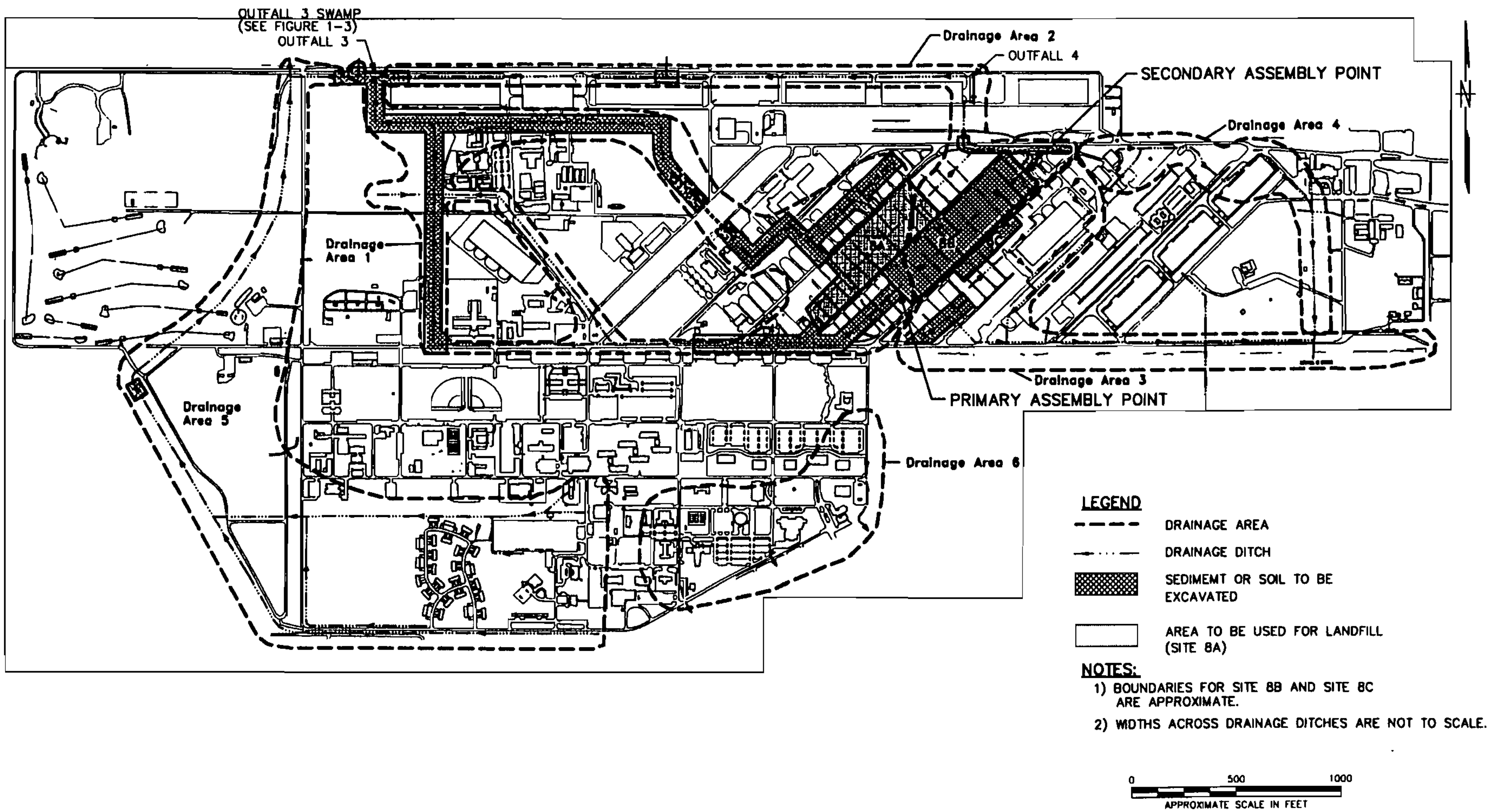


DRAWN BY HJP	DATE 11/1/00	SITE MAP PRIMARY AND SECONDARY ASSEMBLY POINTS NAVAL CONSTRUCTION BATTALION CENTER GULFPORT, MISSISSIPPI	CONTRACT NO 0567	
CHECKED BY SWH	DATE 11/2/00		APPROVED BY JLG	DATE 11/2/00
COST/SCHED-AREA			APPROVED BY	DATE
SCALE AS NOTED			DRAWING NO. FIGURE 2-1	REV. 1

SOURCE: REMEDIATION GUIDANCE DOCUMENT, HARDING LAWSON ASSOCIATES, MARCH 2000.

FORM CADD NO SDIV_BH.DWG - REV 0 - 1/20/98

In all cases this location should be positioned a sufficient (safe) distance from the operation whereas not to be impacted by the emergency. This distance is impacted by a number of conditions (i.e., tasks being conducted; chemical, physical, and toxicological properties; potential for fire and explosion; meteorological conditions; terrain).

2.4.2 Critical Operations

There are no operations being conducted under this scope of work that are considered critical and would require and individual or individuals to man during an emergency. Therefore in the event of an emergency all personnel will cease all operations and report to the safe place of refuge.

2.5 DECONTAMINATION PROCEDURES/EMERGENCY MEDICAL TREATMENT

During an evacuation, decontamination procedures will be performed only if doing so does not further jeopardize the welfare of site workers. However, it is unlikely that an emergency would occur which would require workers to evacuate the site without first performing decontamination procedures. Decontamination of medical emergencies will proceed in the following manner.

2.5.1 Non-Life Threatening Medical Incident (Bruises, Cuts, Scrapes, Etc.)

The area of clothing or suit penetration will be isolated from the decontamination procedure by removing the protective garments or clothing surrounding the area of the injury and applying a light gauze wrap and plastic cover. Decontamination for unaffected areas will proceed as per Table 5-1 of this HASP.

2.5.2 Life Threatening

- Notify off-site response agencies.
- If it will not endanger the injured individual (i.e., spinal cord injury, etc.) remove any outer PPE. Removal may require the use of bandage scissors to remove the outer garments.
- Begin life saving techniques as appropriate (CPR, cooling or warming regimens, etc.).
- Wrap the injured in a blanket for transport to the hospital.
- Engage Emergency Notification Sequence
- Follow instructions provided in Figure 2-2.

Note: One person from the field team will accompany the injured to the hospital with his/her medical data sheet, appropriate MSDSs, a copy of this HASP, and the incident forms. This person will collect as much information as possible and transfer that information to the HSM and Work Care as per the Incident

Response Protocol provided in Figure 2-2. All other personnel will engage site control/site security measures.

The SSO upon insuring care for the injured party will engage an investigation of the incident to gather as much information as possible. This includes as a minimum Who? What? Where? When? Why? And How?. This information will then be communicated to the TOM and the HSM.

2.5.3 Emergency Medical Treatment

Tetra Tech NUS and subcontractor personnel are only permitted to provide treatment to the level of their First-Aid Training.

Emergency medical treatment will be initiated under the following guarded restrictions:

- Notify the FOL and/or the SSO of the incident.
- Take the necessary precautions to prevent direct contamination with the injured person's body fluids.
  - Use surgeons gloves when handling cuts, abrasions, bites, punctures, etc. or any part of the injured person. The use of safety glasses and surgeons masks maybe necessary, if there is the potential for uncontrolled spread of body fluids.
  - Should Cardio-Pulmonary Resuscitation (CPR) be required, use a CPR Micro-Shield mouthpiece when administering CPR.

2.6 EMERGENCY ALERTING AND ACTION/RESPONSE PROCEDURES

If an emergency occurs on Base, the following procedures are to be initiated:

- Initiate an emergency notification by hand signals, voice commands, air horn, or two-way radios to the FOL/SSO. Describe to the SSO (who will serve as the Incident Coordinator) what has occurred and provide as many details as possible.

- Evacuate non-essential persons from the incident scene, engage initial response measures given the emergency type (i.e., spill response, fire extinguisher, first-aid, site control and security).

In the event that site personnel cannot control the incident through offensive and defensive measures, the FOL and/or SSO will enact the emergency notification procedures to secure additional outside assistance in the following manner:

- Call NCBC Gulfport Emergency Number

- Give the emergency operator the location of the emergency and a brief description of what has occurred.
- Stay on the phone and follow the instructions given by the operator
- The appropriate agency will be notified and dispatched
- Call Navy On-Site Representative
- Call the TOM and the HSM

If an incident occurs at outside of our designated operating areas impacting field personnel, the following procedures are to be initiated:

- Initiate an evacuation (if needed) by voice commands, hand signals, air horns, or two-way radio.
- Call Navy On-Site Representative
- Proceed to the assembly points as directed by NCBC Gulfport or other Navy personnel.

2.7 PPE AND EMERGENCY EQUIPMENT

A first aid kit, eye wash units (as necessary), stretcher, and fire extinguishers will be maintained on-site at an easily accessible location and shall be immediately available for use in the event of an emergency. Based on the hazards anticipated, these incident response abatement items may be maintained at the exclusion zone of on-going operations as determine and communicated to the field crew through the Safe Work Permit. This will be at the discretion of the SSO.

The FOL and/or the SSO should ensure the First-Aid Kits are provided stocked with the necessary equipment. All first-aid kits purchased for the job-site shall be American National Standards Institute (ANSI) approved for industrial applications. Additional provisions, if not included in the First-Aid Kit such as a Micro-Shield CPR mask identified within this plan will have to be secured in addition to the kit. The SSO will determine the number of kits necessary based on the number of personnel and the number of remote operations being conducted under the scope of work. It is the SSO's responsibility to assess work site applications for specific first-aid needs based on operations being conducted.

PPE levels to be used in an emergency will not exceed those items used in the completion of identified tasks.

2.7.1 <u>PPE Requirements - Incidental Spill of Investigative Derived Wastes (IDW)</u>

- PVC Rain-Suits or Tyvek based on the potential for soiling work clothes during clean-up
- PVC or Neoprene Over-boots (Pant legs on the outside of the over-boots)
- Nitrile inner surgeons gloves with Nitrile outer gloves over top

- Hard hat as conditions or overhead hazards exist
- Safety Glasses
- Splash Shields as necessary

The determination to tape seams (pant legs and sleeves to boots and gloves will be decided based on existing environmental conditions (external temperatures) and the potential for heat stress. Spill equipment (identified in Section 9.0) will be maintained in the investigative derived waste storage area to support rapid response.

2.7.2 Fire Fighting

Standard field attire will be used to combat incipient fires, from a sufficient distance as not to endanger field personnel. All personnel will be trained to use the fire extinguishers on-site as part of site-specific training. Fire extinguishers will be maintained at the following locations:

- Support trailer
- On each drill rig
- At all locations which store, dispense or otherwise handle flammable or combustible liquids.

All personnel will be trained in the proper use and maintenance of the fire extinguishers provided by their employer for use. The training information to be provided during site-specific training may be found in Attachment VII of this document.

2.8 EMERGENCY CONTACTS

Prior to performing work at the site, all personnel will be briefed on the emergency procedures to be followed in the event of an incident. A mobile phone shall be available on site. Table 2-1 provides a list of emergency contacts and their corresponding telephone numbers. This table must be posted on site where it is readily available to all site personnel.

2.9 INJURY/ILLNESS REPORTING

In addition, TtNUS personnel who are injured or become ill on the job must notify appropriate company representatives. Figure 2-2 and Attachment I presents the procedure for reporting an injury/illness, and the form to use for this purpose. **If the emergency involves personnel exposures to chemicals, follow the steps in Figure 2-2.**

TABLE 2-1

EMERGENCY REFERENCE

NCBC Gulfport

	AGENCY	TELEPHONE
1	**EMERGENCY** Police Fire/Hazardous Materials Release Ambulance Services	 (228) 871-2222 (228) 871-2333 (228) 871-2444
2	Base Contact Mr. Gordon Crane	(228) 871-2485 Pager 1(800) 343-3472
3	Memorial Hospital at Gulfport 4500 13th Street Gulfport, Mississippi 39501-2569	(228) 867-4000
4	Task Order Manager Robert Fisher	(850) 510-2743
5	CLEAN Health and Safety Manager Matthew Soltis, CIH, CSP	(412) 921-8912
	Project Health and Safety Officer Thomas Dickson, CSP	(412) 921-8457
*	Utilities (On Base) (Utility Clearances and Emergencies) Public Works Maintenance Division	(228) 871-2244
	Utilities (Public Utility Locating Service) Mississippi One Call System Inc.	1(800) 227-6477
	Chemtrec National Response Center Mississippi Regional Poison Control Center	(800) 424-9300 (800) 424-8802 (601) 354-7660
	Tetra Tech NUS, Tallahassee Office	(850) 359-9899
	Tetra Tech NUS, Pittsburgh Office	(412) 921-7090

* - The prioritization of the calling sequence has been provided in column 1. This applies to all injuries and incidents determined to be an emergency that may occur at NCBC Gulfport. The only time this will be altered is if a utility is struck and it is necessary to contact Public Works Maintenance Division to provide assistance. They then would be the first party contacted followed by Mr. Gordon Crane and so on as indicated on the list.

2.10 EMERGENCY ROUTE TO HOSPITAL (See Figure 2-3 for Map)

Directions from NCBC Gulfport:

Exit the Main Gate travel approximately two blocks to the traffic light.

Turn Left - At the traffic light

Emergency room is on the right approximately one half to one block travelling distance.

FIGURE 2-2
EMERGENCY RESPONSE PROTOCOL

The purpose of this protocol is to provide guidance for the medical management of injury situations.

In the event of a personnel injury or accident:

- Rescue, when necessary, employing proper equipment and methods.
- Give attention to emergency health problems -- breathing, cardiac function, bleeding, and shock.
- Transfer the victim to the medical facility designated in this HASP by suitable and appropriate conveyance (i.e. ambulance for serious events)
- Obtain as much exposure history as possible (a Potential Exposure report is attached).
- If the injured person is a Tetra Tech NUS employee, call the medical facility and advise them that the patient(s) is/are being sent and that they can anticipate a call from the WorkCare physician. WorkCare will contact the medical facility and request specific testing which may be appropriate. WorkCare physicians will monitor the care of the victim. Site officers and personnel should not attempt to get this information, as this activity leads to confusion and misunderstanding.
- Call WorkCare at 1-800-455-6155 and enter Extension 109, or follow the voice prompt for after hours and weekend notification and be prepared to provide:
  - Any known information about the nature of the injury.
  - As much of the exposure history as was feasible to determine in the time allowed.
  - Name and phone number of the medical facility to which the victim(s) has/have been taken.
  - Name(s) of the involved Tetra Tech NUS, Inc. employee(s).
  - Name and phone number of an informed site officer who will be responsible for further investigations.
  - Fax appropriate information to WorkCare at (714) 456-2154.
- Contact Corporate Health and Safety Department (Matt Soltis) at 1-800-245-2730.
- As data is gathered and the scenario becomes more clearly defined, this information should be forwarded to WorkCare.

WorkCare will compile the results of all data and provide a summary report of the incident. A copy of this report will be placed in each victim's medical file in addition to being distributed to appropriately designated company officials.

Each involved worker will receive a letter describing the incident but deleting any personal or individual comments. A personalized letter describing the individual findings/results will accompany this generalized summary. A copy of the personal letter will be filed in the continuing medical file maintained by WorkCare.

FIGURE 2-2 (continued)
WORKCARE
POTENTIAL EXPOSURE REPORT

Name: ______________________ Date of Exposure: __________

Social Security No.: ______________ Age: __________ Sex: ______

Client Contact: ______________________ Phone No.: __________

Company Name: ______________________________

I. Exposing Agent
Name of Product or Chemicals (if known): ______________________

Characteristics (if the name is not known)
Solid Liquid Gas Fume Mist Vapor

II. Dose Determinants
What was individual doing? ______________________
How long did individual work in area before signs/symptoms developed? __________
Was protective gear being used? If yes, what was the PPE? __________
Was their skin contact? ______________________
Was the exposing agent inhaled? ______________________
Were other persons exposed? If yes, did they experience symptoms? __________

III. Signs and Symptoms (check off appropriate symptoms)

Immediately With Exposure:

Burning of eyes, nose, or throat
Tearing
Headache
Cough
Shortness of Breath
Chest Tightness / Pressure
Nausea / Vomiting
Dizziness
Weakness

Delayed Symptoms:

Weakness
Nausea / Vomiting
Shortness of Breath
Cough
Loss of Appetite
Abdominal Pain
Headache
Numbness / Tingling

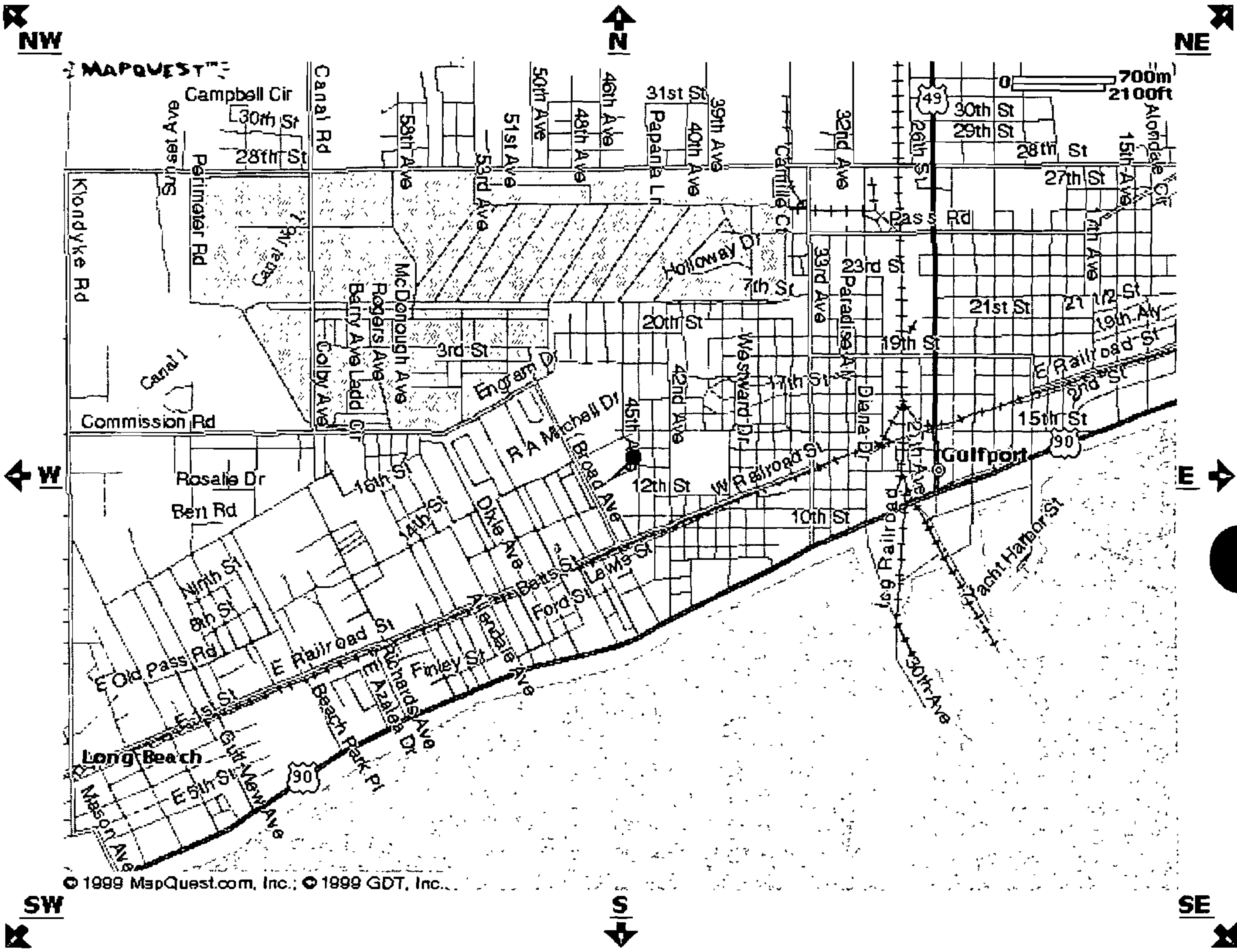
IV. Present Status of Symptoms (check off appropriate symptoms)
Burning of eyes, nose, or throat
Tearing
Headache
Cough
Shortness of Breath
Chest Tightness / Pressure
Cyanosis
Nausea / Vomiting
Dizziness
Weakness
Loss of Appetite
Abdominal Pain
Numbness / Tingling

Have symptoms: (please check off appropriate response and give duration of symptoms)
Improved: ________ Worsened: ______ Remained Unchanged: ______

V. Treatment of Symptoms (check off appropriate response)
None: __________ Self-Medicated: ______ Physician Treated: ______

FIGURE 2-3

HOSPITAL ROUTE MAP



3.0 SITE BACKGROUND

3.1 SITE DESCRIPTION

The Naval Construction Battalion Center (NCBC) Gulfport, Mississippi was commissioned as the homeport of the Atlantic Fleet Seabees in 1966. The Base occupies approximately 1,100 acres in the western part of Gulfport in the southeastern coastal area of Mississippi. The Navy previously used the property as a Naval Training Center and Naval Storehouse starting in 1942. Presently, four Naval Mobile Construction Battalions (NMCB) are based at Gulfport.

3.2 SITE HISTORY AND CURRENT OPERATIONS

From 1968 to 1977, nearly 23 acres of the Base were used for storage and handling of approximately 850,000 gallons of Herbicide Orange (HO) - and associated dioxins and furans (hereinafter referred to as "dioxin") - in 55-gallon drums. Spills and leaks of HO occurred during that period in the area later known as Site 8 (Areas A, B, and C). The magnitude of the release of HO and dioxin was first investigated in 1977 under the Initial HO Monitoring Program. Subsequent investigations in 1986 and 1987 delineated the horizontal and vertical extent of dioxin in soil at Site 8 to 1 microgram per kilogram (mg/kg). The 1986 and 1987 delineation work at Site 8 was followed by full-scale incineration of the soil contaminated above 1 ppb. The incineration was completed in 1988, and the resulting ash was stored in piles on Area A of Site 8.

In 1990, the USEPA changed the regulations concerning dioxin and lowered the maximum contaminant levels (MCL) for soil and groundwater below the 1mg/kg clean-up levels achieved in 1988. Subsequent investigations from 1995 through 1998 delineated the remaining dioxin in surface water and sediment, soil, and groundwater at Site 8 and at areas hydraulically connected to Site 8 (both on Base and off Base). The results of these investigations confirmed that dioxin-contaminated sediment had migrated from Site 8 into Base drainage ditches. Further, it was discovered that the contaminated sediment had migrated off Base and into the Turkey Creek Watershed north of the Base in an area called the Outfall 3 Swamp. Groundwater and soil impacted by HO-related dioxins were limited to the immediate area of Site 8 and associated ditches.

4.0 SCOPE OF WORK

The following subsections discuss the specific tasks that are to be conducted as part of this scope of work as identified by CTO 0143 and Statement of Work # 160. These tasks as identified by the scope of work are the only ones addressed by this HASP. Any tasks to be conducted outside of the elements listed here will be considered a change in scope requiring modification of this document. The TOM or a designated representative will submit all requested modifications to this document to the HSM.

Specific tasks to be conducted include, but are not necessarily limited to, the following:

- Mobilization/demobilization activities
- Excavation of contaminated materials (approximately 395 cubic yards). This material will be subjected to a variety of excavation tests in support of this project. These tests are as follows:
  - Free Water Removal Tests
  - Screening Tests
  - Mixing Tests (In-situ and Ex-situ)
  - Spreading and Compaction Tests
  - Geotechnical and Leachability Tests
- Monitoring well development/redevelopment
- Multi-media Sampling
  - Groundwater sampling
  - Soil sampling – Surface and Subsurface
  - Sediment sampling
  - Surface water sampling
- Decontamination of heavy construction and sampling equipment
- Surveying
- IDW Management

Investigation-derived waste (IDW) generated during sampling activities will be containerized in United Nations (UN1A2) approved 55-gallon drums.

4.1 MOBILIZATION/DEMOBILIZATION

This task includes, but not limited to, the following

- The procurement and shipping of equipment, and materials for the field investigation.

- Review of planning documents (i.e., HASP, Sampling and Analysis Plan, Work Plan, Quality Assurance Plan, etc.)
- Site Reconnaissance to include site characterization, site preparation, the layout of sampling, bench and pilot scale locations as well as excavation materials testing locations, and to secure the necessary utility clearances and isolate physical hazards, where applicable. It should be noted that the Public Works Maintenance Division handles all on-Base utility clearances for ALL utilities. Utility clearances will require 10-day advance notification. All utility clearances off-Base will proceed through Mississippi One Call System, Inc. A 2-working day advance notification is required. Once obtained the ticket is good for a period of 10-days.
- Secure, construct, or equip decontamination facilities to support the field investigations.
- Secure, construct, or equip IDW storage facilities to support the field investigations.

Primary hazards associated with this activity includes those of a physical nature such as lifting, strains/sprains, lacerations achieved during unpacking of equipment and during site preparation (i.e., cutting open boxes, lifting equipment, locating sample points, cutting paths to sample locations)

4.2 EXCAVATION OF CONTAMINATED MEDIA (SOILS AND SEDIMENTS)

In support of the various elements of this project, the excavation of approximately 395 cubic yards will be accomplished during the Pilot Study phase of this project. The collection will take place on and off Base. The collection of this material will be accomplished using heavy construction equipment (i.e., Back-hoes, Track-hoes, drag lines, skid loaders, high lifts, Tri-Axles or Tandem dumps, etc.). The impact areas will be delineated and the excavation will proceed from the furthest point out to the predetermined depth as they work out of the site. Materials will be collected and transported to a pre-determined location near the testing site for the pilot study. These activities will be followed by confirmation sampling to insure all contaminated media has been effectively removed.

Hazards associated with this operation include the following:

Traffic control hazards (heavy equipment, foot, and vehicular)
Dust and particulate emissions
Cross contamination of unaffected areas

4.2.1 Free Water Removal Tests

This activity will consist of the removal of free water within a roll-off container which will result in the formation of a water layer, or through the stockpiling on a dewatering pad and gravitation draining and collection.

Hazards associated with this activity include
Contaminated media contact
Traffic control hazards (heavy equipment, foot, and vehicular)

4.2.2 Screening Tests

The screening tests will be performed to insure particles larger than ¾ of an inch can effectively be removed. The excavated ash and sediment will be loaded into a vibrating mechanical screen. The ash shall be screened as close as possible to the area of the excavation test. The sediments will be screened near the dewatering location. All screened materials will be returned to the excavation areas.

Hazards associated with this activity include
Contaminated media contact (Dusts from the excavated ash materials)
Traffic control hazards (heavy equipment, foot, and vehicular)

4.2.3 Mixing Tests

Mixing tests will be conducted In-situ and Ex-situ. The In-situ mixing tests will consist of spreading the material in defined proportions and then cultivation and mixing using either discs or rototiller attached to a farm tractor.

Hazards associated with this activity include
Contaminated media contact (Dusts from agitated excavated ash materials)
Pinch and compression points; entanglement in rotating machinery

The Ex-situ mixing tests utilizes the mixing of the materials using a pug mill

Hazards associated with this activity include
Contaminated media contact (Dusts from agitated excavated ash materials)
Pinch and compression points; entanglement in rotating machinery

4.2.4 Spreading and Compaction Tests

The material blend generated from the selected mixing tests shall be spread and effectively compacted to build a landfill test cell. The spreading and compaction shall be accomplished through the use of earth moving equipment and a compaction roller. Once the material blend is evenly spread using a front end loader, bull-dozer, or grader the roller will be used to compact. Compaction will be field tested to determine compaction using a pocket penetrometer.

Hazards associated with this activity include
Contaminated media contact (Dusts from the excavated ash materials)
Traffic control hazards (struck by heavy equipment)

4.3 MONITORING WELL DEVELOPMENT/REDEVELOPMENT

The steps to develop or redevelop the new and existing monitoring wells are as follows:

- The depth to water and total depth of the well is measured using an M-scope or other electronic water level indicator.

- A surge block or submersible pump is lowered into the screened section of the well. The surge block or submersible pump is rapidly lowered and raised in the well causing groundwater to flow in and out of the well screen thus flushing fine sediment and debris out of the sandpack.

- A submersible pump or airlift hose is lowered into the well. The monitoring wells are pumped using a submersible pump, or by airlift. The pumping will continue until well stabilization parameters (pH, temperature, specific conductance, etc.) have stabilized or the amount of water extracted from the well has reached a predetermined volume.

The primary hazards during this activity are chemical contaminant exposure that can occur by aerolization of the contaminated media during pumping into the drum. This activity agitates the contaminated media increasing the potential for release. Secondary to the chemical exposure, however, resulting in more reported incidents are the material handling hazards. Site personnel trying to move full drums resulting in back injuries, smashed fingers (between drums), etc.

4.4 MONITORING WELL SAMPLING

The monitoring wells will be sampled using low-flow purging and sampling techniques. Peristaltic pumps will be used to purge and to collect the samples. Field measurements of pH, temperature, specific conductance, and turbidity will be made during purging. These measurements will be taken at the start of purging and every 3 to 5 minutes until the parameters have stabilized. The wells will be purged until a sufficient predetermined amount of water has been removed and the water quality measurements are acceptable. All tubing used for sampling will be dedicated and disposed of after the sample has been collected.

See primary hazards for monitoring well development.

4.4.1 Water Level Measurements

Water level measurements will be taken at the existing and newly installed monitoring wells during this field investigation. The water levels will be taken with an electric water level indicator using the top of the well casing as the reference point for determining water depths. Water levels will be conducted upon completion of the newly installed wells. All wells will be allowed to set for 24 hours after installation prior to development and 24 hours after that prior to the one round of water level measurements. The water level; measurements will be conducted within the same time interval (same day) to ensure minimal fluctuation.

Potential chemical exposure exists in this situation through direct contact with the contaminated water level measurement device. In addition to this hazard, but more predominant in remotely located wells are the potential for insect (bees) and spiders nest in the wells protective casing.

4.5 MULTI-MEDIA SAMPLING

4.5.1 Surface and Subsurface Soil Samples

Surface and Subsurface soil samples will be collected utilizing a variety of techniques. Surface and Subsurface soil sample acquisition from mechanized equipment will use split spoon, shelby tube, macro-core sampler by inserting them into either the borehole or annulus to extract a sample from a desired depth. The sample is removed from the device, scanned with the direct reading instrumentation, then transferred into the appropriate sample container.

4.5.1.1 Hand Augers

The hand auger borings will be advanced to the desired depth utilizing stainless steel hand auger stems with an over size bucket. Once at the desired depth, the oversize bucket will be exchanged for a smaller diameter bucket to grab the sample. The sample is extracted from the bucket and is placed in a stainless steel bowl, scanned with a direct reading instrument, then transferred into the appropriate glass container using a stainless steel trowel.

Hazards include direct chemical contaminant exposure, strain and sprain, and pinches and compressions when attempting to separate auger flights and buckets. Natural hazards, foot and vehicular traffic hazards also must be addressed relative to the location of the sampling point.

4.5.1.2 Drill Rigs Hollow-Stem Auger

Continuous-Flight Hollow-Stem Auger Drilling

This method of drilling consists of rotating augers with a hollow stem into the ground. Cuttings are brought to the surface by the rotating action of the auger. Advantages of this type of drilling include:

- Samples can be obtained while augers remain in the ground. Sampling requires the use of split-barrel or thin-wall tube samplers advanced through the hollow core of the auger.
- No drilling fluids are required.
- A well can be installed inside the auger stem and back-filled as the augers are withdrawn.

Primary physical hazards associated with this activity include lifting, rotating equipment, caught between/pinches and compressions, slips, trips and falls in and around rotating equipment, noise, underground or overhead energized sources, overhead hazards, and equipment failure. Bringing contamination to the surface through the drilling action the potential now also exists for chemical contaminant exposure.

See hazards in monitoring well installation above.

4.5.1.3 Direct-Push Technology

This method uses hydraulic pressure and percussion hammer to advance tooling into the ground. For soil sampling a Macro-core sampler is advanced in 2-foot intervals for soil sample extraction.

See hazards in monitoring well installation above.

4.5.2 Surface Water and Sediments

The collection of these environmental media will proceed as follows:

- Selection of location
- Direct-Reading monitoring instrument sweep.
- Transfer the selected environmental media into the containers to be sent to the analytical laboratory using direct pour, peristaltic pumps, or for sediments using stainless steel or disposable trowels

Hazards associated with activities of this nature include the potential for direct contact with contaminated media that in many cases is diluted or washed over. Natural hazards play a greater role in these locations because many species utilize streams and bodies of water for nesting or sustenance. This increases the potential for direct contact.

4.6 GEOGRAPHICAL/GEOPHYSICAL SURVEYING

This activity is generally non-intrusive in nature, however limited brush removal may be required. The brush removal will facilitate lines of sight and passage routes for the equipment during the survey. Given the activities that are to take place only limited samples remotely situated from Site 8, removal of vegetation for this purpose is not anticipated to any great extent.

Hazards associated with this activity are generally physical or natural hazards including lacerations (clearing brush), slips trips and falls, traffic hazards, insect (spiders, ticks, bees, etc.) and animal bites.

4.7 DECONTAMINATION

The equipment involved in the field activities for this investigation will be decontaminated prior to, during and after the completion of field activities. Decontamination of heavy equipment shall occur using pressure or steam cleaning apparatus.

4.7.1 Sampling Equipment

All non-dedicated sampling equipment (i.e. stainless-steel hand augers, trowels, bowls) will be decontaminated prior to the initiation of field sampling, between sample locations, and at the completion of the field activities. The following decontamination steps will be taken.

- Potable water rinse
- Alconox or Liquinox detergent wash

- Deionized (DI) water rinse
- Solvent rinse (Isopropanol)
- DI water rinse
- Air dry

All dedicated sampling and PPE equipment will be rinse to remove gross contamination. Then pending the sampling results be disposed of accordingly.

The primary hazards associated with this activity include direct contact with contaminated tooling or media as well as contact with cleaning solvents. Other associated hazards include noise (pressure washers and steam cleaners), high-pressure water (potential for water lacerations), flying projectiles, and material handling hazards (handling and stacking heavy auger flights).

4.8 IDW MANAGEMENT

This task includes the containerization, labeling, staging, monitoring, and final deposition of Investigation Derived Wastes (IDW). These are as follows:

Containerization -- Materials generated including soils; development, decontamination, and purge waters (Any and all materials that cannot be cleaned which may have direct contact with contaminated media). Containerization may utilize bulk storage (i.e., roll-off boxes or frac-tanks) or smaller United Nations approved 55-gallon drums (UN 1A2).

Labeling – All containers will be labeled as to their contents. The labels will include the following information

Site
Job Number
Location (SWMU)
Date – To be completed upon filling the container or when no more material is to be added
Drum # - Assign an inventory number to be added to a comprehensive log
Contents – Description
Volume – Final volume
Contact – This person should be available on base. To this end an up-dated inventory should be provided at the close of each shift to this person.
Emergency Number – Contact person provided above

Staging – All drums will be staged on pallets (4 to a pallet) with lid retention ring bolt accessible on the outside as well as the label. Pallet rows will maintain a minimum of 3 feet between rows for access and monitoring for leaks.

Monitoring – During staging site personnel will examine containers to ensure they are not leaking.

Final Deposition – IDW materials will be separated as determined through sampling and disposed of through pre-determined routes.

For more detailed description of the associated tasks, refer to the Pilot and Bench Scale Work Plans. Any tasks to be conducted outside of the elements listed here will be considered a change in scope requiring modification of this HASP. The PHSO or a designated representative will submit all requested modifications to this document to the HSM.

5.0 TASKS/HAZARDS/ASSOCIATED CONTROL MEASURES SUMMARIZATION

Table 5-1 of this section serves as the primary portion of the site specific HASP. This table is intended to assist project personnel in the recognition of hazards and recommended procedures necessary to minimize potential exposure or injuries related to those hazards. The table also assists field team members in determining which personal protective equipment (PPE) and decontamination procedures to be used as well as appropriate air monitoring techniques and site-specific conditions. The evaluation of each task provides detailed information including anticipated hazards, recommended control measures, air monitoring recommendations, required PPE, and decontamination measures. This table must be updated if the scope of work, contaminants of concern, or pertinent conditions change.

Table 5-1 and the HASP are not meant to be stand alone documents and must be accompanied by the TtNUS Health and Safety Guidance Manual. This manual is designed to further explain supporting elements for any site specific operations as required by 29 CFR 1910.120. The Guidance Manual should be referenced for additional information regarding air monitoring instrumentation, decontamination activities, emergency response, hazard assessments, hazard communication and hearing conservation programs, medical surveillance, PPE, respiratory protection, site control measures, standard work practices, and training requirements. Many of TtNUS's SOPs are also provided in the Guidance Manual.

Safe Work Permits will be issued for all exclusion zone activities (See Section 10.2). The FOL and/or the SSO will use the elements defined in Table 5-1 as the primary reference. The FOL and/or the SSO completing the Safe Work Permit will add additional site-specific information as warranted. In situations where the Safe Work Permit is more conservative than the direction provided in Table 5-1 due to the incorporation of site-specific elements, the Safe Work Permit will be followed.

5.1 GENERAL SAFE WORK PRACTICES

In addition to the task-specific work practices identified on Table 5-1, the following general safe work practices (SWP) are to be followed when conducting work on-site. These safe work practices address a pattern of general precautions and measures for reducing risks associated with site operations. This list is not all inclusive and may be amended as necessary.

- NO eating, drinking, chewing gum or tobacco, taking medication, or smoking in contaminated or potentially contaminated areas or where the possibility for the transfer of contamination exists.

- Wash hands and face thoroughly upon leaving a contaminated or suspected contaminated area. A thorough shower and washing must be conducted as soon as possible if excessive skin contamination occurs.

- Avoid contact with potentially contaminated substances. Avoid puddles, pools, mud, or other such areas. Avoid, whenever possible, kneeling on the ground or leaning or sitting on equipment. Keep monitoring equipment away from potentially contaminated surfaces.

- Obey all instructions in the site-specific HASP.

- Take note of the location of the nearest telephone and all emergency telephone numbers. See Section 2.0, Table 2-1.

- Attend briefings on anticipated hazards, equipment requirements, safe work permits, emergency procedures, and communication methods before going on site.

- Plan and mark entrance, exit, and emergency escape routes. See Section 2.0.

- Rehearse unfamiliar operations prior to implementation.

- Buddies should maintain visual contact with each other and with other on-site team members by remaining in close proximity to assist each other in case of emergency.

- Establish appropriate Safety Zones including Support, Contamination Reduction, and Exclusion Zones.

- Minimize the number of personnel and equipment in contaminated areas (such as the Exclusion Zone). Non-essential vehicles and equipment should remain within the Support Zone.

- Establish appropriate decontamination procedures for leaving the site.

- Immediately report all injuries, illnesses, and unsafe conditions, practices, and equipment to the Site Safety Officer (SSO).

- Matches and lighters are restricted from entering in the Exclusion Zone or Contamination Reduction Zone.

- Observe coworkers for signs of toxic exposure and heat or cold stress.

- Inform co-workers of potential symptoms of illness, such as headaches, dizziness, nausea, or blurred vision.

5.2 DRILLING OPERATIONS - SAFE WORK PRACTICES

The following Safe Work Practices are to be followed when working in or around Direct Push Operations.

5.2.1 Before Drilling Operations

- Identify all underground utilities and buried structures before drilling. Use the Utility Locating and Excavation Clearance Standard Operating Procedure provided in Attachment II. See notes for the time lines required on and off-Base utility clearances under mobilization/demobilization Section 4.1.

- All drilling rigs will be inspected by a Competent Person (the SSO or designee), prior to the acceptance of the equipment at the site and prior to the use of the equipment. All repairs or deficiencies identified will be corrected prior to use. The inspection will be accomplished using the Equipment Inspection Checklist provided in Attachment III. Inspection frequencies will be once every 10 day shift or following repairs.

- The work area around the point of operation will be graded to the extent possible to remove any trip hazards near or surrounding operating equipment.

- The driller's helper will establish an equipment staging and lay-down plan. The purpose of this is to keep the work area clear of clutter and slips, trips, and fall hazards. Mechanisms to secure heavy objects such as drill flights will be provided to avoid the collapse stacked equipment.

- All potentially contaminated tooling will be wrapped in polyethylene sheeting for storage and transport to the centrally located decontamination unit.

5.2.2 During Drilling Operations

- Minimize contact to the extent possible with contaminated tooling and environmental media.

- Support functions (sampling and screening stations) will be maintained a minimum distance from the drilling rig of the height of the mast plus five feet to remove these activities from within physical hazard boundaries.

- Only qualified operators and knowledgeable ground crew personnel will participate in the operation of the drill rig.

- In order to minimize contact with potentially contaminated tooling and media and to minimize lifting hazards, multiple personnel should move heavy tooling, where necessary.

- Only personnel absolutely essential to the work activity will be allowed in the exclusion zone. Site visitors will be escorted at all times.

5.2.3 After Drilling Operations

- All equipment used within the exclusion zone will undergo a complete decontamination and evaluation by the SSO to determined cleanliness prior to moving to the next location, exiting the site, or prior to down time for maintenance.

- All motorized equipment will be fueled prior to the commencement of the day's activities. During fueling operations all equipment will be shutdown and bonded to the fuel provider.

- When not in use all direct push rigs will be shutdown, emergency brakes set, and wheels chocked.

- All areas subjected to subsurface investigative methods will be restored to equal or better condition than original to remove any contamination brought to the surface and to remove any physical hazards. In situations where these hazards cannot be removed these areas will be barricaded to minimize the impact on field crews working in the area.

5.3 EXCAVATION – GENERAL SAFE WORK PRACTICES

5.3.1 Before Excavation Activities

- Identify all underground utilities and buried structures before the commencement of excavation activities. Use the Utility Locating and Excavation Clearance Standard Operating Procedure provided in Attachment II. This includes an evaluation of the intended loading areas to insure swing patterns of excavators are not nearing any overhead power lines. A minimum clearance of 20 feet must be maintained from overhead power lines unless positive control of the energy source may be obtained. See Attachment II for additional information. See notes for the time lines required on and off-Base utility clearances under mobilization/demobilization Section 4.1.

- All excavation boundaries will be demarcated with appropriated signage warning of construction activities in progress. Signs shall be used also for informational purposes as well to direct personnel, to indicate PPE requirements.

- All heavy equipment will be subjected to an equipment inspection, upon arrival on-site and prior to leaving. This inspection will be recorded on the Equipment Inspection Checklist provided in Attachment III of this HASP.

- Establish traffic patterns for equipment and the loading of trucks. This pattern should form a loop to minimize backing (an activity involved in when many accidents occur).

- Establish traffic patterns for foot and small vehicular traffic out of the pattern for heavy equipment.

- All traffic patterns for heavy equipment will be constructed to maintain traffic flow a minimum of 10 feet from unsupported walls (excavation boundaries) Note: The standard (29 CFR 1926 Subpart P) stipulates 2 feet distance from unsupported walls for resource staging. However, a maintenance distance of 10 feet will be maintained until soil classification is complete supporting a closer distance.

- Excavation along thoroughfares will require the use of signage, barricades and flag-persons for alteration of traffic patterns, as necessary.

- Calculate load limits based on the types of materials and level of saturation. Saturated or wet earth will weigh approximately 100 pounds per cubic foot or 2700 pounds per cubic yard. A 24-ton dump truck then will take approximately 15 one-yard buckets before it is overloaded. It is critical not to overload the trucks as they have to move over public roads and properties. This is both a public safety and a structural (roadways) restriction.

- All ground personnel will be provided with reflective vests to increase visibility and air horns to signal loud trucks and heavy equipment.

- All operators travelling over public roadways will carry a Commercial Drivers License (Class B minimum) and up-to-date medical clearance.

5.3.2 During Excavation Activities

- Ground activities such as the loading of trucks should be supported with a ground spotter controlling the actions of the truck to be loaded as well as the loader. The operators will be instructed they are to follow only the instructions provided by the ground spotter unless another party is otherwise authorized.

- All trucks being loaded will be mathematically calculated as to the amount being loaded. Trucks will pass portable scales to confirm weight prior to entering the public thoroughfares.

- All loads travelling over public roadways and unaffected pathways on base will be loaded and a load inspection report completed for each load by the FOL, SSO or appointed designee.

- A decontamination station will be established at the loading and off loading areas to flush mud and dirt from the wheels and tires as well as any areas of the vehicle impacted during the loading operation.

- If excavations are greater than four feet in total depth this plan will require modification to address sloping and shoring requirements as they may exist in accordance with 29 CFR 1926 Subpart P (Soil Classification - Class A, 53° slope or 0.75:1; Class B, 45° slope or 1:1; Class C, 34° slope or 1.5:1).

- All access into the excavation shall be controlled and limited to authorized personnel. Access to excavations deeper than four feet or trenches shall be denied unless approved by a Competent Person in accordance with 29 CFR 1926 Subpart P.

- All routes other than those traffic patterns established shall be controlled or barricaded to focus entry and exiting through control points.

5.3.3 After Excavation Activities

- Confirmation sampling to indicate removal of contaminated materials will not occur during heavy equipment operation. Samplers will move in after hours or during break periods for obvious reasons.

- Control points for excavations to be left open and unattended shall be secured in the off hours.

- For excavations greater than four feet in depth ladders, earthen ramps, etc. will be provided for every twenty-five feet of lateral travel to provide means for entering and exiting.

- An active effort to remove standing water from excavations will be conducted, also due to the obvious hazards invoked.

TABLE 5-1

TASKS/HAZARDS/CONTROL MEASURES COMPENDIUM
NAVAL CONSTRUCTION BATTALION CENTER GULFPORT, MISSISSIPPI

Task/Operation/Location	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring - Type and Action Levels	Personal Protective Equipment *(Items in italics are deemed optional as conditions or the FOL or SSO dictate.)*	Decontamination Procedures
Mobilization/ Demobilization	***Chemical hazards:*** 1) The on-site Hazard Communication Program (Section 5.0 TtNUS Health and Safety Guidance Manual) will be followed. All chemicals brought onto the site by Tetra Tech NUS and subcontractor personnel will be inventoried and have an MSDS on site, on file. This effort shall include Accurate Chemical Inventory List (Entries will match chemicals brought on-site, as the names appear on the MSDS) This list, which also includes quantities and storage locations will be provided to NCBC Gulfport Emergency Response Units. MSDS's will be maintained in a central location, accessible to all personnel. All containers will have labels specifying the following information: Chemical Identity (As it appears on the label, MSDS, and Chemical Inventory List) Appropriate Warning (i.e., Eye and skin irritation, flammable, etc.) Manufacturer's Name Address and Phone Number It will be the FOL and/or the SSO's responsibility to insure this is completed. ***Physical hazards:*** 2) Lifting (strain/muscle pulls) 3) Pinches and compressions/Struck by 4) Slips, trips, and falls 5) Heavy equipment hazards (rotating equipment, hydraulic lines, etc.) 6) Vehicular and foot traffic 7) Ambient temperature extremes (heat/cold stress) ***Natural hazards:*** 8) Insect/animal bites and stings, poisonous plants, etc. 9) Inclement weather	***Chemical hazards:*** 1) All personnel will be required to review the appropriate MSDS's, prior to the use of a specified chemical substance. This direction should also be communicated on the Safe Work Permit completed for this task. ***Physical hazards:*** 2) Use machinery or multiple personnel for heavy lifts. - Use proper lifting techniques - Lift with your legs, not your back, bend your knees move as close to the load as possible, and ensure good hand holds are available. - Minimize the horizontal distance to the center of the lift to your center of gravity. - Minimize turning and twisting when lifting as the lower back is especially vulnerable at this time. - Break lifts into steps if the vertical distance (from the start point to the placement of the lift) is excessive. - Plan your lifts – Place heavy items on shelves between the waist and chest; lighter items on higher shelves. - Periods of high frequency lifts or extended duration lifts should provide sufficient breaks to guard against fatigue and injury. In determining whether you can lift an item several factors must be considered, these are as follows: Maximum weight lifted by a single person should not exceed 70 pounds. Items over 70 pounds or the amount you feel you can confidently lift up to 70 pounds should define a point where assistance in the lift is sought. Other considerations defining lifting hazards - Area available to maneuver the lift. - Area of the lift – Work place clutter, slippery surfaces - Overall physical condition 3) Keep any machine guarding in place. Do not modify tooling without manufacturer's expressed permission. - Avoid moving parts. - Use tools or equipment where necessary to avoid contacting pinch points. - Adjust machine guarding as necessary to minimize distance between guards and point of operation. - When staging equipment, insure all stacked loads, shelving, are adequately secure to avoid creating a hazard from falling objects. - All equipment will undergo a thorough equipment inspection. Mechanized and powered equipment inspections will be documented on the Equipment Inspection Checklist provided in Attachment III. All hand tools will be inspected (handle condition, cutting attachment, as applicable) to insure acceptable condition. 4) Preview work locations for unstable/uneven terrain. - Cover, guard and barricade all open pits, ditches, and floor opening as necessary. - The FOL and the SSO during site surveys and site preparation should identify these potential hazards. 5) All equipment will be - Inspected in accordance with OSHA and manufacturer's design. - Operated by knowledgeable operators and ground crew. 6) Traffic and equipment considerations are to include the following: - Establish safe zones of approach (i.e. Boom or mast + 5 feet). - Foot and vehicular traffic routes shall be well defined - All self-propelled equipment shall be equipped with movement warning systems. - All activities are to be conducted consistent with the site requirements. - The FOL and/or the SSO as a precautionary measure to remove or demarcate physical hazards shall preview traffic routes (foot and vehicular) before the commitment of personnel and resources. 7) Wear appropriate clothing for weather conditions. Provide acceptable shelter and liquids for field crews. Additional information regarding heat and cold stress is provided in Section 4.0 of the TtNUS Health and Safety Guidance Manual. ***Natural hazards:*** 8) Avoid nesting areas; Tape pant legs to work boots when in high brush (knee high) (tick hazards); Use repellents – Apply Permonone over clothing articles to avoid skin irritation. Application of repellants should concentrate where ticks and other insects will gain entry. Pant to boots, shirt to pants, collar; Perform close body inspections upon exiting high brush areas to facilitate and remove ticks and other insects; Report potential hazards to the SSO. Follow guidance presented in Section 4.0 of the TtNUS Health and Safety Guidance Manual. 9) Suspend or terminate operations until directed otherwise by SSO.	Visual observation of work practices by the SSO to minimize potential physical hazards (i.e., improper lifting, unsecured loads, noise, etc.).	Level D - (Minimum Requirements) - Standard field attire (Sleeved shirt; long pants) - Safety shoes (Steel toe/shank) - *Safety glasses* - *Hardhat (when overhead hazards exists, or identified as a operation requirement)* - *Reflective vest for high traffic areas* - *Hearing protection for high noise areas, or as directed on an operation by operation scenario.*	Not required. However, to minimize the potential for the ticks or other insects to attach themselves to human hosts, persons exiting woods or high brush areas should perform a close body inspection to identify and remove these vectors as soon as possible. This should be conducted prior to entering site vehicles, trailers, etc. where the ticks or other insects may detach impacting other whose use this equipment or facilities.

TABLE 5-1

TASKS/HAZARDS/CONTROL MEASURES COMPENDIUM
NAVAL CONSTRUCTION BATTALION CENTER GULFPORT, MISSISSIPPI

Tasks/Operation/ Locations	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring - Type and Action Levels	Personal Protective Equipment (Items in italics are deemed optional as conditions or the FOL or SSO dictate.)	Decontamination Procedures
Soil borings using Hollow Stem Auger Drill Rig	***Chemical hazards:*** 1) Previous analytical data identified the following compounds as contaminants of concern (Air - Dust/particulate contaminants) 2,3,7,8 –TCDD (Tetrachlorodibenzo –p-dioxin) It is estimated that concentrations within the soil range between Non-detectable to 5 ppb in the soils. At this concentration TCDD represents little occupational exposure threat in an outdoor setting. See Attachment VIII for mathematical calculations for determining potential airborne concentrations. It is recommended that exposure (via inhalation, ingestion, or skin contact) to this contaminant be minimized due to its bio-accumulative properties. Further information on this contaminant is presented in Figure 6-1. 2) Transfer of contamination into clean areas or onto persons ***Physical hazards:*** 3) Heavy equipment hazards (pinch/compressions points, rotating equipment, hydraulic lines, etc.) 4) Noise in excess of 85 dBA 5) Energized systems (contact with underground or overhead utilities) 6) Lifting (strain/muscle pulls) 7) Slips, trips, and falls 8) Vehicular and foot traffic 9) Ambient temperature extremes (heat/cold stress) 10) Flying projectiles ***Natural hazards:*** 11) Insect/animal bites and stings, poisonous plants, etc. 12) Inclement weather	***Chemical hazards:*** 1) As a general rule, avoiding contact with contaminated media (air, water, soils, etc.) and free product will be a universal control measure. As the material in question is a solid and/or bound to particulates, dust/particulate suppression will be the next control measure employed to minimize potential exposure. Given, the reported concentrations existing within the soils up to 5 ppb, the overall dust concentrations in the air would have to exceed 50,000 mg/m^3 total dust concentration to present an exposure threat TCDD. Although this is unlikely even in the absence of any control measures, monitoring will be conducted to provide quantitative data regarding emissions 2) Restrict the cross use of equipment and supplies between locations and activities without first going through a suitable decontamination. Work practices including - A rigid decontamination procedure will be employed between locations will insure materials are not carried and deposited in unaffected areas. ***Physical hazards:*** 3) All equipment will be: - Inspected in accordance with Federal safety and transportation guidelines, OSHA (1926.600 601.602), and manufacturer's design. All inspections will be documented using the Equipment Inspection Checklist found in Attachment III of this HASP. - Operated and supported by knowledgeable operators, and ground crew. - Used within safe work zones, with routes of approach clearly demarcated. All personnel not directly supporting this operation will remain at least 25 feet from the point of operation. See Section 9.0 of this HASP. This will be the area identified as the exclusion zone. In addition to equipment considerations, the following safe operating procedures will be incorporated: - Hydraulic masts or other projecting devices shall be at least 20 feet from overhead power sources and a minimum of 3 feet from underground utilities - Hand signals will be established prior to the commencement of the operation. - A remote sampling device must be used to sample drill cuttings near rotating tools - Only manufacturer-approved equipment may be used in conjunction with equipment repair procedures (e.g., flight connectors). - Work areas will be kept clear of clutter. - Secure all loose articles to avoid possible entanglement during coring activities. - All self-propelled equipment shall be equipped with movement warning systems. - All personnel will be instructed in the location and operations of the emergency shut-off device(s). This device will be tested initially (and then periodically) to ensure its operational status. - Areas will be inspected prior to the movement of the drill rig and support vehicles to eliminate any physical hazards. This will be the responsibility of the FOL and/or SSO. - The drill rig and support vehicles will be moved no closer than 10 feet to unsupported side-walls of excavations and embankments. 4) Hearing protection will be used during all subsurface activities using drill rig when noise levels are > 85 dBA. (during operation). Boundaries will be established to limit noise hazard. Height of the mast + 5 feet or a minimum of 25 feet is normal. Excessive noise levels are being approach when you have to raise your voice to talk to someone within 2 feet of your location. 5) All drilling activities will proceed in accordance with the Utility Locating and Excavation Clearance SOP in Attachment II of this HASP. All utility clearances will be obtained, in writing, and locations identified and marked prior to activities. Overhead utilities will also be identified. 6) Use machinery or multiple personnel for heavy lifts. Use proper lifting techniques. 7) Preview work locations for unstable/uneven terrain. 8) Use traffic-warning signs, flag persons, and high visibility vests as determined by the SSO when working in or along traffic thoroughfares. 9) Wear appropriate clothing for weather conditions. Acceptable shelter and liquids for field crews 10) Wear eye protection and hard hat when the drill rig is operating. Restrict all others from the area. ***Natural hazards:*** 11) Avoid nesting areas, use repellents. Report potential hazards to the SSO. See Section 6.3 of this HASP and Section 4.0 of the TtNUS Health and Safety Guidance Manual for additional information concerning natural hazards. 12) Suspend or terminate operations until directed otherwise by SSO.	Continuous monitoring will be performed during operations to ensure safe work conditions do not change as a result of work being performed or other external factors. Monitoring of each excavation activity, in particular, will be performed in an attempt to anticipate and characterize site contaminants. **Dusts/Particulates** Mini-Ram Dust Monitors Action Levels Visible dust (2 mg/m^3) – Employ dust suppression (area wetting) methods when handling dry materials which have a tendency to become airborne much more easily than wet or moist materials. This action level should control potential overexposure to the primary contaminant of concern TCDD There have been no other contaminants of concern reported as determined through historical information.	All drilling operations will be performed in Level D protection, including the following articles: - Standard field dress (long pants, Sleeved shirts) - Steel toe safety shoes or work boots - Hard hat - Tyvek or washable cotton coveralls - Impermeable boot covers **Driller and Driller Helper** - Standard field attire including sleeved shirt and long pants - Safety shoes (Steel toe/shank) - Safety glasses - Nitrile inner gloves; Butyl outer gloves - Hard hat (when overhead hazard exists) - Impermeable outer garments such as PVC Rain-suit or Saranex®, PE coated Tyvek® due to contact with contaminated tooling. An impermeable apron is acceptable due to heat stress. - Hearing protection for high noise areas - *Reflective vest for traffic areas* Upgrade to Level C protection Dust concentrations exceeding 2 mg/m^3 that cannot be controlled through dust suppression methods. - Level D minimum requirements listed above - Full-face APR with organic vapor/acid gas/HEPA cartridges. The material in question is suspected to be in solid form. The cartridges will be changed out as necessary. As the HEPA cartridges become more difficult to breath through the mechanical filtration is becoming overloaded and should be exchanged. **Note:** The Safe Work Permit(s) for this task (see Attachment IV of this HASP) will be issued at the beginning of each day to address the tasks planned for that day. As part of this task, additional PPE may be assigned to reflect site-specific conditions or special considerations or conditions associated with any identified task. Protective levels may require modification should this activity be required to be conducted within a controlled zone due to an on-going operation.	**Personnel Decontamination** will consist of a soap/water wash and rinse for reusable and non-reusable outer protective equipment (boots, gloves, PVC splash suits, as applicable). In addition to the soap and water wash and rinse a vacuum equipped with a HEPA filter may be used to remove dust and dirt from cotton coveralls. This decontamination function may be subdivided into two locations. Gross contamination of outer boots and outer gloves will be removed at a satellite location near the operation. Final wash and rinse will take place at the centralized decontamination pad. The sequential procedure is as follows: Stage 1: Equipment drop, remove outer protective wrapping; Decon personnel will wipe down the outer shell and pass hand equipment through as necessary. Stage 2: Soap/water wash and rinse of outer boots and gloves Stage 3: Soap/water wash and rinse of the outer splash suit, as applicable. If personnel are wearing cotton coveralls these may be vacuumed at this point. Stage 4: Disposable PPE will be removed and bagged. Stage 5: Wash face and hands Stage 6: Depending on ambient conditions, you may be required to report for medical evaluation. This evaluation consists of pulse, breathing rate, oral temperature, and body weight. This medical screening will be performed when ambient conditions dictate and during periods of acclimatization. **Equipment Decontamination** - All heavy equipment decontamination will take place at a centralized decontamination pad utilizing a steam cleaner. Current technology indicates hot water deactivation of the Mustard component is the most suitable means for removal and neutralization. Heavy equipment will have the wheels and tires cleaned along with any loose debris removed, prior to transporting to the central decontamination area. All site vehicles will have restricted access to exclusion zones, and have their wheels/tires sprayed off as not to track mud onto the roadways servicing this installation. Roadways shall be cleared of any debris resulting from the onsite activity. **Sampling Equipment Decontamination** Sampling equipment will be decontaminated as per the requirements in the Sampling and Analysis Plan and/or Work Plan. All equipment used in the exclusion zone will require a complete decontamination between locations and prior to removal from the site. The FOL or the SSO will be responsible for evaluating equipment arriving on-site, leaving the site, and between locations. No equipment will be authorized access, exit, or movement to another location without this evaluation.

TABLE 5-1

TASKS/HAZARDS/CONTROL MEASURES COMPENDIUM
NAVAL CONSTRUCTION BATTALION CENTER GULFPORT, MISSISSIPPI

Tasks/Operation/ Locations	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring – Types and Action Levels	Personal Protective Equipment *(Items in italics are deemed optional as conditions or the FOL or SSO dictate.)*	Decontamination Procedures
Excavation of contaminated media from locations on and off NCBC Gulfport The purpose of this activity is to move the contaminated media to a location suitable to conduct the pilot, bench, and feasibility studies. This activity shall also include - Free water removal tests - Screening testing - Mixing testing - Spreading and compaction testing To be performed on the excavated media	*Chemical hazards:* 1) Previous analytical data identified the following compounds as contaminants of concern (Air - Dust/particulate contaminants) 2,3,7,8 –TCDD (Tetrachlorodibenzo –p-dioxin) It is estimated that concentrations within the soil range between Non-detectable to 5 ppb in the soils. At this concentration TCDD represents little occupational exposure threat in an outdoor setting. See Attachment VIII for mathematical calculations for determining potential airborne concentrations. It is recommended that exposure (via inhalation, ingestion, or skin contact) to this contaminant be minimized due to its bio-accumulative properties. Further information on this contaminant is presented in Figure 6-1. 2) Transfer of contamination into clean areas or onto persons. *Physical hazards:* 3) Heavy equipment/machinery hazards (moving equipment, struck by hazards, etc.) 4) Collapse of the excavation 5) Energized systems (contact with underground or overhead utilities) 6) Noise in excess of 85 dBA 7) Vehicular and equipment traffic 8) Strain from heavy lifting 9) Slips, trips, and falls 10) Ambient temperature extremes (heat stress) 11) Cut, abrasions, and lacerations *Natural hazards:* 12) Insect/animal bites and stings, poisonous plants, etc. 13) Inclement weather	***Chemical hazards:*** 1) As a general rule, avoiding contact with contaminated media (air, water, soils, etc) and free product will be a universal control measure. As the material in question is a solid and/or bound to particulates, dust/particulate suppression will be the next control measure employed to minimize potential exposure. Given, the reported concentrations existing within the soils up to 5 ppb, the overall dust concentrations in the air would have to exceed 50,000 mg/m^3 total dust concentration to present an exposure threat TCDD Although this is unlikely even in the absence of any control measures, monitoring will be conducted to provide quantitative data regarding emissions. 2) Restrict the cross use of equipment and supplies between locations and activities without first going through a suitable decontamination. Work practices including - Excavating from the furthest point on the site and working out will minimize tracking contaminated materials over clean areas. - A rigid decontamination procedure at the loading and off-loading locations will insure materials are not carried and deposited in unaffected areas. - Sealable tail gates and liners, and covered/tarped loads, if necessary will be employed to minimize the spread of this material during transportation into unaffected areas. ***Physical hazards:*** 3) All equipment to be employed will be - Inspected in accordance with Federal safety and transportation guidelines, OSHA (1926 600,601, 602), and manufacturer's design, and documented as such using Equipment Inspection Checklist provided as Attachment III. Complete the Equipment Inspection Checklist for each piece of equipment used at the site. Equipment operation will be: - Conducted by knowledgeable operators and coordinated by experienced ground crew, as applicable. 4) All excavations shall be in conformance with requirements established under 29 CFR 1926.650 - .652 concerning sloping, shoring, storage, and movement on and over and around trenches and excavations. - **No personnel associated with this field effort will enter any excavations without expressed permission of the SSO.** - All supplies, clean fill, vehicular traffic will be maintained at a minimum distance of 10 feet from the excavation until soil classification can be determined or side-wall restraining device is employed. - Excavations will not proceed any closer than 6 feet to any foundation, footer, and/or support base. - The teeth of the bucket will have a flat bar or cutting bar attached to the teeth to prevent the teeth of the backhoe from snagging an undetected utility. - Site control during excavation will be accomplished through the use of barricade tape and weighted poles and signs indicating excavation in progress 5) All utility clearances shall be obtained prior to any excavation activities. Where the utility clearance cannot be obtained in a reasonable period, or not located, excavations shall proceed with extreme caution and proceed using cable and piping locators and other geophysical detection methods to avoid utility damage 6) Hearing protection will be worn by all personnel in the immediate area of the excavator during test pit operations. 7) Traffic and equipment considerations are to include the following: - Establish safe zones of approach (i e., Boom + 3 feet). - All equipment shall be equipped with movement warning systems. - Employ safety belts and follow the site traffic rules. See Section 5.3.1 through 5.3.3 of this HASP. 8) Use machinery or multiple personnel for heavy lifts. Use proper lifting techniques. 9) Preview work locations for unstable/uneven terrain. Avoid working/walking too close to excavation and other areas of unsure footing. 10) Wear appropriate clothing for weather conditions. Provide acceptable shelter and liquids for field crews Additional information regarding heat stress concerns is provided in Section 4.0 of the TtNUS Health and Safety Guidance Manual. 11) Avoid contacting sharp or jagged edges of containers or debris. Wear leather or cut-resistant gloves when handling excavated/sharp objects 12) Avoid nesting areas; Tape pant legs to work boots when in high brush (knee high) (tick hazards); Use repellents – Apply Permonone over clothing articles to avoid skin irritation. Application of repellants should concentrate where ticks and other insects will gain entry. Pant to boots, Shirt to pants, collar; Perform close body inspections upon exiting high brush areas to facilitate and remove ticks and other insects; Report potential hazards to the SSO. Follow guidance presented in Section 4.0 of the TtNUS Health and Safety Guidance Manual and Section 6.3 of this HASP. 13) Suspend or terminate operations until directed otherwise by SSO	Continuous monitoring will be performed during operations to ensure safe work conditions do not change as a result of work being performed or other external factors Monitoring of each excavation activity, in particular, will be performed in an attempt to anticipate and characterize site contaminants. **Dusts/Particulates** Mini-Ram Dust Monitors Action Levels Visible dust (2 mg/m^3) – Employ dust suppression (area wetting) methods when handling dry materials which have a tendency to become airborne much more easily than wet or moist materials. This action level should control potential overexposure to the primary contaminant of concern TCDD. There have been no other contaminants of concern reported as determined through historical information.	All excavation operations will be performed in Level D protection, including the following articles: - Standard field dress (long pants, Sleeved shirts) - Steel toe safety shoes or work boots - Hard hat - Tyvek or washable cotton coveralls - Impermeable boot covers Personnel must closely inspect all PPE prior to beginning any on-site activities. **Note:** The Safe Work Permit(s) for this task (see Attachment IV) will be issued at the beginning of each day to address the tasks planned for that day. As part of this task, additional PPE may be assigned to reflect site-specific conditions or special considerations or conditions associated with any identified task. As site conditions may change, the following equipment will be maintained during all on-site activities - Fire Extinguishers Upgrade to Level C protection Dust concentrations exceeding 2 mg/m^3 that cannot be controlled through dust suppression methods. - Level D minimum requirements listed above - Full-face APR with organic vapor/acid gas/HEPA cartridges. The material in question is suspected to be in solid form. The cartridges will be changed out as necessary. As the HEPA cartridges become more difficult to breath through the mechanical filtration is becoming overloaded and should be exchanged.	**Personnel Decontamination** – This decontamination procedure for **Level D** protection will consist of - Equipment drop - Soap/water wash and rinse of outer gloves, boots, - Vacuum outer Tyvek or cotton coveralls - Removal or PPE in the following order: Boot covers, Outer gloves, coveralls, and inner gloves Level C Decontamination - Equipment drop - Soap/water wash and rinse of outer gloves, boots, - Vacuum outer Tyvek or cotton coveralls - Removal or PPE in the following order: Boot covers, Outer gloves, APR, coveralls, and inner gloves All levels of protection - Wash hands and face, leave contamination reduction zone - Report for any heat stress surveillance as directed.

TABLE 5-1

TASKS/HAZARDS/CONTROL MEASURES COMPENDIUM
NAVAL CONSTRUCTION BATTALION CENTER GULFPORT, MISSISSIPPI

Tasks/Operation/Locations	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring - Type and Action Levels	Personal Protective Equipment *(Items in Italics are deemed optional as conditions or the FOL or SSO dictate.)*	Decontamination Procedures
Multi-media sampling, including soils (surface and subsurface); surface water, ground water, and sediments. This task also includes well development of existing ground water monitoring wells.	***Chemical hazards:*** 1) Previous analytical data identified the following compounds as contaminants of concern (Air - Dust/particulate contaminants) 2,3,7,8 –TCDD (Tetrachlorodibenzo –p-dioxin) It is recommended that exposure (via inhalation, ingestion, or skin contact) to this contaminant be minimized due to . Further information on this contaminant is presented in Figure 6-1. See Attachment VIII for mathematical calculations for determining potential airborne concentrations. 2) Transfer of contamination into clean areas ***Physical hazards:*** 3) Noise in excess of 85 dBA 4) Lifting (strain/muscle pulls) 5) Pinches and compressions 6) Slips, trips, and falls 7) Ambient temperature extremes (heat/cold stress) 8) Vehicular and foot traffic 9) Site Characterization ***Natural hazards:*** 10) Insect/animal bites and stings, poisonous plants, etc. 11) Inclement weather	1) As a general rule, avoiding contact with contaminated media (air, water, soils, etc.) and free product will be a universal control measure. As the material in question is a solid and/or bound to particulates, dust/particulate suppression will be the next control measure employed to minimize potential exposure. Given, the reported concentrations existing within the soils up to 5 ppb, the overall dust concentrations in the air would have to exceed 50,000 mg/m^3 total dust concentration to present an exposure threat TCDD. Although this is unlikely even in the absence of any control measures, monitoring will be conducted to provide quantitative data regarding emissions. 2) Decontaminate all equipment and supplies between sampling locations and prior to leaving the site. See decontamination of heavy and sampling equipment for direction in this task. 3) When sampling at an operating DPT or Hollow Stem Auger or other type of drill rig use hearing protection. The use of hearing protection outside of 25 feet from the DPT rig should be incorporated under the following condition: If you have to raise your voice to talk to someone who is within 2 feet of your location, you may be approaching excessive noise levels (>85dBA) and hearing protection should be worn until the noise source may be positively quantified. 4) Use machinery or multiple personnel for heavy lifts. Use proper lifting techniques (See Lifting Mobilization/Demobilization, Page 1 of 6, Table 5-1) 5) Avoid moving parts, do not remove any machine guarding. - Use tools or equipment where necessary to avoid contacting pinch points - A remote sampling device must be used to sample drill cuttings near rotating tools. The equipment operator shall shutdown machinery if the sampler is near moving machinery parts. - Remove any snag points - Follow Safe Work Permit and Safe Work Practices for drilling procedures when working in and around the drill rigs(See Section 5.1 & 5.2). 6) Preview work locations for unstable/uneven terrain. - Ruts, roots, and other tripping hazards should be eliminated from around the rotating apparatus to minimize trips and falls when approaching the rotating tooling. - Use multiple persons and small loads to pack sampling resources to remote locations. - Construct rope ladders and other engineered assistance for traversing hills and inclines > 45°. 7) Wear appropriate clothing for weather conditions. Provide acceptable shelter and liquids for field crews. Additional information regarding heat/cold stress is provided in Section 4.0 of the Health and Safety Guidance Manual. 8) Traffic and equipment considerations are to include the following: - Establish safe zones of approach (i.e. Mast or Boom + 5 feet). See Section 9 of the HASP for specific safety zones and established clearance recommendations. - All self-propelled equipment shall be equipped with movement warning systems. - When sampling along roadways, use signs to indicate men working as well flag persons, as necessary. Personnel working in and around any established traffic patterns should wear high visibility vests to increase visual recognition. 9) Work areas will be surveyed prior to committing personnel or resources. The survey will be conducted by the FOL and/or the SSO. The purpose is to identify physical and natural hazards that may impact the proposed work area. These hazards are to be identified, barricaded, or eliminated to the extent possible to minimize potential effect to field crew. 10) Avoid nesting areas, use repellents approved by the FOL. Report potential hazards to the SSO. Follow guidance presented in Appendix F, Hazard Assessment. 11) Suspend or terminate operations until directed otherwise by the SSO.	Continuous monitoring will be performed during operations to ensure safe work conditions do not change as a result of work being performed or other external factors Monitoring of each excavation activity, in particular, will be performed in an attempt to anticipate and characterize site contaminants. **Dusts/Particulates** Mini-Ram Dust Monitors Action Levels Visible dust (2 mg/m^3) – Employ dust suppression (area wetting) methods when handling dry materials which have a tendency to become airborne much more easily than wet or moist materials This action level should control potential overexposure to the primary contaminant of concern TCDD There have been no other contaminants of concern reported as determined through historical information Dusts - > 2mg/m^3 (Visible dusts) Site contaminants may adhere to or be part of airborne dusts or particulates generated during site activities Generation of dusts should be minimized to avoid inhalation of contaminated dusts or particulates. Evaluation of dust concentrations will be performed by observing work conditions for visible dust clouds. Potential exposure to contaminated dust will be controlled using water suppression, evacuating the operation area until dust subsides, through ascension to Level C protection. Monitoring During Sampling Activities During excavation activities (As stated above) During confirmation sampling (Not Required) Groundwater or surface water sampling (Not Required) Sediment sampling (This will be determined based on the method employed and the potential for the generation of dust and/or particulates) With a trowel – Not required, Shovels and Hand Augers – Required only if the sediment is dry	Level D protection will be utilized for the following sampling activities Surface soils, subsurface soils, surface water, groundwater, and sediments Level D - (Minimum Requirements) - Standard field attire (Sleeved shirt; long pants) - Safety shoes (steel toe/shank) - Safety glasses - Surgical style gloves *(double-layered if necessary)* - *Reflective vest for high traffic areas* - *Hardhat (when overhead hazards exists, or identified as a operation requirement)* - *Tyvek coveralls and disposable boot covers if surface contamination is present or if the potential for soiling work attire exists.* - *Hearing protection for high noise areas, or as directed on an operation by operation scenario.* Upgrades to Level C protection will be based on the following: Dust concentrations exceeding 2 mg/m^3 that cannot be controlled through dust suppression methods. - Level D minimum requirements listed above - Full-face APR with organic vapor/acid gas/HEPA cartridges. The material in question is suspected to be in solid form. The cartridges will be changed out as necessary As the HEPA cartridges become more difficult to breath through the mechanical filtration is becoming overloaded and should be exchanged. **Note:** The Safe Work Permit(s) for this task (See Attachment IV) will be issued at the beginning of each day to address the tasks planned for that day. As part of this task, additional PPE may be assigned to reflect site-specific conditions or special considerations or conditions associated with any identified task.	**Personnel Decontamination** Personal decontamination will vary based on the type of sampling conducted. These are as follows: Supporting subsurface investigations at the drill rig. - Decontamination will be the same as prescribed for the drilling activity Sampling surface water, groundwater, and sediments, the following provisions will apply - Upon completion of the sampling dedicated trowels, tubing, etc. will be bagged for transport back to the central decontamination area. - PPE (gloves) will be removed and also bagged for disposal. - Handi-Wipes or similar product will be used to clean hands prior to moving to the next location. **Equipment Decontamination** All equipment used in remote sampling locations will be brought back to the central decontamination area for decontamination and re-use or decontamination and gross removal of contamination prior to disposal. **Note:** Field screening instruments will be wrapped to minimize the necessary decontamination except for wiping down parts which are necessary to expose to the external environment. The equipment reference above is largely directed at hand tools Decontamination of equipment (sampling and hand tools) will proceed as indicated in the Sampling and Analysis Plan and/or Work Plan.

TABLE 5-1

TASKS/HAZARDS/CONTROL MEASURES COMPENDIUM
NAVAL CONSTRUCTION BATTALION CENTER GULFPORT, MISSISSIPPI

Tasks/Operation/Locations	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring - Type And Action Levels	Personal Protective Equipment (*Items In Italics Are Deemed Optional As Conditions Or The FOL Or the SSO Dictate.*)	Decontamination Procedures
Surveying – Geographical and Geophysical This activity is proposed for improved areas. The likelihood of encountering some of the natural hazards discussed is negligible However, the information is provided in the event that benchmarks (horizontal and vertical control) has to be carried from a remote location	***Chemical hazards:*** Significant exposure to site contaminants is anticipated to be unlikely given the nature of this task. ***Physical hazards:*** 1) Slips, trips, and falls 2) Struck by 3) Ambient temperature extremes (heat stress) ***Natural hazards:*** 4) Inclement weather 5) Insect/animal bites or stings, poisonous plants, etc.	***Physical hazards:*** 1) Preview work locations and site lines for uneven and unstable terrain. Clear necessary vegetation, establish temporary means for traversing hazardous terrain (i.e , rope ladders, etc.) 2) If hand tools (brush hooks, machetes, etc.) are necessary to clear and carry lines and bench marks to the area of operation the following precautions are recommended - Insure handles are of good construction (no cracks, splinters, loose heads/cuuting apparatus - Insure all cutting tools are maintained. Blades shall be sharp without knicks and gouges in the blade. - All hand tools (brush hooks, machetes, etc.) with cutting blades shall be provided with a sheath to protect individuals when not in use. - All personnel will maintain a 10-foot perimeter around persons clearing brush. **Note:** It is not anticipated that trees will be required to be dropped as part of this operation and therefore will not be addressed. The additional use of chainsaws and chippers will require this HASP to be modified. 3) Wear appropriate clothing for weather conditions Acceptable shelter and liquids for field crews. ***Natural hazards:*** 4) Suspend or terminate operations until directed otherwise by SSO 5) To combat the potential impact of natural hazards, the following actions are recommended - Avoid nesting – Preview routes, monitoring well protective casings for nests. Avoid if at all possible. - Wear light color clothes This will allow easier detection of ticks and insects crawling on your body. It will also assist in heat stress control. - Tape pant legs to work boots to block direct access. - Use repellents – Permanone should be applied liberally to the clothing, but not the skin as it may cause irritation. Concentrate on areas where ticks and other insects may access your body such as pant cuffs, shirt to pants, and collars. - Upon exiting the high brush and wooded areas perform a close body inspection to remove any ticks or other insects that have attached to your clothing or skin. - If clearing lines in snake infested areas surveyors are recommended to wear snake chaps as a precaution. - Report potential hazards or signs and symptoms to the SSO. See Section 4.0 of the TtNUS Health and Safety Guidance Manual and Section 6.3 of this HASP for additional information concerning natural hazards.	No air monitoring is needed given the unlikelihood that airborne contaminants will be present. The potential for exposure to site contaminants during this activity is considered minimal. As most of this activity is conducted either before or after the intrusive aspect of this operation, therefore, minimizing potential exposure.	Surveying activities shall be performed in Level D protection Level D Protection consists of the following: - Standard field dress including sleeved shirt and long pants - Safety shoes (Steel toe/shank) - Work gloves shall be worn when clearing brush. - *Safety glasses, hard hats (if working near machinery, or overhead hazards)* - *Snake chaps for heavily wooded area where encounters are likely.* - *Tyvek coveralls may be worn to provide additional protection against poisonous plants and insects, particularly ticks.* **Note:** The Safe Work Permit(s) for this task (See Attachment IV) will be issued at the beginning of each day to address the tasks planned for that day. As part of this task, additional PPE may be assigned to reflect site-specific conditions or special considerations or conditions associated with any identified task Protective levels may require modification should this activity be required to be conducted within a controlled zone due to an on-going operation.	**Personnel Decontamination** - A structured decontamination is not required as the likelihood of encountering contaminated media is considered remote. However, survey parties should inspect themselves and one another for the presence of ticks when exiting wooded areas, grassy fields, etc. This action will be employed to stop the transfer of these insects into vehicles, homes, and offices.

TABLE 5-1

TASKS/HAZARDS/CONTROL MEASURES COMPENDIUM
NAVAL CONSTRUCTION BATTALION CENTER GULFPORT, MISSISSIPPI

Tasks/Operation/Locations	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring - Type and Action Levels	Personal Protective Equipment *(Items in italics are deemed optional as conditions or the FOL or SSO dictate.)*	Decontamination Procedures
Decontamination of Sampling and Heavy Equipment It is anticipated that this activity will take place at centralized locations. Gross contamination will be removed to the extent possible at the site. Contaminated tooling then will be wrapped in polyethylene sheeting for transport to the centralized location for a full decontamination and evaluation.	***Chemical hazards:*** 1) The only chemical to pose an occupational threat during sampling was TCDD. This substance is in a solid form. It is anticipated, once wetted down are not considered to pose an occupational threat through inhalation. However, ingestion may still pose an exposure threat. Figure 6-1 provides additional information about TCDD 2) Decontamination fluids - Liquinox (detergent); isopropanol (decontamination solvent) ***Physical hazards:*** 3) Lifting (strain/muscle pulls) 4) Noise in excess of 85 dBA 5) Flying projectiles 6) Struck by 7) Slips, trips, and falls ***Natural hazards:*** 8) Inclement weather	1) and 2) Employ protective equipment to minimize contact with site contaminants and hazardous decontamination fluids. Control potential non-occupational exposures through good work hygiene practices (i.e., avoid hand to mouth contact; wash hands and face before breaks and lunch; minimize contact with contaminated media). Obtain manufacturer's MSDS for any decontamination fluids used on-site. Solvents may only be used in well-ventilated areas, such as outdoors. Use appropriate PPE as identified on MSDS or within this HASP. All chemicals used must be listed on the Chemical Inventory for the site, and site activities must be consistent with the Hazard Communication Program provided in Section 5.0 of the TtNUS Health and Safety Guidance Manual. 3) Use multiple persons where necessary for lifting and handling heavy equipment, such as auger flights for decontamination purposes. - Employ proper lifting techniques as described in Table 5-1, Mobilization/Demobilization. 4) Wear hearing protection when operating the pressure washer and/or steam cleaner Sound pressure levels measured during the operation of similar pieces of equipment indicate a range of 87 to 93 dBA. 5) Use eye and face protective equipment when operating the pressure washer and/or steam cleaner, due to flying projectiles All other personnel must be restricted from the area. In addition to minimize hazards (flying projectiles, water lacerations and burns) associated with this operation, the following controls will be implemented - A Fan Tip 25° or greater will be used on pressurized systems over 3,000 psi. This will reduce the possibility of water lacerations or punctures. - Thermostat control will be in place and operational to control the temperature levels of the water where applicable. - Visual evaluations of hoses and fittings for structural defects - Construct deflection screens as necessary to control overspray and to guard against dispersion of contaminants driven off by the spray. 6) Struck by – Insure wash and drying racks are suitable construction to support heavier items such as auger flights and will secure them against falling during this process. 7) The decontamination pad should be constructed to contain wash waters generated during decontamination procedures. Temporary decontamination pads are usually 10-30 mil polyethylene or polyvinyl chloride tarp construction. Although these items when used as a liner offer containment, they also present a slipping hazard. When these temporary liners are employed, it is recommended that a light coating of sand be spread over the walking surface to provide traction. - In addition, adequate slope should be provided to the pad to permit drainage away from the object being cleaned The collection point for wash waters should be of adequate distance that the decontamination workers do not have to walk through the wash waters while completing their tasks. - Hoses should be gathered when not in use to eliminate potential tripping hazards. 8) Suspend or terminate operations until directed otherwise by SSO.	Use visual observation and real-time monitoring instrumentation to ensure all equipment has been properly cleaned of contamination and dried.	For Heavy Equipment This applies to pressure washing and/or steam cleaning operations and soap/water wash and rinse procedures. Level D Minimum requirements - Standard field attire (Long sleeve shirt; long pants) - Safety shoes (Steel toe/shank) - Chemical resistant boot covers - Nitrile outer gloves over nitrile inner gloves - Safety glasses underneath a splash shield - Hearing protection (plugs or muffs) - Hooded PVC Rainsuits or PE or PVC coated Tyvek **For sampling equipment** (trowels, Macro-Core Samplers, bailers, etc), the following PPE is required **Note**. Consult MSDS for PPE guidance. Otherwise, observe the following Level D Minimum requirements - - Standard field attire (Long sleeve shirt; long pants) - Safety shoes (Steel toe/shank) - Nitrile outer gloves over nitrile inner gloves - Safety glasses - Impermeable apron In the event of overspray of chemical decontamination fluids, employ PVC Rainsuits or PE or PVC coated Tyvek as necessary. **Note:** The Safe Work Permit(s) for this task (See Attachment IV) will be issued at the beginning of each day to address the tasks planned for that day. As part of this task, additional PPE may be assigned to reflect site-specific conditions or special considerations or conditions associated with any identified task.	**Personnel Decontamination** will consist of a soap/water wash and rinse for reusable and non-reusable outer protective equipment (boots, gloves, PVC splash suits, as applicable) This decontamination function may be subdivided into two locations Gross contamination of outer boots and outer gloves will be removed at a satellite location near the operation. Final wash and rinse will take place at the centralized decontamination pad. The sequential procedure is as follows: Stage 1: Equipment drop, remove outer protective wrapping; personnel will wipe down the outer shell and pass hand equipment through as necessary. Stage 2. Soap/water wash and rinse of outer boots and gloves Stage 3. Soap/water wash and rinse of the outer splash suit, as applicable Stage 4: Disposable PPE will be removed and bagged Stage 5 Wash face and hands Stage 6: Depending on ambient conditions, you may be required to report for medical evaluation. This evaluation consists of pulse, breathing rate, oral temperature, and body weight This medical screening will be performed when ambient conditions dictate and during periods of acclimatization. **Equipment Decontamination** - All heavy equipment decontamination will take place at a centralized decontamination pad utilizing a steam cleaner. Heavy equipment will have the wheels and tires cleaned along with any loose debris removed, prior to transporting to the central decontamination area. All site vehicles will have restricted access to exclusion zones, and have their wheels/tires sprayed off as not to track mud onto the roadways servicing this installation Roadways shall be cleared of any debris resulting from the on-site activity **Sampling Equipment Decontamination** Sampling equipment will be decontaminated as per the requirements in the Sampling and Analysis Plan and/or Work Plan. All equipment used in the exclusion zone will require a complete decontamination between locations and prior to removal from the site. The FOL or the SSO will be responsible for evaluating equipment arriving on-site, leaving the site, and between locations. No equipment will be authorized access, exit, or movement to another location without this evaluation This will include the screening process for radiological contaminants.

6.0 HAZARD ASSESSMENT

The following section provides information regarding the chemical, physical, and natural hazards associated with the sites to be investigated and the activities that are to be conducted as part of the scope of work. Figure 6-1, which is included as part of this HASP, provides information on potential chemical contaminants, including exposure limits, symptoms of exposure, physical properties, and air monitoring and sampling data.

6.1 CHEMICAL HAZARDS

The potential health hazards associated with work to be conducted at NCBC Gulfport include inhalation, ingestion, and dermal contact with contaminants that may be present in shallow soils. Based on the site history and prior sampling efforts, the following have been identified as the primary classes of site contaminants, including the specific compound(s) of interest:

2,3,7,8 – Tetrachlorodibenzodioxin (TCDD)

There are theoretically 75 different possible chlorinated species. Of those the one considered most toxic is 2,3,7,8 – Tetrachlorodibenzo-p-dioxin (TCDD).

Figure 6-1 provides information on this compound including information on the toxicological, chemical, and physical properties of this substance. It is anticipated that the greatest potential for exposure to site contaminants is during intrusive activities (excavation, soil borings, sampling, etc.). Exposure to these compounds is most likely to occur through inhalation or dermal contact of contaminated soil or water, or through ingestion via hand-to-mouth contact during soil disturbance activities. For this reason, PPE and basic hygiene practices (e.g., washing face and hands before leaving site) will be extremely important. Inhalation exposure will be avoided by using appropriate PPE and engineering controls where necessary. Given the nature of planned activities and that work will be conducted outside in the open air, however, it us highly unlikely that any appreciable airborne concentrations will be present. As this material is a solid, mobility is limited to mechanical agitation. Based on this consideration care should be taken when handling dry product as it can become airborne more easily than those that are wet, thereby increasing exposure potential.

Other sources of potential chemical exposure are decontamination fluids (e.g., Liquinox, isopropanol), and analytical preservatives. For any substances brought onto the site, the SSO is responsible for instituting a site-specific Hazard Communication Program (see Section 5.0 of the TtNUS Health and Safety Guidance Manual) and for collecting the appropriate Material Safety Data Sheets (MSDS) from the chemical manufacturers/suppliers. The SSO is also responsible for completing the Safe Work Permit for the decontamination task using the appropriate MSDS and for reviewing the contents of the MSDSs and Safe Work Permit with anyone who will use these substances.

6.2 PHYSICAL HAZARDS

In addition to the chemical hazards discussed above, the following physical hazards may be present during the performance of the site activities.

- Slips, trips, and falls
- Cuts (or other injuries associated with hand tool use)
- Lifting (strain/muscle pulls)
- Ambient temperature extremes (cold and heat stress)
- Pinches and compressions
- Heavy equipment hazards (rotating equipment, hydraulic lines, etc.)
- Energized systems (contact with underground or overhead utilities)
- Vehicular and foot traffic
- Noise in excess of 85 dBA
- Flying projectiles

Each of these physical hazards is discussed in greater detail in Section 4.0 of the TtNUS health and Safety Guidance Manual. Additionally, information on the associated control measures for these hazards are discussed in Table 5-1 of this HASP. Some of these hazards and the associated control measures are discussed below due to the emphasis on incident and injury history.

6.2.1 Slips, Trips, and Falls

Conditions such as steep terrain and/or heavy vegetation may create an increased potential for slip, trip, and fall hazards.

- The safest approach to sample points will be identified and cleared to permit field crew access to sample locations.
- Establish anchor points and rope handrails for traversing/ascending/descending angles and slopes greater than 45% grade.
- Footwear with an adequate traction.
- Prepare work areas by removing tripping hazards (ruts, roots, debris). This is especially critical around rotating equipment, where a fall into the rotating apparatus could be life threatening.

6.2.2 Cuts or Other Injuries Associated with Hand Tool Use

The clearing of brush and vegetation will be performed using hand tools that may include machetes, and brush axes. However, the use of hand tools has only briefly discussed. The control measures presented below will help minimize the potential for physical and cutting hazards.

- Wear leather or heavy cotton work gloves when using tools to protect against blisters, cuts, or other hand injuries.
- Wear eye protection (safety glasses with side shields) to protect the eyes from twigs, sticks, or flying debris.
- Clear the immediate cutting area of all personnel (radius of the tool swing area).
- Wear long pants and long-sleeved shirts to protect against abrasions.
- Wear hard hats if work will involve areas with overhead hazards (e.g., overhanging branches).
- Wear sturdy work boots.
- Inspect all hand tools [i.e., shovel handles (cracks, splinters, etc.), brush hook handles and blade attachment points, etc.)
- Ensure all hand tools are sharp to facilitate cutting action. This will avoid persons forcing the tool to cut and increasing potential hazards.
- Use the proper tool for the intended purpose. This to will avoid potential injury possibly created through improper use.

6.2.3 Energized Systems (Contact with Underground or Overhead Utilities)

Underground utilities such as pressurized lines, water, telephone, buried utility, and high voltage power lines may be present throughout the facility. **Therefore, all subsurface activities must be conducted following the requirements of the Tetra Tech NUS SOP for "Utility Locating and Excavation Clearance (HS-1.0)"**. A copy of this SOP is provided as Attachment II. Clearance of underground and overhead utilities for each location will be coordinated with the NCBC Gulfport Public Works Department – Maintenance Division through Mr. Gordon Crane. Time lines required to obtain utility clearances are as follows:

Public Works: 10-Day advance notification

Mississippi One Call System, Inc.: 2-working day advance notification, ticket then is good for a period of 10 days before renewal is required.

Additionally, drilling operations will be conducted at a safe distance from overhead power lines as discussed in Attachment II. In certain cases, there may be a need to de-energize electrical cables using facility lockout/tagout procedures to insure electrical hazards are eliminated. For this assistance from the Public Works Maintenance Division will be sought.

6.3 NATURAL HAZARDS

Insect/animal bites and stings, poisonous plants, and inclement weather are natural hazards that may be present given the location of activities to be conducted. As previously discussed, some portions of the site include vegetated areas which increases the potential for field crews to encounter ticks, bees, mosquitoes/insects, snakes, and poisonous vegetation.

6.3.1 Insect Bites and Stings

Various insects and animals may be present and should be considered. For example, fire ants present a unique situation when working outdoors in the southern portion of the United States. Their aggressive behavior and their ability to sting repeatedly can pose a unique health threat. The sting injects venom (formic acid) that causes an extreme burning sensation. Pustules form which can become infected if scratched. Allergic reactions of people sensitive to the venom include dizziness, swelling, shock and in extreme cases unconsciousness and death. People exhibiting such symptoms should see a physician. Fire ants can be identified by their habitat. They build mounds in open sunny areas sometimes supported by a wall or shrub. The mound has no external opening. The size of the mound can range from a few inches across to some which are in excess of two feet or more in height and diameter. When disturbed they defend it by swarming out and over the mound, even running up grass blades and sticks.

Insect/animal bites and stings are difficult to control given the climate and environmental setting of NCBC Gulfport. However, in an effort to minimize this hazard the following control measures will be implemented where possible.

- Commercially available bug sprays and repellents will be used whenever possible – Pesticides analytical screening includes chlordane, endrin, lindane, methoxychlor, toxaphene and heptachlor. Commercially available repellants may be used providing they don't contain substances which appear on the analytical list for pesticide analysis. Products such as DEET should not be applied directly to the skin due to potential irritation. This product, when permitted for use, should be applied over clothing articles.

- Where possible, loose-fitting and light-colored clothing with long sleeves should be worn. This will also aid in insect control by providing a barrier between the field person and the insects and to provide easy recognition of crawling insects against the lighter background. Pant legs should be secured to the work-boots using duct tape to prevent access by ticks. Mosquito nets are also recommended for use when commercially available repellents are not permitted.

- Clothing/limited body checks for ticks and other crawling insects should be conducted upon exiting heavily vegetated areas. Workers should perform a more detailed check of themselves when showering in the evening. Ticks prefer moist areas of the body (arm-pits, genitals, etc.) and will migrate to those locations.

- The FOL/SSO will preview all access routes and work areas in an effort to identify physical hazards including nesting areas in and around the work sites. These areas will be flagged and communicated to all site personnel.

- The FOL/SSO must determine if site personnel (through completion of Medical Data Sheets), suffer allergic reactions to bee and other insect stings and bites. Field crew members who are allergic to bites should have their emergency kit containing antihistamine and a preloaded syringe of epinephrine readily available.

Any allergies (insect bites, bee stings, etc.) must be reported on the Medical Data Sheet and to the SSO.

6.3.1.1 Tick and Mosquito Transmitted Illnesses and Diseases

Ticks and mosquitoes have been identified in the transmission of diseases including Lyme's disease and malaria. Warm months (Spring through early Fall) are the most predominant time for this hazard. Information concerning Lyme's Disease including recognition, evaluation, tick removal, and control is provided in Section 4.0 of the TtNUS Health and Safety Guidance Manual.

Malaria may occur when a mosquito or other infected insect sucks blood from an infected person, and the insect becomes the carrier to infect other hosts. The parasite reproduces within the mosquito, and is then passed on to another person through the biting action. Acute symptoms include chills accompanied by fever and general flu like symptoms. This generally terminates in a sweating stage. These symptoms may recur every 48 to 72 hours.

6.3.1.1.1 West Nile Virus

The West Nile is a type of virus that causes encephalitis or inflammation of the brain. The virus is transmitted by mosquitoes, that acquire it from infected birds. To date the West Nile virus has claimed 7 people and has infected at least 55 others. Symptoms generally occur five to 15 days following the bite of an infected mosquito, and range from a slight fever or headache to rapid onset of severe headache, high fever, stiff neck, muscle weakness, disorientation and death.

West Nile encephalitis has no specific treatment. In northern areas of the world, West Nile encephalitis cases occur primarily in the late summer or early fall. In southern climates, where temperatures are milder, West Nile encephalitis can occur year round. There is no vaccine.

6.3.2 Snakes and Other Wild Animals

Indigenous animals including snakes (poisonous and non-poisonous varieties), raccoons, and other animals native to the region may be present at the site. These animals may be encountered if work locations encroach on nesting or territories claimed by these animals. This is not generally considered to be a problem at this location as most of the activities will take place in improved areas. It is however addressed as part some tasks that may take personnel off of improved areas.

To avoid the obvious hazards conveyed as part of a direct encounter, the following actions will be taken to minimize impact on the field crews and/or operations. The FOL/SSO will preview access routes and work locations for nesting areas or signs of animal activities (tracks, foraging areas, etc.). All identified suspect areas will be communicated to the field crews. Snake chaps will be required as a precaution.

6.3.2.1 Snake Bites

All initial efforts will be directed to avoid, where possible, nesting and territorial areas. However, should field personnel come in contact with these animals and receive a bite, the following actions are necessary.

- Obtain a detailed description of the snake. This and the bite mark will enable medical personnel administering medical aid to provide prompt and correct antidotes, as necessary.

- Immobilize the bite victim to the extent possible. Physical exertion will mobilize the toxins (if poisonous varieties) from the bite point systemically through the body.

- Apply a pressure wrap (for extremities), just above and over the bite area. With a couple wraps of the pressure wrap in place over the bite area, apply a splint, and continue the application of the pressure wrap. The purpose for the splint is to restrict the movement of the extremity, this along with the pressure wrap will aid in restricting the toxins from leaving the site of the bite.

- Seek medical attention immediately.

6.3.2.2 Alligators

Alligators are indigenous to south eastern portion of the United States including the eastern third of Texas and may be present in ponds, swamps, drainage channels, and other wet areas. Alligators are fairly inactive in the winter months when the water temperatures are cool; their metabolism slows down and there is little need for food. The breeding season is mostly during April and May (but may begin as early as mid-February); male and female move around more during this time. Nests are constructed by the female during June and July. The female will build a nest of leaves and vegetation up to 6 feet across and several feet high. She lays and buries her eggs in the center of this mound, allowing the warmth of the pile to incubate the eggs. Females typically lay over 50 eggs and each egg is about 3 inches long. The eggs incubate for about 9 weeks, and the female will watch and defend the nest during this time. As the young hatch, they "peep" and the female will assist them by digging them out of the nest. Newborn alligators are about 9 inches long and will stay near the female for up to a year. The female will continue to protect the young during this period.

Alligators are very protective of their domain during courtship and nesting. Alligators can outrun humans for short distances.

Other indication of their presence includes slides (areas marked by entering and exiting the water) and areas of cleared access for purposes of sunning (internal thermal regulation).

Control Measures

- Treat alligators with extreme caution. Never approach an alligator, either on land or in the water.
- If sampling involves entering areas where alligators may be present, use an "alligator-watch" as a lookout.
- Use a remote sampling device (such as a sample jar/vial on a long pole) to reach into surface water and along waters edge, **Never Use Your Hand.**
- When accessing sample locations always insure you have left yourself a clear means of retreat. Obtain the sample as quickly as possible and immediately leave the area.

6.3.3 Poisonous Plants

Various plants which can cause allergic reactions may be encountered during field work. These include, poison ivy, poison oak, and poison sumac. Contact with these plants may occur when clearing vegetation for access to work areas, or as a result of movement through these plants. An irritating, allergic reaction can occur after direct contact with the plant or indirect contact through some piece of equipment or clothing article. Oils are transferred from the plant to exposed skin, clothing, or piece of equipment. The degree of the irritating, allergic reaction can vary significantly from one person to the next.

Protective measures to control and minimize the effects of this hazard may include, but not be limited to, the following:

- Identify plants for field personnel.
  - Poison Ivy - Characterized by climbing vines, three leaf configuration ovate to elliptical in shape, deep green leaves with a reddish tint, greenish flowers, and white berries.
  - Poison Sumac - Characterized as a tall bush of the sumac family bearing compound leaves (7-13 entire leaflets), branched from a central axis, drooping, with axillary clusters of white fruit: However, these white fruits and berries may exist only during pubescent stages.
  - Poison oak - Characterized as similar to poison ivy consisting of a shrub, stems erect, 0.3 to 2.0 meters tall, leaflets consist of broad thick lobes coarsely serrated configuration, denser at the base, less so than the top.
- Protective measures may include wearing disposable garments such as Tyvek when clearing brush. These may be carefully removed and disposed of along with any oils accumulated from the plants.
- Personal Hygiene - The oils obtained from the plants will only elicit an allergic response when the person's bare skin layer is contacted. This can be aggravated when skin pores are open (perspiring), or through breaks in the skin such as cuts, nicks, scratches, etc. This can also be accomplished when using excessively hot water for cleaning the skin, which also causes pores to open. Prior to break time, lunchtime, etc. personnel should wash with cool water and soap to remove as much of the oils as possible. In heavily vegetated areas of these plants, additional measures including barrier creams and blocks may be used to prevent the oils from accessing and penetrating the skin.

All of these plants present an airborne sensitization hazard when burned. This is not to occur as part of this scope of work and therefore will not be addressed.

6.3.4 Inclement Weather

Project tasks under this Scope of Work will be performed outdoors. As a result, inclement weather may be encountered. In the event that adverse weather conditions arise (electrical storms, hurricanes, etc.), the FOL and/or the SSO will be responsible for temporarily suspending or terminating activities until hazardous conditions no longer exist.

NTP CHEMICAL REPOSITORY
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN

-IDENTIFIERS

*CATALOG ID NUMBER: 000203

*CAS NUMBER: 1746-01-6

*BASE CHEMICAL NAME: TETRACHLORODIBENZODIOXIN,2,3,7,8-,P-

*PRIMARY NAME: 2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN

*CHEMICAL FORMULA: C12H4C14O2

*STRUCTURAL FORMULA: Not printable

*WLN: T C666 BO IOJ EG FG LG MG

*SYNONYMS:
DIOXIN
TCDD
2,3,7,8-TETRACHLORODIBENZO(B,E)(1,4)DIOXIN
2,3,6,7-TETRACHLORODIBENZO-P-DIOXIN
2,3,7,8-TETRACHLORODIBENZO-1,4-DIOXIN
TETRACHLORODIBENZODIOXIN
2,3,6,7-TETRACHLORODIBENZOIDIOXIN
2,3,7,8-TCDD
DIOXINE
DIOXIN (HERBICIDE CONTAMINANT)
TCDBD
TETRADIOXIN
NCI-C03714

-PHYSICAL CHEMICAL DATA

*PHYSICAL DESCRIPTION: LITERATURE: Colorless to white crystals
REPOSITORY: Tan crystalline powder

*MOLECULAR WEIGHT: 321.96

*SPECIFIC GRAVITY: Not available

*DENSITY: Not available

*MP (DEG C): 295 C [026,031]

*BP (DEG C): Decomposes @ 500 C [051,072,346]

*SOLUBILITIES:
WATER : <1 mg/mL @ 25 C (RAD)

DMSO : <1 mg/mL @ 25 C (RAD)

95% ETHANOL : <1 mg/mL @ 25 C (RAD)

METHANOL : 0.01 mg/mL @ 25 C [072,395,900]

ACETONE : <1 mg/mL @ 25 C (RAD)

TOLUENE : <1 mg/mL @ 20 C (RAD)

OTHER SOLVENTS:
Benzene: 0.57 mg/mL [072,395]
Chloroform: 0.37 mg/mL [072,395]
Perchloroethylene: 0.68 mg/mL @ 25 C [900]
Chlorobenzene: 0.72 mg/mL [072,395]
o-Dichlorobenzene: 1.4 mg/mL [072,395]
n-Octanol: 0.05 mg/mL [051,072,395]
Lard oil: 0.04 mg/mL [395]
Hexane: 0.28 mg/mL @ 25 C [900]

*VOLATILITY:
Vapor pressure: 0.00000000064 mm Hg @ 20 C; 0.0000000014 mm Hg @ 25 C [901]
Vapor density : Not available

*FLAMMABILITY(FLASH POINT):
Literature sources indicate that this chemical is nonflammable [051,072]. Fires involving this material can be controlled with a dry chemical, carbon dioxide or Halon extinguisher.

*UEL: Not available LEL: Not available

*REACTIVITY:
This chemical is changed chemically when exposed as solutions in iso-octane or n-octanol to ultraviolet light [395]. It undergoes catalytic perchlorination [051,072].

*STABILITY:
This chemical undergoes slow photochemical degradation and slow bacterial degradation. It is extremely stable but is chemically degraded by temperatures in excess of 500 C or by irradiation with ultraviolet light under certain conditions [051,072]. Photodecomposition is negligible in aqueous solutions [055]. Solutions of this chemical in water, DMSO, 95% ethanol or acetone should be stable for 24 hours when protected from light (RAD).

*OTHER PHYSICAL DATA:
Crystals from anisole (melting point: 320-325 C) [031,072]
Decomposition begins at 500 C and is virtually complete within 21 seconds at a temperature of 800 C [051,072,346]
Partition coefficient in water (hexane system): 1000 [072]
Lambda max (in chloroform): 248 nm, 310 nm (E = 92.2, 173.6) [395]

-TOXICITY
========

*NIOSH REGISTRY NUMBER: HP3500000

*TOXICITY:

typ. dose	mode	specie	amount	units	other
LD50	orl	rat	20	ug/kg	
LD50	orl	mus	114	ug/kg	
LDLo	skn	mus	80	ug/kg	
LDLo	unr	mus	200	ug/kg	
LD50	ipr	ham	3	mg/kg	
LD50	orl	mky	2	ug/kg	
LD50	skn	rbt	275	ug/kg	
LD50	orl	gpg	500	ng/kg	
LD50	orl	ham	1157	ug/kg	
LDLo	orl	ckn	25	ug/kg	
LD50	ipr	rat	60	ug/kg	
TDLo	skn	hmn	107	ug/kg	

LD50	ipr	mus	120	ug/kg
LD50	orl	dog	1	ug/kg
LD50	ipr	rbt	252	ug/kg
LD50	orl	frg	1	mg/kg

*AQTX/TLM96: Not available

*SAX TOXICITY EVALUATION:
THR: One of the most toxic synthetic chemicals. A deadly experimental poison by ingestion, skin contact, intraperitoneal and possibly other routes. May be a human carcinogen. An experimental carcinogen, neoplastigen, tumorigen and teratogen. Experimental reproductive effects. Human mutagenic data. TCDD is the most toxic member of the 75 dioxins. It causes death in rats by hepatic cell necrosis. Death can follow a lethal dose by weeks. A by product of the manufacture of polychlorinated phenols. It is found at low levels in 2,4,5-T; 2,4,5-trichlorophenol and hexachlorophene. It is also formed during various combustion processes. Incineration of chemical wastes, including chlorophenols, chlorinated benzenes and biphenyl ethers, may result in the presence of TCDD in flue gases, fly ash and soot particles. It is immobile in contaminated soil and may be retained for years. TCDD has potential for bio-accumulation in animals. An accident in Seveso, Italy and inadvertant soil contamination in Missouri have resulted in abandonment of the contaminated areas.

*CARCINOGENICITY:
Tumorigenic Data:

TD	orl-rat	73	ug/kg/2Y-C
TDLo	orl-rat	52	ug/kg/2Y-I
TD	orl-rat	328	ug/kg/78W-C
TDLo	orl-mus	52	ug/kg/2Y-I
TD	skn-mus	80	ug/kg
TD	orl-rat	137	ug/kg/65W-C
TD	orl-rat	1	ug/kg/2Y-I
TD	orl-mus	1	ug/kg/2Y-I
TDLo	skn-mus	62	ug/kg/2Y-I
TD	orl-rat	27	ug/kg/65W-C
TD	orl-mus	36	ug/kg/52W-I

Review: IARC Cancer Review: Animal Sufficient Evidence
IARC Cancer Review: Human Inadequate Evidence
IARC possible human carcinogen (Group 2B) [015,610]
Status: NCI Carcinogenesis Bioassay (Gavage); Positive: Male and Female Rat, Male and Female Mouse [620]
NCI Carcinogenesis Bioassay (Dermal); Equivocal: Male Mouse [620]
NCI Carcinogenesis Bioassay (Dermal); Positive: Female Mouse [620]
NTP Fourth Annual Report on Carcinogens, 1984
NTP anticipated human carcinogen [610]
EPA Carcinogen Assessment Group [610]

*MUTATION DATA:

test	lowest dose	test	lowest dose
dni-mus-ipr	400 ug/kg	msc-mus:lym	50 mg/L
dni-rat-orl	200 ug/kg	mmo-sat	2 mg/L
dni-rat-ipr	10 ug/kg	cyt-rat-orl	100 ug/kg
pic-esc	500 ug/L	cyt-rat-ipr	10 mg/kg
mmo-esc	2 mg/L	cyt-mus-orl	100 ug/kg
mmo-smc	10 mg/L	mrc-smc	10 mg/L
dns-rat-orl	5 ug/kg	hma-mus/smc	25 ug/kg
mma-smc	2 mg/L	cyt-mus-ipr	10 ug/kg
otr-mus:fbr	200 nmol/L	dni-hmn:oth	10 nmol/L
oms-mus:oth	1 nmol/L	dnd-rat-orl	100 ug/kg
dns-mus-orl	800 pmol/kg		

*TERATOGENICITY:

```
Reproductive Effects Data:
  TDLo: orl-rat   1250 ng/kg (6-15D preg)
  TDLo: orl-rat     20 ug/kg (1D pre)
  TDLo: orl-rat    127 ng/kg (MGN)
  TDLo: ipr-rat      6 ug/kg (17D preg)
  TDLo: scu-rat      5 mg/kg (6-15D preg)
  TDLo: orl-mus     30 ug/kg (6-15D preg)
  TDLo: orl-mus     23 ug/kg (11D preg)
  TDLo: orl-mus    235 ug/kg (28D pre-21D post)
  TDLo: orl-mus     20 ug/kg (14D preg/3D post)
  TDLo: ipr-mus     25 ug/kg (7-11D preg)
  TDLo: ipr-mus     20 ug/kg (11D preg)
  TDLo: scu-mus    250 ug/kg (7-16D preg)
  TDLo: scu-mus    100 ug/kg (2D preg)
  TDLo: scu-mus    100 ug/kg (10D preg)
  TDLo: scu-mus     30 ug/kg (10D preg)
  TDLo: orl-mus      1 ug/kg (10D preg)
  TDLo: orl-rbt      1 ug/kg (6-15D preg)
  TDLo: orl-rbt     10 ug/kg (6-15D preg)
  TDLo: orl-rat   1500 ng/kg (1-3D preg)
  TDLo: orl-rat   1270 ng/kg (MGN)
  TDLo: orl-rbt   2500 ng/kg (6-15D preg)
  TDLo: orl-mus     12 ug/kg (10-13D preg)
  TDLo: unr-rat   1500 mg/kg (1D male)

*STANDARDS, REGULATIONS & RECOMMENDATIONS:
 OSHA: None
 ACGIH: None
 NIOSH Criteria Document: Recommended Exposure Limit to this compound-air:
                           Reduce exposure to lowest feasible level [015,610]
 NFPA Hazard Rating: Health (H): None
                     Flammability (F): None
                     Reactivity (R): None

*OTHER TOXICITY DATA:
 Skin and Eye Irritation Data:
   eye-rbt  2 mg MOD
 Review: Toxicology Review-21
 Status: Meets criteria for proposed OSHA Medical Records Rule
         EPA TSCA Section 8(e) Status Report 8EHQ-0381-0390
         EPA TSCA Section 8(e) Status Report 8EHQ-0778-0209
         EPA Genetox Program 1988, Negative: Rodent dominant lethal
         EPA TSCA Test Submission (TSCATS) Data Base, January 1989
         NIOSH Current Intelligence Bulletin 40, 1984
         EPA Genetox Program 1988, Positive: Carcinogenicity-mouse/rat


-OTHER DATA (Regulatory)
 ======================

*PROPER SHIPPING NAME (IATA): Poisonous solids, n.o.s.
                              (2,3,7,8-Tetrachlorodibenzo-p-dioxin)

*UN/ID NUMBER: UN2811

*HAZARD CLASS: 6.1          SUBSIDIARY RISK: None    PACKING GROUP: I

*LABELS REQUIRED: Poison

*PACKAGING: PASSENGER: PKG. INSTR.: 606          MAXIMUM QUANTITY: 5 kg
            CARGO    : PKG. INSTR.: 607          MAXIMUM QUANTITY: 50 kg

*SPECIAL PROVISIONS: A5
```

*USES:
This compound is present in certain herbicide and fungicide formulations, such as 2,4,5-T and the pentachlorophenols. It has been tested for use in flameproofing polyesters and against insects and wood-destroying fungi.

*COMMENTS:
This compound is a contaminant created in the manufacture of Agent Orange, a widely used defoliant in Vietnam [031]. It is implicated as the causative agent of various symptoms described by veterans exposed in the war [031,051]. It is considered to be the most toxic chemical manufactured [406].

-HANDLING PROCEDURES
==================

*ACUTE/CHRONIC HAZARDS:
This chemical is extremely toxic [026,031]. It may cause eye irritation [043,301]. Ingestion of even microgram quantities can cause toxic effects and possibly death. Allow only your most experienced personnel to work with this chemical. All non-essential personnel should leave the laboratory.

*MINIMUM PROTECTIVE CLOTHING:
If Tyvek-type disposable protective clothing is not worn during handling of this chemical, wear disposable Tyvek-type sleeves taped to your gloves.

*RECOMMENDED GLOVE MATERIALS:
Permeation Test Results For The Neat (Undiluted) Chemical:
The permeation test results for the neat (undiluted) chemical are given below. The breakthrough times of this chemical are given for each glove type tested. The table is a presentation of actual test results, not specific recommendations or suggestions. Avoid glove types which exhibit breakthrough times of less than the anticipated task time plus an adequate safety factor. If this chemical makes direct contact with your glove, or if a tear, puncture or hole develops, replace them at once.

Glove Type	Model Number	Thickness	Breakthrough Time
No information available			

*RECOMMENDED RESPIRATOR:
Where the neat test chemical is weighed and diluted, wear a NIOSH-approved half face respirator equipped with a combination filter cartridge, i.e. organic vapor/acid gas/HEPA (specific for organic vapors, HCl, acid gas, SO2 and a high efficiency particulate filter).

*OTHER:
Since this chemical is a known or suspected carcinogen you should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician will depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

*STORAGE PRECAUTIONS:
You should protect this container from damage. Store at room temperature and protect from light. Allow only your most experienced personnel access to this aliquot.

*SPILLS AND LEAKAGE:
If you spill this chemical, FIRST REMOVE ALL SOURCES OF IGNITION, then dampen the solid spill material with toluene, then using absorbent paper transfer the dampened material to a suitable container. Use absorbent paper dampened with toluene to pick up any remaining material. Your contaminated clothing and absorbent paper should be sealed in a vapor-tight plastic bag for

eventual disposal. Solvent-wash all contaminated surfaces with toluene followed by washing with a soap and water solution. Do not reenter the contaminated area until the Safety Officer (or other responsible person) has verified that the area has been properly cleaned.

*DISPOSAL AND WASTE TREATMENT: Not available

-EMERGENCY PROCEDURES
===================

*SKIN CONTACT:
IMMEDIATELY flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water.
IMMEDIATELY call a hospital or poison control center even if no symptoms (such as redness or irritation) develop.
IMMEDIATELY transport the victim to a hospital for treatment after washing the affected areas.

*INHALATION:
IMMEDIATELY leave the contaminated area; take deep breaths of fresh air. IMMEDIATELY call a physician and be prepared to transport the victim to a hospital even if no symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop.
Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, Self-Contained Breathing Apparatus (SCBA) should be used; if not available, use a level of protection greater than or equal to that advised under Respirator Recommendation.

*EYE CONTACT:
First check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center.
Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician.
IMMEDIATELY transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop.

*INGESTION:
If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and IMMEDIATELY call a hospital or poison control center.
Generally, the induction of vomiting is NOT recommended outside of a physician's care due to the risk of aspirating the chemical into the victim's lungs. However, if the victim is conscious and not convulsing and if medical help is not readily available, consider the risk of inducing vomiting because of the high toxicity of the chemical ingested. Ipecac syrup or salt water may be used in such an emergency. IMMEDIATELY transport the victim to a hospital.
If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. DO NOT INDUCE VOMITING. IMMEDIATELY transport the victim to a hospital.

*SYMPTOMS:
Symptoms of exposure to this compound may include eye irritation, allergic dermatitis, wasting, hepatic necrosis, thymic atrophy, hemorrhage, lymphoid depletion and chloracne [043]. It may cause hypercholesterolemia and psychiatric disturbances [406]. It may also cause hyperpigmentation, liver damage, Hodgkin's lymphoma, raised serum hepatic enzyme levels, disorders of fat metabolism, disorders of carbohydrate metabolism, cardiovascular disorders, urinary tract disorders, respiratory disorders, pancreatic disorders, polyneuropathies, lower extremity weakness, sensorial impairments and neurasthemic or depressive syndromes [395]. Exposure may lead to excessive oiliness of the

skin, abdominal pains, excessive flatulence, loss of body weight, oppressive headaches, excessive fatigue, unusual loss of vigor, porphyria cutanea tarda, porphyrinuria, uncharacteristic irritability and high blood cholesterol [173]. It may cause hepatotoxicity, thrombocytopenia, supression of cellular immunity and death [346]. It may also cause a burning sensation to the eyes, nose and throat, headache, dizziness, nausea, vomiting, itching, redness, swelling of the face, nodules on the face, forearms, shoulders, neck and throat which may progress to come domes and cysts, acneform eruptions, aching muscles (mainly thighs and chest), insomnia, hirsutism, loss of libido, pain, hepatic dysfunction, hyperlipidemia and emotional disorders [301]. Other symptoms may include hemorrhagic cystitis, focal pyelonephritis, arthralgias, diabetes mellitus, burn-like sores, spontaneous abortions, liver damage (fatty changes, mild fibrosis, hemofuscin deposition and degeneration) and death [072].

-SOURCES
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*SOURCES:

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7.0 HAZARD MONITORING – TYPES AND ACTION LEVELS

This section provides direction and protocol for the real time monitoring. The monitoring of hazardous conditions has two primary objectives.

- Qualify and quantify potential hazards (chemical, physical, and biological) that may impact the work force or sensitive receptors in the immediate area.

- Evaluate environmental sampling media, which will be sent off-site. The purpose of this evaluation will be to qualify potential hazards to provide sufficient warning to down stream parties, which may potentially encounter these hazards. This would include hazard qualification for transportation purposes as well as notification to the analytical laboratory of potentially high hazard samples.

7.1 TASKS TO BE CONDUCTED

The following tasks are to be conducted as part of the scope of work at NCBC Gulfport. It is hazards associated with these tasks, which may be monitored for the purpose of quantification/ qualification of those hazards.

- Hollow Stem Auger (HSA) Drilling
- Excavation of contaminated soils for the pilot study.
- Monitoring Well Development/Monitoring Well Sampling
- Multi-media Sampling – Surface and subsurface soils; sediment; surface and groundwater sampling.
- Decontamination activities
- Geophysical and Geographical surveying

7.2 ASSOCIATED HAZARDS

Hazards associated with these tasks for which monitoring may be used to qualify/quantify, include, but not limited to:

- Noise – Information obtained from previous monitoring efforts indicate noise levels associated with this type of activity, dependent on the type of rig,

    - HSA Drill rig sound levels range from 87 to 92 dBA- Time Weighted Average (TWA)
    - Generators – When generators are used as portable power sources for well development or sampling, the generator should be placed a sufficient distance from the operation to eliminate the noise hazard. The generators emit approximately 82 to 88 dBA.

- Steam Cleaners and pressure washers – Previous data indicate that these machines emit from 94 to 102 dBA.

Noise dosimetry may be performed to quantify noise levels associated with the type of rig selected to perform the subsurface investigation. In addition noise quantification may be performed to insure the hearing protection devices selected attenuation capabilities are sufficient for those noise levels produced. All noise monitoring will proceed in accordance with the Hearing Conservation Program provided in Attachment VI of this HASP.

- Chemical hazards (Contaminated environmental media exposure) – TCDD is the primary contaminant of concern. This contaminant was evaluated based on its concentration that existed in the media to determine exposure threat. See Attachment VIII for mathematical calculations of potential exposure threat.

7.3 INSTRUMENTS TO BE USED FOR HAZARD MONITORING

The following instrument will be used for monitoring the hazards identified above.

7.3.1 Metrosonics dB-307 Noise Dosimeter/Sound Level Meter

The db-307 is a dual purpose sound level meter and noise dosimeter. The instrument is calibrated in accordance with manufacturers instructions using a 102dBA acoustical calibrator. The instrument is calibrated pre- and post to monitoring activities in accordance with the Hearing Conservation program provided in Attachment VI of this HASP. Information regarding calibration is recorded either on the Noise Dosimetry Log or the Sound Level Measurement Log, relative to the type of monitoring being performed.

7.3.1.1 Frequency of Monitoring

Noise dosimetry and sound level measurements will be performed under the following circumstances:

- Noise source exists for which no similar data is available.
- Quantification is necessary to evaluate hearing protection attenuation capabilities.

Additional monitoring will only be performed if it is necessary to quantify other noise sources or through changes in procedure that may result in higher noise levels.

This monitoring will be conducted during intervals of the project, as deemed necessary, during the operation of powered equipment capable of generating noise sources over 85 dBA.

7.3.2 Chemical Contaminant Monitoring

Monitoring for airborne chemical contaminant released from environmental media will be performed during the following intrusive activities:

- Excavation and Soil boring activities

Chemical air monitoring will be performed by the SSO or field team members using a Mini-Ram Dust Monitor to measure fugitive emissions that may be created during mechanical dispersion associated during excavation and soil boring activities. This activity denotes general screening based on previous analytical results these substances do not present an exposure threat based on concentrations reported in the media.

7.4 INSTRUMENT PREPARATIONS FOR FIELD SERVICE

All direct reading instruments will require calibration prior to use. The frequency of this calibration is stated below.

- Noise Dosimeter - Manufacturer yearly service and primary calibration
  In the field – Pre and Post secondary calibration to a yearly calibrated acoustical reference.

- Dust Monitor – Manufacturer yearly service and primary calibration
  In the field – Pre and Post secondary calibration to a reference gas

All instruments will operated and calibrated in accordance to manufacturers instructions.

Calibration information will be recorded on the equipment calibration sheet provided as Figure 7-1.

7.5 INSTRUMENT MAINTENANCE

Maintenance activities to be conducted on site are as follows:

- Wiping down the outer shells of the monitoring equipment used – Daily
- Battery charging – Daily (As applicable)
- Dust Monitor – Filter Replacement – Daily

Maintenance greater than that mentioned above will require the attention of a certified technician and will not be performed on site.

7.6 INSTRUMENT CALIBRATION

Hazard monitoring instruments will be maintained and pre-field calibrated by the TtNUS Equipment Manager or selected commercial vendor. Operational checks and field calibration will be performed on all instruments each day prior to their use. Field calibration will be performed on instruments according to manufacturer's recommendations. These operational checks and calibration efforts will be performed in a manner that complies with the employees health and safety training, the manufacturer's recommendations, and with the applicable manufacturer's standard operating procedure (copies of which can be found in the Health & Safety Guidance Manual which will be maintained on site for reference). All calibration observations must be documented. Figure 7-1 is provided for documenting these calibration observations. This information may instead be recorded in a field operations logbook, provided that all of the information specified in Figure 7-1 is recorded. This required information includes the following:

- Date calibration was performed
- Individual calibrating the instrument
- Instrument name, model, and serial number
- Any relevant instrument settings and resultant readings (before and after) calibration
- Identification of the calibration standard (lot no., source concentration, and supplier)
- Any relevant comments or remarks

FIGURE 7-1

DOCUMENTATION OF FIELD CALIBRATION

SITE NAME: ______________________ PROJECT NO.: ____________

Date of Calibration	Instrument Name and Model	Instrument I.D. Number	Person Performing Calibration	Instrument Settings		Instrument Readings		Calibration Standard (Lot Number)	Remarks/ Comments
				Pre-Calibration	Post-Calibration	Pre-Calibration	Post-Calibration		

8.0 TRAINING/MEDICAL SURVEILLANCE REQUIREMENTS

8.1 INTRODUCTORY/REFRESHER/SUPERVISORY TRAINING

This section specifies health and safety training and medical surveillance requirements for both Tetra Tech NUS and subcontractor personnel participating in on site activities.

8.1.1 Requirements For All Field Personnel

All Tetra Tech NUS and subcontractor personnel who will engage in field associated activities as described in this HASP must have:

- Completed 40 hours of introductory hazardous waste site training or equivalent work experience as defined in OSHA Standard 29 CFR 1910.120(e).
- Completed 8-Hour Refresher Training, if the identified persons had introductory training more than 12 months prior to site work.
- Completed 8-hour Supervisory training in accordance with 29 CFR 1910.120(e)(4), if their assigned function will involve the supervision of subordinate personnel.

Documentation of introductory training or equivalent work experience, supervisory, and refresher training as well as site-specific training will be maintained at the site. Copies of certificates or other official documentation will be used to fulfill this requirement.

8.2 SITE-SPECIFIC TRAINING

Tetra Tech NUS will provide site-specific training to all Tetra Tech NUS employees and subcontractor personnel who will perform work on this project.

Figure 8-1 will be used to document the provision and content of the project-specific and associated training. All site personnel will be required to sign this form prior to commencement of site activities.

TtNUS will conduct a pre-activities training session prior to initiating site work. Additionally, a brief meeting will be held daily to discuss operations planned for that day. At the end of the workday, a short meeting may be held to discuss the operations completed and any problems encountered. This activity will be supported through the use of a Safe Work Permit System (See Section 10.10).

8.3 MEDICAL SURVEILLANCE

8.3.1 Medical Surveillance Requirements for Tetra Tech NUS and Subcontractor Personnel

All Tetra Tech NUS and subcontractor personnel participating in project field activities will have had a physical examination. All physical examinations shall meet the minimum requirements of paragraph (f) of OSHA 29 CFR 1910.120. The physical examinations will be performed to ensure all personnel are medically qualified to perform hazardous waste site work using respiratory protection.

Documentation for medical clearances will be maintained at the job site and made available, as necessary. Subcontractor personnel may use an alternative documentation for this purpose. The "Subcontractor Medical Approval Form" can be used to satisfy this requirement, or a letter from an officer of the company. The letter should state that the persons listed in the letter participate in a medical surveillance program meeting the requirements contained in paragraph (f) of Title 29 of the Code of Federal Regulations (CFR), Part 1910.120, entitled "Hazardous Waste Operations and Emergency Response." The letter should further state the following:

- The persons listed have had physical examinations under this program within the frequency as determined sufficient by their occupational health care provider
- Date of the exam
- The persons identified have been cleared, by a licensed physician, to perform hazardous waste site work and to wear positive- and negative- pressure respiratory protection.

A sample Subcontractor Medical Approval Form and form letter have been provided to all eligible subcontractors in the Bid Specification package.

8.3.2 Requirements for All Field Personnel

Each field team member, including subcontractors and visitors, entering the exclusion zone(s) shall be required to complete and submit a copy of the Medical Data Sheet also supplied to eligible subcontractors as part of the Bid Specifications Package and is available in Attachment V of this HASP. This shall be provided to the SSO, prior to participating in site activities. The purpose of this document is to provide site personnel and emergency responders with additional information that may be necessary in order to administer medical attention.

8.4 SUBCONTRACTOR EXCEPTION

If through the execution of their contract elements the subcontractor will not enter the exclusion zone and there is no potential for exposure to site contaminants, subcontractor personnel may be exempt from the training and medical surveillance requirements with the exception of Section 8.2. Examples of subcontractors who may qualify as exempt from training and medical surveillance requirements may include surveyors who perform surveying activities in site perimeter areas or areas were there is no potential for exposure to site contaminants and support or restoration services. **Use of this Subcontractor Exception is strictly limited to the authority of the CLEAN Health and Safety Manager.**

FIGURE 8-1

SITE-SPECIFIC TRAINING DOCUMENTATION

My signature below indicates that I am aware of the potential hazardous nature of performing field investigation activities at NCBC Gulfport, Mississippi and that I have received site-specific training that included the elements presented below:

- Names of designated personnel and alternates responsible for site safety and health (Section 1.2)
- Safety, health, and other hazards present on site (Table 5-1 and 6-1)
- Use of personal protective equipment (Table 5-1)
- Safe use of engineering controls and equipment (Table 5-1)
- Medical surveillance requirements (Section 8.3)
- Signs and symptoms of overexposure (Table 6-1)
- Contents of the Health and Safety Plan
- Emergency response procedures (evacuation and assembly points)(Section 2.0)
- Incipient response procedures (Section 2.0)
- Review of the contents of relevant Material Safety Data Sheets
- Review of the use of Safe Work Permits (Attachment IV)

My signature below indicates that I have been given the opportunity to ask questions and that all of my questions have been answered to my satisfaction and that the date of my training and my medical surveillance requirements indicated below are accurate.

Name (Printed and Signature)	Site-Specific Training Date	40-Hour Training (Date)	8-Hour Refresher Training (Date)	8-Hour Supervisory Training (Date)	Medical Exam

9.0 SPILL PREVENTION AND CONTAINMENT PROGRAM

9.1 SCOPE AND APPLICATION

This program applies to the single or aggregate accumulation of bulk storage materials (over 55-gallons). As the classification of certain materials such as IDW is unknown, all materials will be treated as hazardous, pending laboratory certification to the contrary. The types of materials for which this program will apply are as follows:

- Investigative Derived Wastes (IDW) such as decontamination fluids, soil cuttings, and purge and well development waters
- Resource Storage – Limited fuel and lubricant storage

The spill containment and control will be engaged any time there is a release of the above identified materials from a containment system or vessel. This spill containment program will be engaged in order to minimize associated hazards.

9.2 POTENTIAL SPILL AREAS

Potential spill areas will be periodically monitored in an ongoing attempt to prevent and control further potential contamination of the environment. Currently, limited areas are vulnerable to this hazard including:

- Resource deployment
- Waste transfer
- Central staging

It is anticipated that all IDW generated as a result of this scope of work will be containerized, labeled, and staged to await further analyses. The results of these analyses will determine the method of disposal.

9.3 CONTAINMENT AREAS

In order to facilitate leak and spill inspection and response, and to minimize potential hazards which may impact the integrity of the storage containers, the staging area for these substances will be structured as follows:

9.3.1 IDW

- 55 Gallon Drums (United Nations 1A2 configurations) – 4 Drums to a Pallet; labels and the retaining ring bolt and nut on the outside of each drum to facilitate easy access; Minimum 3 feet between each row of pallets. The decision to construct a bermed and lined area will be the decision of project management .

- Storage Tank – Polyethylene Construction – Tank shall be placed into a bermed enclosure of sufficient size to accommodate 110% of anticipated volume (Largest container plus 10% for rainwater and container displacement).

Regardless of container types selected, the staging area will be identified as a Satellite Storage Area with proper signage, points of contact in the event of an emergency, alternate contacts, and identification of stored material (i.e, Purge or decontamination waters, soil cuttings, etc.).

An Inventory Log will be maintained by the FOL regarding types of IDW and volumes generated. An updated Inventory List will be provided by the FOL to the designated Emergency Response Agency or Base Contact during days off and between shifts or phases of operations.

9.3.2 Flammable/POL Storage

Flammable Storage [i.e., fuels, decontamination solvents (Isopropanol)] and Petroleum/oil/lubricants (POL) will require proper dispensing containers and necessary storage for cumulative volumes in excess of 25 gallons. Storage and dispensing will comply with the following requirements:

- All fuels, which will be stored and dispensed from portable containers, will utilize safety cans.
- All portable hand held storage containers will be labeled per Hazard Communication requirements.
- Larger volumes stored for fueling equipment will be stored in approved mobile Above Ground Storage Tanks with secondary containment capable of holding the tank volume plus 10%.
- All portable flammable liquid storage tanks will be properly grounded and will have bonding capabilities for the transfer of loading and off-loading of its contents.
- All dispensing locations will be supported by a Fire Extinguisher positioned no closer than 50 feet from the storage tank, properly mounted and identified.
- The storage location will be well marked with proper signage, protective bumper poles and will have straight through access/egress for vehicles.

9.4 MATERIALS HANDLING

To minimize the hazards associated with moving drums and containers (i.e, lifting, pinch and compression points) material handling will be supported in the following manner:

- A drum cart with pneumatic tires will be required, if drums are used for IDW storage. This cart will be used to relocate drums within the staging and satellite storage location.

- In addition, a mechanized means such as a suitably equipped skid loader or back-hoe will be provided to move IDW containers from the field location to the staging and satellite storage location. This piece of equipment will also be used in site clearance and restoration as deemed appropriate and necessary.

Other means of material handling will be evaluated by the SSO based on their ability to minimize or eliminate material handling hazards.

9.5 LEAK AND SPILL DETECTION

To establish an early detection of potential spills or leaks, a periodic walk-around by the personnel staging or disposing of drums or in the Resource Deployment area will be conducted during working hours to visually determine that storage vessels are not leaking. If a leak is detected, the FOL will be notified and the Spill Containment/Control Response Plan as specified in Section 9.8 will be engaged. All inspections will be documented in the project logbook.

9.6 PERSONNEL TRAINING AND SPILL PREVENTION

All personnel will be instructed in the procedures for incipient spill prevention, containment, and collection of hazardous materials in the site-specific training. The FOL and/or the SSO will serve as the Spill Response Coordinators for this operation, should the need arise. Personnel through the course of this project will be drilled as part of testing the EAP.

9.7 SPILL PREVENTION AND CONTAINMENT EQUIPMENT

The following represents the minimum equipment that will be maintained at the staging areas at all times for the purpose of supporting this Spill Containment/Control Plan.

- Sand, clean fill, vermiculite, or other non combustible absorbent (Oil-dry)
- Extra Drums (55-gallon U.N. 1A2) should the need to transfer material from leaking containers arise.

- Pumps (Gas or Electric necessary for transferring liquids from leaking containers)/tubing
- Drum Repair Kit
- Shovels, rakes, and brooms
- Container labels
- Personal Protective Equipment
  - Nitrile outer gloves
  - Splash Shield
  - Impermeable over-boots
  - Rain suit

9.8 SPILL CONTAINMENT/CONTROL RESPONSE PLAN

This section describes the procedures the Tetra Tech NUS field personnel will employ upon the detection of a spill or leak.

- Notify the SSO or FOL immediately upon detection of a leak or spill. Activate emergency alerting procedures for that area to remove all non-essential personnel.

- Employ the personal protective equipment stored at the staging area. Take immediate actions to stop the leak or spill by plugging or patching the container or raising the leak to the highest point in the vessel. Spread the absorbent material in the area of the spill, covering it completely.

- Transfer the material to a new vessel; collect and containerize the absorbent material. Label the new container appropriately. Await analyses for treatment and disposal options.

- Recontainerize spills, including 2-inch of top cover (if over soils) impacted by the spill. Await test results for treatment or disposal options.

It is not anticipated that a spill will occur that the field crew cannot handle. Should this occur, notification of the appropriate Emergency Response agencies will be carried out by the FOL or SSO in accordance with the procedures specified in Section 2.0 of this HASP.

10.0 SITE OPERATIONS AND CONTROL

Site operations and control will be facilitated through the use of established work zones and security and control of those zones. These activities will minimize the impact and spread of contaminants brought to the surface through subsurface investigative methods as well as protect personnel and visitors within these zones during ongoing operations.

10.1 WORK ZONES

Tetra Tech NUS will delineate and use work zones in conjunction with decontamination procedures to prevent the spread of contaminants to other areas of the site. A three-zone approach will be used for work at this site; an Exclusion Zone, a Contamination Reduction Zone, and a Support Zone. These will be used to control access to the work areas, restricting the general public, avoiding potentials to spread any contaminants, and to protect individuals who are not cleared to enter by way of training and/or medical surveillance qualifications.

10.1.1 Exclusion Zone

An Exclusion Zone will be established at each sampling point/location. The purpose of the exclusion zone is to define a area where a more rigorous protocol for workers within what is determined to be an impact area. The impact area is that area which could be adversely impacted by either chemical or physical hazards. Exclusion zone size and dimensions will vary based on activities. Impact areas dimensions will be influenced by the following considerations:

- Physical and topographical features of the site
- Weather conditions
- Field and analytical measurements of air and environmental contaminants
- Air dispersion calculations
- Potential for explosion and dispersion
- Physical, chemical and toxicological properties of the contaminants being investigated
- Tasks to be conducted
- Decontamination procedures
- Potential for exposure

As conditions change the dimensions of the exclusion zone will change. However, the following dimension represent a starting point from which the exclusion zones will be expanded:

- Excavation Activities. The exclusion zone for this activity will be set at the fence line surrounding the excavation activities. Within the exclusion zone, no one will approach an operating piece of heavy equipment within a distance of a fully extended boom + 5 feet or within the turning radius of the equipment without the expressed permission of the ground spotter.

- Soil Boring (Hollow stem auger). The exclusion zone for this activity will be set at the height of the mast, plus five feet surrounding the point of operation, with a minimum of 25 feet. This distance will also apply when subsurface soil sampling from behind these type rigs.

- Monitoring well development and sampling. The exclusion zone for this activity will be set at 10 feet surrounding the well head and discharge collection container.

- Surface soils and surface/groundwater sampling. The exclusion zone for this activity will be set at five feet surrounding the point of operation.

- Clearing and grubbing. The exclusion zone for this activity will be set at 10 feet surrounding someone with a brush hook or machete.

- Decontamination operation. The exclusion zone for this activity will be set at 25 feet surrounding the gross contamination wash and rinse as well as 25 feet surrounding the heavy equipment decontamination area.

- Investigative Derived Waste (IDW) area will be constructed and barricaded. Only authorized personnel will be allowed access.

All exclusion zones shall remain marked until the SSO has evaluated the restoration effort and has authorized changing the zone status.

Exclusion zones will be marked using barrier tape, traffic cones and/or drive poles. Signs will be posted to inform and direct site personnel and site visitors.

10.1.2 Contamination Reduction Zone

The contamination reduction zone will be split to represent two separate functions. The first function will be a control/supply point for supporting exclusion zone activities. The second function, which may take place a sufficient distance from the exclusion zone is the decontamination of personnel and heavy equipment.

In order to move from the exclusion zone to a separate location the following activities will be used:

- As samplers move from location to location during sampling activities, dedicated sampling devices and PPE will be washed of gross contamination, removed, separated, and bagged. Personnel will use hygienic wipes, such as Handy Wipes, as necessary for personnel decontamination until they can access the centralized decontamination unit. At the first available opportunity personnel will wash their face and hands. This is critical prior to breaks and lunch when contamination can be transferred to the mouth through hand to mouth contact.

- Muddy over-boots and gloves may be required to go through a gross contamination wash at the exclusion zone. These items will then be cleaned thoroughly at the centralized decontamination unit.

- Potentially contaminated tooling along with PPE will be wrapped, when necessary, for transport to the decontamination area.

- Upon completion of the assigned tasks all personnel will move through the central decontamination area to clean reusable PPE and field equipment. Based on ambient conditions medical evaluations may take place at the termination point of the decontamination line. These evaluations will include pulse rate, oral temperature, breathing rate to evaluate physiological demands on site personnel. As stated earlier, these evaluations will be based on ambient conditions and acclimation periods.

10.1.3 Support Zone

The Support Zone will consist of a field trailer, storage, lay-down areas, or some other uncontaminated, controlled point. The Support Zone for this project will include a staging area where site vehicles can be parked, equipment will be unloaded, and where food and drink containers will be maintained. In all cases, the support zones will be established in clean areas of the site.

10.2 SAFE WORK PERMITS

All Exclusion Zone work conducted in support of this project will be performed using Safe Work Permits to guide and direct field crews on a task by task basis. An example of the Safe Work Permit is included in Figure 10-1. The daily meetings conducted by the FOL/SSO will further support these work permits. The use of these permits will ensure that site-specific considerations and changing conditions are incorporated into the planning effort. All Safe Work Permits will require the signatures of either the FOL or the SSO. All personnel engaged in on-site activities must be made aware of the elements indicating levels of protection and precautionary measures to be used.

The use of these permits will establish and provide for reviewing protective measures and hazards associated with each operation. This HASP will be used as the primary reference for selecting levels of protection and control measures. The Safe Work Permit will take precedence over the HASP when more conservative measures are required based on specific site conditions.

Upon completion of the work for which the Safe Work Permit was assigned, the Safe Work Permit will be turned into the FOL or the SSO. Concerns, complaints, and suggestions may be made on the reverse of the Safe Work Permit for consideration by the FOL and/or the SSO. All permit turned in with suggestions, difficulties, or complaints will be forwarded to the PHSO for review.

The Safe Work Permit and the HASP will serve as the primary reference for work place evaluations and audits conducted to determine if the task is being conducted under the direction conveyed by the HASP and the Safe Work Permit.

10.3 SITE MAP

Once the areas of contamination, access routes, topography, dispersion routes are determined, a site map will be generated and adjusted as site conditions change. This map will be posted to illustrate up-to-date information of contaminants and adjustment of zones and access points. This map will be posted at the field support trailer. Figure 10-2 will serve as the preliminary version until investigation reveals more information.

10.4 BUDDY SYSTEM

Personnel engaged in on-site activities will practice the "buddy system" to ensure the safety of all personnel involved in this operation.

FIGURE 10-1
SAFE WORK PERMIT

Permit No. ________________ Date: __________________________ Time: From ________ to ____

SECTION I: General Job Scope (To be filled in by person performing work)

I. Work limited to the following (description, area, equipment used): ______________________________

____

II. Names: ____

____

III. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector __________________ ________
TtNUS

SECTION II: General Safety Requirements (To be filled in by permit issuer)

IV. Protective equipment required

Level D ☐ Level B ☐
Level C ☐ Level A ☐

Respiratory equipment required

Full face APR	☐	Escape Pack	☐
Half face APR	☐	SCBA	☐
SKA-PAC SAR	☐	Bottle Trailer	☐
Skid Rig	☐	None	☐

Modifications/Exceptions: ____

____

V. Chemicals of Concern	Action Level(s)	Response Measures
______________	______________	______________
______________	______________	______________
______________	______________	______________
______________	______________	______________

VI. Additional Safety Equipment/Procedures

Hardhat	☐ Yes ☐ No	Hearing Protection (Plugs/Muffs)	☐ Yes ☐ No
Safety Glasses	☐ Yes ☐ No	Safety belt/harness	☐ Yes ☐ No
Chemical/splash goggles	☐ Yes ☐ No	Radio	☐ Yes ☐ No
Splash Shield	☐ Yes ☐ No	Barricades	☐ Yes ☐ No
Splash suit/coveralls (Type:________)	☐ Yes ☐ No	Gloves (Type)	☐ Yes ☐ No
Steel toe/shank Workboots	☐ Yes ☐ No	Work/rest regimen	☐ Yes ☐ No

Chemical Protective Over-boots (Type:_______) ☐ Yes ☐ No

Modifications/Exceptions: ____

____

____

VII. Procedure review with permit acceptors	Yes	NA		Yes	NA
Safety shower/eyewash (Location & Use)	☐	☐	Emergency alarms	☐	☐
Procedure for safe job completion	☐	☐	Evacuation routes	☐	☐
Contractor tools/equipment inspected	☐	☐	Assembly points	☐	☐

VII. Site Preparation	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Equipment and Foot Traffic Routes Cleared and Established	☐	☐	☐
Physical Hazards Barricaded and Isolated	☐	☐	☐
Emergency Equipment Staged	☐	☐	☐

VIII. Additional Permits required (Hot work, confined space entry, excavation, etc.). ☐Yes ☐No
If yes, See SSO for appropriate permit

IX. Special instructions, precautions: ____

____

____

Permit Issued by: __________________________ Permit Accepted by: __________________________

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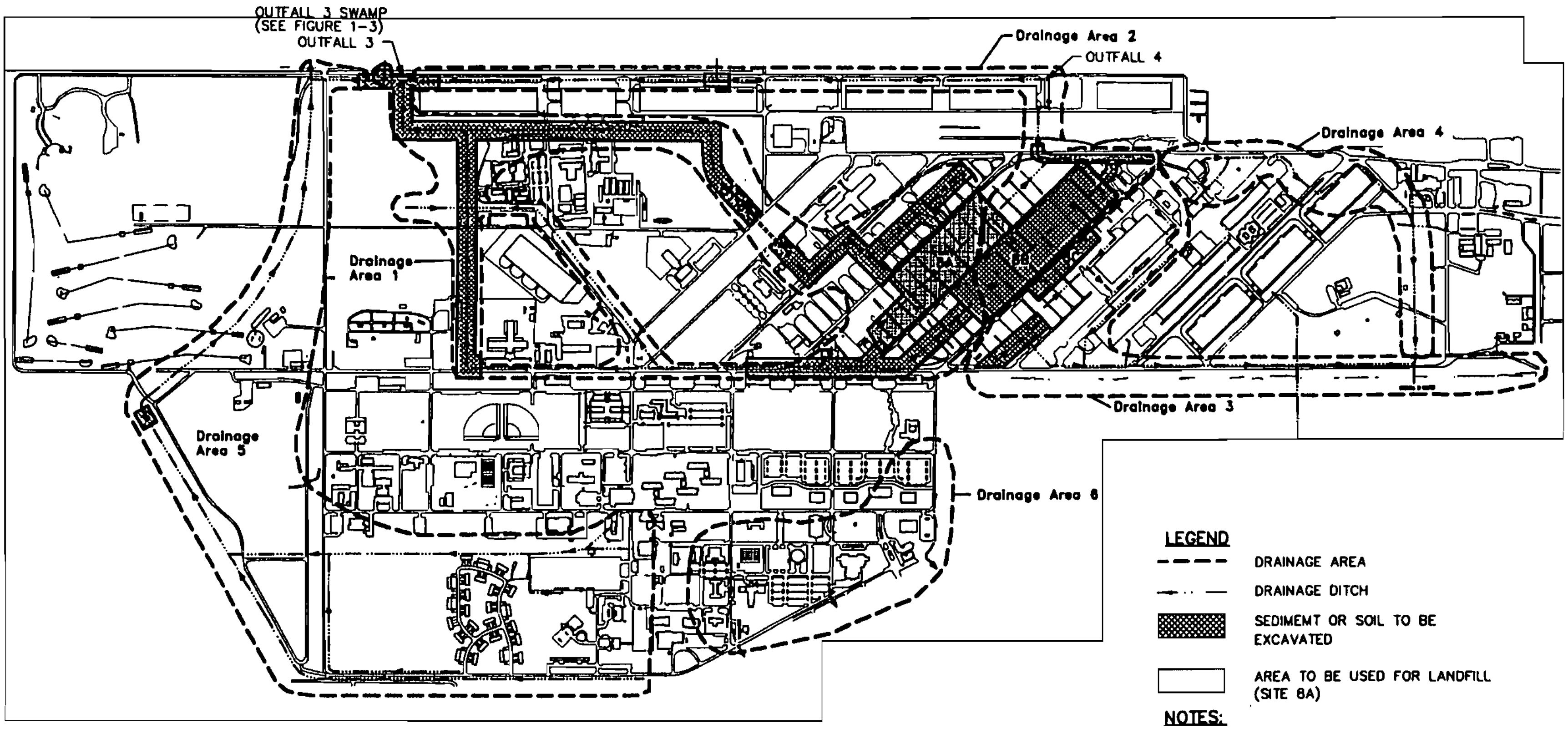


LEGEND

- DRAINAGE AREA
- DRAINAGE DITCH
- SEDIMEMT OR SOIL TO BE EXCAVATED
- AREA TO BE USED FOR LANDFILL (SITE 8A)

NOTES:

1) BOUNDARIES FOR SITE 8B AND SITE 8C ARE APPROXIMATE.
2) WIDTHS ACROSS DRAINAGE DITCHES ARE NOT TO SCALE.

0 500 1000
APPROXIMATE SCALE IN FEET

DRAWN BY: HJP	DATE: 11/1/00	AREAL EXTENT OF ON-BASE CONTAMINATED MEDIA NAVAL CONSTRUCTION BATTALION CENTER GULFPORT, MISSISSIPPI	CONTRACT NO. 0567	
CHECKED BY: SWH	DATE: 11/2/00		APPROVED BY: JLG	DATE: 11/2/00
COST/SCHED-AREA			APPROVED BY	DATE
SCALE: AS NOTED			DRAWING NO. FIGURE 10-2	REV. 1

SOURCE. REMEDIATION GUIDANCE DOCUMENT, HARDING LAWSON ASSOCIATES, MARCH 2000.

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

10.5 MATERIAL SAFETY DATA SHEET (MSDS) REQUIREMENTS

Tetra Tech NUS personnel will provide MSDSs for all chemicals brought on-site. The contents of these documents will be reviewed by the SSO with the user(s) of the chemical substances prior to any actual use or application or the substances on-site. The MSDSs will be maintained in a central location (i.e., temporary office) and will be available for anyone to review upon request. The SSO will be responsible for implementing a site-specific Hazard Communication Program (See Section 5.0 of the TtNUS Health and Safety Guidance Manual). This includes collection of MSDSs, creation and maintenance of an accurate Chemical Inventory Listing, addressing container labeling and personnel training issues, and other aspects of Hazard Communication.

10.6 COMMUNICATION

It is anticipated that site personnel will be working in close proximity during proposed field activities. In the event that site personnel are in isolated areas or are separated by significant distances, a supported means of communication between field crews will be utilized. Two-way radio communication devices, if needed, will be used only with NCBC Gulfport approval.

External communications will be accomplished utilizing telephones at predetermined and approved locations or through cellular phones. External communication will primarily be used for the purpose of resource and emergency resource communications. Prior to the commencement of site activities, the FOL will determine and arrange for telephone communications, if it is determined a cellular means will not be used.

The hand-held radios and cellular phones that will be used if permitted are as follows:

Motorola HT-1000	Power Output 5 watts
Cellular Phone	Power Output 5 watts

10.7 SITE VISITORS

Potential site visitors that may be encountered during the performance of the field work could include the following:

- Personnel invited to observe or participate in operations by Tetra Tech NUS.
- Regulatory personnel (i.e., DOD, MDEQ, EPA, OSHA, etc.)
- Southern Division Navy personnel

- Other authorized visitors

All non-DOD personnel working on this project are required to gain initial access to the base by coordinating with the TtNUS TOM or designee and following established base access procedures.

Once access to the base is obtained, all personnel who require access to Tetra Tech NUS work sites (areas of ongoing operations) will be required to obtain permission from the FOL and the Base Contact. Upon gaining access to the work site, all site visitors wishing to observe operations in progress will be required to meet the minimum requirements as stipulated below.

- All site visitors will be routed to the FOL, who will sign them into the field logbook. Information to be recorded in the logbook will include the individuals name (proper identification required), who they represent, and the purpose for the visit. **The FOL is responsible for ensuring that site visitors are escorted at all times.**

- All site visitors will be required to produce the necessary information supporting clearance on to the site. This includes information attesting to applicable training (40-hours of HAZWOPER training required for all Southern Division Navy Personnel), and medical surveillance as stipulated in Section 8.3, of this document. In addition, to enter the sites operational zones during planned activities, all visitors will be required to first go through site-specific training covering the topics stipulated in Section 8.2 of this HASP.

Once the site visitors have completed the above items they will be permitted to enter the site and applicable operational areas. All visitors are required to observe the protective equipment and site restrictions in effect at the work areas visited. Any and all visitors not meeting the requirements as stipulated in this plan for site clearance will not be permitted to enter the site operational zones during planned activities. Any incidence of unauthorized site visitation will cause all on-site activities to be terminated until that visitor can be removed. Removal of unauthorized visitors will be accomplished with support form the Base Contact, if necessary. At a minimum, the Base Contact will be notified of any unauthorized visitors.

10.8 SITE SECURITY

As this activity will take place at a Navy facility, the first line of security will be provided by the base gate restricting the general public. The second line of security will take place at the work site referring interested parties to the FOL and Base Contact.

Security at the work areas will be accomplished using field personnel. This is a multiple person operation, involving multiple operational zones. Tetra Tech NUS personnel will retain complete control over active operational zones.

The Base Contact will serve as the focal point for base personnel and interested parties and will serve as the primary enforcement contact.

10.9 SANITATION AND BREAK AREAS

This section will address the following items:

- Toilets
- Potable water
- Showers and change rooms
- Break Areas

10.9.1 Toilets

One toilet will be provided for every 20 people. All toilets will be unisex and will have locking doors. The toilet provided will either be a chemical toilet and service provider or the flush toilet associated with a predetermined location.

10.9.2 Potable Water

Potable water as well as electrolyte balance sports drinks such as Gatorade will be provided to the field crews for fluid replacement. Storage and dispensing will proceed as follows:

- All containers will be clean and replenished daily.

- All containers will clearly marked as to their contents (Potable Water – Drinking Water Only; Gatorade, etc.).

- Dispensing locations will be placed in identified break areas within the support zone. The most likely location will be a break trailer. This will serve as an area for cooling or warming as well as an identified food and drink consumption area.

- If larger containers are used, dispensing cups will be provided.

- The coolers used for storage of potable drinks and cups will be stored in plastic bags away from potentially contaminating materials.

Fluid intake recommendations will be made based on the medical evaluations conducted at the end of the decontamination process.

10.9.3 Showers and Change Rooms

Based on this scope and duration of this project shower facilities and locker rooms will not be provided.

10.9.4 Break Areas

Suitable locations will be provided for field personnel for the following use:

- Break areas for food and drink consumption
- Areas suitable for warming and cooling regimens
- Areas suitable for Safety Meetings

This location will be either the project trailer, or its own separate trailer based on the crew size. This area will be climate control to provide suitable shelter to combat heat or cold stress.

11.0 CONFINED SPACE ENTRY

It is not anticipated, under the proposed scope of work, that confined space and permit-required confined space activities will be conducted. **Therefore, personnel under the provisions of this HASP are not allowed, under any circumstances, to enter confined spaces**. A confined space is defined as an area which has the following characteristics:

- Is large enough and so configured that an employee can bodily enter and perform assigned work.
- Has limited or restricted means for entry or exit (for example, tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry).
- Is not designed for continuous employee occupancy.

A Permit-Required Confined Space is one that:

- Contains or has a potential to contain a hazardous atmosphere.
- Contains a material that has the potential to engulf an entrant.
- Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section.
- Contains any other recognized, serious, safety or health hazard.

For further information on confined space, consult the Health and Safety Guidance Manual or call the PHSO. If confined space operations are to be performed as part of the scope of work, detailed procedures and training requirements will have to be addressed, and the HSM will have to be notified.

12.0 MATERIALS AND DOCUMENTATION

The TtNUS FOL shall ensure the following materials/documents are taken to the project site and used when required.

- A complete copy of this HASP
- Health and Safety Guidance Manual
- Incident Reports
- Medical Data Sheets
- Material Safety Data Sheets for all chemicals brought on site, including decontamination solutions, fuels, sample preservatives, calibration gases, etc.
- A full-size OSHA Job Safety and Health Poster (posted in the site trailers)
- Training/Medical Surveillance Documentation Form (Blank)
- Emergency Reference Information (Section 2.0, extra copy for posting)

12.1 MATERIALS TO BE POSTED OR MAINTAINED AT THE SITE

The following documentation is to be posted or maintained at the site for quick reference purposes. In situations where posting these documents is not feasible, (such as no office trailer), these documents should be separated and immediately accessible.

Chemical Inventory Listing (posted) - This list represents all chemicals brought on-site, including decontamination solutions, sample preservations, fuel, etc.. This list should be posted in a central area.

MSDSs (maintained) - The MSDSs should also be in a central area accessible to all site personnel. These documents should match all the listings on the chemical inventory list for all substances employed on-site. It is acceptable to have these documents within a central folder and the chemical inventory as the table of contents.

The OSHA Job Safety & Health Protection Poster (posted) - this poster, as directed by 29 CFR 1903.2 (a)(1), should be conspicuously posted in places where notices to employees are normally posted. Each FOL shall ensure that this poster is not defaced, altered, or covered by other material.

Site Clearance (maintained) - This list is found within the training section of the HASP (See Figure 8-2). This list identifies all site personnel, dates of training (including site-specific training), and medical surveillance. The lists indicates not only clearance but also status. If personnel do not meet these requirements, they do not enter the site while site personnel are engaged in activities.

Emergency Phone Numbers and Directions to the Hospital(s) (posted) - This list of numbers and directions will be maintained at all phone communications points and in each site vehicle.

Medical Data Sheets/Cards (maintained) - Medical Data Sheets will be filled out by on-site personnel and filed in a central location. The Medical Data Sheet will accompany any injury or illness requiring medical attention to the medical facility. A copy of this sheet or a wallet card will be given to all personnel to be carried on their person.

Hearing Conservation Standard (29 CFR 1910.95) (posted) - this standard will be posted anytime hearing protection or other noise abatement procedures are employed.

Personnel Monitoring (maintained) - All results generated through personnel sampling (levels of airborne toxins, noise levels, etc.) will be posted to inform individuals of the results of that effort.

Placards and Labels (maintained) - Where chemical inventories have been separated because of quantities and incompatibilities, these areas will be conspicuously marked using Department of Transportation (DOT) placards and acceptable (Hazard Communication 29 CFR 1910.1200(f)) labels.

The purpose of maintaining or posting this information, as stated above, is to allow site personnel quick access. Variations concerning location and methods of presentation are acceptable, providing the objection is accomplished.

13.0 GLOSSARY

ACGIH	American Conference of Governmental Industrial Hygienists
APR	Air Purifying Respirators
AOC	Area of Concern
CERCLA	Comprehensive Environmental Response Compensation, and Liability Act
CFR	Code of Federal Regulations
CNS	Central Nervous System
CRZ	Contamination Reduction Zone
CTO	Contract Task Order
DOD	Department of Defense
DOT	Department of Transportation
DPT	Direct-Push Technology
EPA	Environmental Protection Agency
FDEP	Florida Department of Environmental Protection
FFA	Federal Facilities Agreement
eV	Electron Volts
FID	Flame Ionization Detector
FOL	Field Operations Leader
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HEPA	High Efficiency Particulate Air
HSM	Health and Safety Manager
IDW	Investigation-derived Waste
LEL/O_2	Lower Explosive Limit/Oxygen
MSDS	Material Safety Data Sheet
N/A	Not Available
NAS	Naval Air Station
NIOSH	National Institute Occupational Safety and Health
NPL	National Priorities List
OSHA	Occupational Safety and Health Administration (U.S. Department of Labor)
PEL	Permissible Exposure Limit
PHSO	Project Health and Safety Officer
PID	Photo Ionization Detector
PM	Project Manager
PPE	Personal Protective Equipment
RIFS	Remedial Investigation and Feasibility Study

SAP	Sampling and Analysis Plan
SCBA	Self Contained Breathing Apparatus
SOPs	Standard Operating Procedures
SSO	Site Safety Officer
STEL	Short Term Exposure Limit
SVOC	Semi-volatile Organic Compounds
TOM	Task Order Manager
TPH	Total Petroleum Hydrocarbons
TtNUS	Tetra Tech NUS, Inc.
TWA	Time Weighted Average
USTs	Underground Storage Tanks
UV	Ultra Violet
VOCs	Volatile Organic Compounds

ATTACHMENT I

INJURY/ILLNESS PROCEDURE AND REPORT FORM

case no. __________

TETRA TECH NUS, INC.

INJURY/ILLNESS PROCEDURE
WORKER'S COMPENSATION PROGRAM

WHAT YOU SHOULD DO IF YOU ARE INJURED OR DEVELOP AN ILLNESS AS A RESULT OF YOUR EMPLOYMENT:

- If injury is minor, obtain appropriate first aid treatment.
- If injury or illness is severe or life threatening, obtain professional medical treatment at the nearest hospital emergency room.
- If incident involves a chemical exposure on a project work site, follow instructions in the Health & Safety Plan.
- Immediately report any injury or illness to your supervisor or office manager. In addition, you must contact your Human Resources representative, Marilyn Diethorn at (412) 921-8475, and the Corporate Health and Safety Manager, Matt Soltis at (412) 921-8912 within 24 hours. You will be required to complete an Injury/Illness Report (attached). You may also be required to participate in a more detailed investigation from the Health Sciences Department.
- If further medical treatment is needed, The Hartford Network Referral Unit will furnish a list of network providers customized to the location of the injured employee. These providers are to be used for treatment of Worker's Compensation injuries subject to the laws of the state in which you work. Please call Marilyn Diethorn at (412) 921-8475 for the number of the Referral Unit.

ADDITIONAL QUESTIONS REGARDING WORKER'S COMPENSATION:

Contact your local human resources representative, corporate health and safety coordinator, or Corporate Administration in Pasadena, California, at (626) 351-4664.

Worker's compensation is a state-mandated program that provides medical and disability benefits to employees who become disabled due to job related injury or illness. Tetra Tech, Inc. and its subsidiaries (Tetra Tech or Company) pay premiums on behalf of their employees. The type of injuries or illnesses covered and the amount of benefits paid are regulated by the state worker's compensation boards and vary from state to state. Corporate Administration in Pasadena is responsible for administering the Company's worker's compensation program. The following is a general explanation of worker's compensation provided in the event that you become injured or develop an illness as a result of your employment with Tetra Tech or any of its subsidiaries. Please be aware that the term used for worker's compensation varies from state to state.

WHO IS COVERED:

All employees of Tetra Tech, whether they are on a full-time, part-time or temporary status, working in an office or in the field, are entitled to worker's compensation benefits.

All employees must follow the above injury/illness reporting procedures. Consultants, independent contractors, and employees of subcontractors are not covered by Tetra Tech's Worker's Compensation plan.

WHAT IS COVERED:

If you are injured or develop an illness caused by your employment, worker's compensation benefits are available to you subject to the laws of the state you work in. Injuries do not have to be serious; even injuries treated by first aid practices are covered and must be reported. Please note that if you are working out-of-state and away from your home office, you are still eligible for worker's compensation benefits.

case no. ___________

TETRA TECH NUS, INC.
INJURY/ILLNESS PROCEDURE
WORKER'S COMPENSATION PROGRAM

To: Corporate Health and Safety Manager
Human Resource Administrator

Prepared by: ______________________
Position: ______________________
Office: ______________________
Telephone: ______________________

Project Name: ______________________
Project No. ______________________

Information Regarding Injured or Ill Employee:

Name: ______________________ Office: ______________________

Home address: ______________________ Gender: M ☐ F ☐ No. of dependents: ________

______________________ Marital status: ______________________

Home telephone: ______________________ Date of birth: ______________________

Occupation (regular job title): ______________________ Social Security No.: ______________________

Department: ______________________

Date of Accident: ______________________ **Time of Accident:** ______________________

Location of Accident Was place of accident or exposure on employer's premises Yes ☐ No ☐

Street address: ______________________

City, state, and zip code: ______________________

County: ______________________

Narrative Description of How Accident Occurred: (Be specific. Explain what the employee was doing and how the accident occurred.)

TETRA TECH, INC.
INJURY/ILLNESS REPORT

Did employee die? Yes ☐ No ☐
Was employee performing regular job duties? Yes ☐ No ☐
Was safety equipment provided? Yes ☐ No ☐
Was safety equipment used? Yes ☐ No ☐
Note: Attach any police reports or related diagrams to this accident report.

Witness(es):
Name:
Address:
Telephone:

Describe the Illness or Injury and Part of Body Affected:

Name the Object or Substance which Directly Injured the Employee:

Medical Treatment Required:	**Lost Work Days:**
☐ No ☐ Yes ☐ First Aid Only	☐ No. of Lost Work Days ______
Physician's Name: ______	Last Date Worked ______
Address: ______	Time Employee Left Work ______
Hospital or Office Name: ______	Date Employee Returned to Work ______
Address: ______	☐ No. of Restricted Work Days ______
______	☐ None
Telephone No.: ______	

Corrective Action(s) Taken by Unit Reporting the Accident:

Corrective Action Still to be Taken (by whom and when):

Name of Tetra Tech employee the injury or illness was first reported to: ______________________

Date of Report: ______________________ Time of Report: ______________________

	Printed Name	Signature	Telephone No.	Date
Project or Office Manager				
Site Safety Coordinator				
Injured Employee				

To be completed by Human Resources:

Date of hire: Hire date in current job:

Wage information: $____________ per __________ (hour, day, week, or month)

Position at time of hire:

Shift hours:

State in which employee was hired:

Status: ☐ Full-time ☐ Part-time Hours per week: ________ Days per week: ________

Temporary job end date:

To be completed during report to workers' compensation insurance carrier:

Date reported: Reported by:

TeleClaim phone number:

TeleClaim account number:

Location code:

Confirmation number:

Name of contact:

Field office of claims adjuster:

ATTACHMENT II

STANDARD OPERATING PROCEDURE
FOR
UTILITY LOCATING AND EXCAVATION CLEARANCE

TETRA TECH NUS, INC.	STANDARD OPERATING PROCEDURES	Number HS-1.0	Page 1 of 11
		Effective Date 03/00	Revision 1
		Applicability Tetra Tech NUS, Inc.	
		Prepared Health & Safety	
Subject UTILITY LOCATING AND EXCAVATION CLEARANCE		Approved D. Senovich	

TABLE OF CONTENTS

1.0 PURPOSE

Utilities such as electric service lines, natural or propane gas lines, water and sewage lines, telecommunications, and steam lines are very often in the immediate vicinity of work locations. Contact with underground or overhead utilities can have serious consequences including employee injury/fatality, property and equipment damage, substantial financial impacts, and loss of utility service to users.

The purpose of this procedure is to provide minimum requirements and technical guidelines regarding the appropriate procedures to be followed when performing subsurface and overhead utility locating services. It is the policy of Tetra Tech NUS, Inc. (TtNUS) to provide a safe and healthful work environment for the protection of our employees. The purpose of this Standard Operating Procedure (SOP) is to aid in achieving the objectives of the TtNUS Utility Locating and Clearance Policy. The TtNUS Utility Locating and Clearance Policy must be reviewed by anyone potentially involved with underground or overhead utility services.

2.0 SCOPE

This procedure applies to all TtNUS field activities where there may be potential contact with underground or overhead utilities. This procedure provides a description of the principles of operation, instrumentation, applicability, and implementability of typical methods used to determine the presence or absence of utility services. This procedure is intended to assist with work planning and scheduling, resource planning, field implementation, and subcontractor procurement. Utility locating and excavation clearance requires site-specific information prior to the development of detailed operating procedures. This guidance is not intended to provide a detailed description of methodology and instrument operation. Specialized expertise during both planning and execution of several of the geophysical methods may also be required.

3.0 GLOSSARY

Electromagnetic Induction (EMI) Survey - A geophysical exploration method whereby electromagnetic fields are induced in the ground and the resultant secondary electromagnetic fields are detected as a measure of ground conductivity.

Magnetometer – A device used for precise and sensitive measurements of magnetic fields.

Magnetic Survey – A geophysical survey method that depends on detection of magnetic anomalies caused by the presence of buried ferromagnetic objects.

Metal Detection – A geophysical survey method that is based on electromagnetic coupling caused by underground conductive objects.

Vertical Gradiometer – A magnetometer equipped with two sensors that are vertically separated by a fixed distance. It is best suited to map near surface features and is less susceptible to deep geologic features.

Ground Penetrating Radar – Ground Penetrating Radar (GPR) involves specialized radar equipment whereby a signal is sent into the ground via a transmitter. Some portion of the signal will be reflected from the subsurface material, which is then recorded with a receiver and electronically converted into a graphic picture.

4.0 RESPONSIBILITIES

Project Manager (PM)/Task Order Manager (TOM) - Responsible for ensuring that all field activities are conducted in accordance with this procedure and the TtNUS Utility Locating and Clearance Policy.

Site Manager (SM)/Field Operations Leader (FOL) - Responsible for the onsite verification that all field activities are performed in compliance with approved SOPs or as otherwise directed by the approved project plan(s).

Site Health & Safety Officer (SHSO) – Responsible to provide technical assistance and verify full compliance with this SOP and the TtNUS Utility Locating and Clearance Policy. The SHSO is also responsible for reporting any deficiencies to the Corporate Health and Safety Manager (HSM) and to the PM/TOM.

Health & Safety Manager (HSM) – Responsible for preparing, implementing, and modifying corporate health and safety policy.

Site Personnel – Responsible for understanding and implementing this SOP and the TtNUS Utility Locating and Clearance Policy.

5.0 PROCEDURES

This procedure addresses the requirements and technical procedures that must be performed to minimize the potential for contact with underground and overhead utility services. These procedures are addressed individually from a buried and overhead standpoint.

5.1 Buried Utilities

Buried utilities present a heightened concern because their location is not typically obvious by visual observation, and it is common that their presence and/or location is unknown or incorrectly known on client properties. The following procedure must be followed prior to beginning any excavation that might potentially be in the vicinity of underground utility services. In addition, the Utility Clearance Form (Attachment 3) must be completed for every location or cluster of locations where intrusive activities will occur.

Where the positive identification and de-energizing of underground utilities cannot be obtained and confirmed using the following steps, the PM/TOM is responsible for arranging for the procurement of a qualified, experienced, utility locating subcontractor who will accomplish the utility location and demarcation duties specified herein.

1. A comprehensive review must be made of any available property maps, blue lines, or as-builts prior to site activities. Interviews with local personnel familiar with the area should be performed to provide additional information concerning the location of potential underground utilities. Information regarding utility locations shall be added to project maps upon completion of this exercise.

2. A visual site inspection must be performed to compare the site plan information to actual field conditions. Any findings must be documented and the site plan/maps revised. The area(s) of proposed excavation or other subsurface activities must be marked at the site in white paint or pin flags to identify those locations of the proposed intrusive activities. The site inspection should focus on locating surface indications of potential underground utilities. Items of interest include the presence of nearby area lights, telephone service, drainage grates, fire hydrants, electrical service vaults/panels, asphalt/concrete scares and patches, and topographical depressions. Note the location of any emergency shut off switches. Any additional information regarding utility locations shall be added to project maps upon completion of this exercise and returned to the PM/TOM.

3. If the planned work is to be conducted on private property (e.g., military installations, manufacturing facilities, etc.) the FOL must identify and contact appropriate facility personnel (e.g., public works or facility engineering) before any intrusive work begins to inquire about (and comply with) property owner requirements. It is important to note that private property owners may require several days to several weeks advance notice prior to locating utilities.

4. If the work location is on public property, the state agency that performs utility clearances must be notified (see Attachment 1). State "one-call" services must be notified prior to commencing fieldwork per their requirements. Most one-call services require, by law, 48- to 72-hour advance notice prior to beginning any excavation. Such services typically assign a "ticket" number to the particular site. This ticket number must be recorded for future reference and is valid for a specific period of time, but may be extended by contacting the service again. The utility service will notify utility representatives who then mark their respective lines within the specified time frame. It should be noted that most military installations own their own utilities but may lease service and maintenance from area providers. Given this situation, "one call" systems may still be required to provide location services on military installations.

5. Utilities must be identified and their locations plainly marked using pin flags, spray paint, or other accepted means. The location of all utilities must be noted on a field sketch for future inclusion on project maps. Utility locations are to be identified using the following industry-standard color code scheme, unless the property owner or utility locator service uses a different color code:

white	excavation/subsurface investigation location
red	electrical
yellow	gas, oil, steam
orange	telephone, communications
blue	water, irrigation, slurry
green	sewer, drain

6. Where utility locations are not confirmed with a high degree of confidence through drawings, schematics, location services, etc., the work area must be thoroughly investigated prior to beginning the excavation. In these situations, utilities must be identified using such methods as passive and intrusive surveys, physical probing, or hand augering. Each method has advantages and disadvantages including complexity, applicability, and price. It also should be noted that in many states, initial excavation is required by hand to a specified depth.

7. At each location where trenching or excavating will occur using a backhoe or other heavy equipment, and where utility identifications and locations cannot be confirmed prior to groundbreaking, the soil must be probed with a hand auger or pole (tile probe) made of non-conductive material. If these efforts are not successful in clearing the excavation area of suspect utilities, hand shoveling must be performed for the perimeter of the intended excavation.

8. All utilities uncovered or undermined during excavation must be structurally supported to prevent potential damage. Unless necessary as an emergency corrective measure, TtNUS shall not make any repairs or modifications to existing utility lines without prior permission of the utility owner, property owner, and Corporate HSM. All repairs require that the line be locked-out/tagged-out prior to work.

5.2 Overhead Power Lines

If it is necessary to work within the minimum clearance distance of an overhead power line, the overhead line must be de-energized and grounded, or re-routed by the utility company or a registered electrician. If protective measures such as guarding, isolating, or insulating are provided, these precautions must be adequate to prevent employees from contacting such lines directly with any part of their body or indirectly though conductive materials, tools, or equipment.

The following table provides the required minimum clearances for working in proximity to overhead power lines.

Nominal Voltage	Minimum Clearance
0 -50 kV	10 feet, or one mast length; whichever is greater
50+ kV	10 feet plus 4 inches for every 10 kV over 50 kV or 1.5 mast lengths; whichever is greater

6.0 UNDERGROUND LOCATING TECHNIQUES

6.1 Geophysical Methods

Geophysical methods include electromagnetic induction, magnetics, and ground penetrating radar. Additional details concerning the design and implementation of electromagnetic induction, magnetics, and ground penetrating radar surveys can be found in one or more of the TtNUS SOPs included in the References (Section 8.0).

Electromagnetic Induction

Electromagnetic Induction (EMI) line locators operate either by locating a background signal or by locating a signal introduced into the utility line using a transmitter. A utility line acts like a radio antenna, producing electrons, which can be picked up with a radiofrequency receiver. Electrical current carrying conductors have a 60HZ signal associated with them. This signal occurs in all power lines regardless of voltage. Utilities in close proximity to power lines or used as grounds may also have a 60HZ signal, which can be picked up with an EM receiver. A typical example of this type of geophysical equipment is an EM-61.

EMI locators specifically designed for utility locating use a special signal that is either indirectly induced onto a utility line by placing the transmitter above the line or directly induced using an induction clamp. The clamp induces a signal on the specific utility and is the preferred method of tracing since there is little chance of the resulting signals being interfered with. A good example of this type of equipment is the Schonstedt® MAC-51B locator. The MAC-51B performs inductively traced surveys, simple magnetic locating, and traced nonmetallic surveys.

When access can be gained inside a conduit to be traced, a flexible insulated trace wire can be used. This is very useful for non-metallic conduits but is limited by the availability of gaining access inside the pipe.

Magnetics

Magnetic locators operate by detecting the relative amounts of buried ferrous metal. They are incapable of locating or identifying nonferrous utility lines but can be very useful for locating underground storage tanks (UST's), steel utility lines, and buried electrical lines. A typical example of this type of equipment is the Schonstedt® GA-52Cx locator. The GA-52Cx is capable of locating 4-inch steel pipe up to 8 feet deep.

Non-ferrous lines are often located by using a typical plumbing tool (snake) fed through the line. A signal is then introduced to the snake that is then traced.

Ground Penetrating Radar

Ground Penetrating Radar (GPR) involves specialized radar equipment whereby a signal is sent into the ground via a transmitter. Some portion of the signal will be reflected from the subsurface material, which is then recorded with a receiver and electronically converted into a graphic picture. In general, an object which is harder than the surrounding soil will reflect a stronger signal. Utilities, tunnels, UST's, and footings will reflect a stronger signal than the surrounding soil. Although this surface detection method may determine the location of a utility, this method does not specifically identify utilities (i.e., water vs. gas, electrical vs. telephone); hence, verification may be necessary using other methods. This method is somewhat limited when used in areas with clay soil types or with a high water table.

6.2 Passive Detection Surveys

Acoustic Surveys

Acoustic location methods are generally most applicable to waterlines or gas lines. A highly sensitive Acoustic Receiver listens for background sounds of water flowing (at joints, leaks, etc.) or to sounds introduced into the water main using a transducer. Acoustics may also be applicable to determine the location of plastic gas lines.

Thermal Imaging

Thermal (i.e., infrared) imaging is a passive method for detecting the heat emitted by an object. Electronics in the infrared camera convert subtle heat differentials into a visual image on the viewfinder or a monitor. The operator does not look for an exact temperature; rather they look for heat anomalies (either elevated or suppressed temperatures) characteristic of a potential utility line.

The thermal fingerprint of underground utilities results from differences in temperature between the atmosphere and the fluid present in a pipe or the heat generated by electrical resistance. In addition, infrared scanners may be capable of detecting differences in the compaction, temperature and moisture content of underground utility trenches. High-performance thermal imagery can detect temperature differences to hundredths of a degree.

6.3 Intrusive Detection Surveys

Vacuum Excavation

Vacuum excavation is used to physically expose utility services. The process involves removing the surface material over approximately a 1' x 1' area at the site location. The air-vacuum process proceeds with the simultaneous action of compressed air-jets to loosen soil and vacuum extraction of the resulting debris. This process ensures the integrity of the utility line during the excavation process, as no hammers, blades, or heavy mechanical equipment comes into contact with the utility line, eliminating the risk of damage to utilities. The process continues until the utility is uncovered. Vacuum excavation can be used at the proposed site location to excavate below the "utility window" which is usually 8 feet.

Hand-auger Surveys

When the identification and location of underground utilities cannot be positively confirmed through document reviews and/or other methods, borings must be hand-augered for all locations where there is a potential to impact buried utilities. The minimum hand-auger depth that must be reached is to be determined considering the geographical location of the work site. This approach recognizes that the placement of buried utilities is influenced by frost line depths that vary by geographical region. Attachment 2 presents frost line depths for the regions of the contiguous United States. At a minimum, hand-auger depths must be at least to the frost line depth plus two (2) feet, but never less than 4 feet below ground surface (bgs). For augering, the hole must be reamed by hand to at least the diameter of the drill rig auger or bit prior to drilling. For soil gas surveys, the survey probe shall be placed as close as possible to the cleared hand-auger. It is important to note that a post-hole digger must not be used in place of a hand-auger.

Tile Probe Surveys

For some soil types, site conditions, and excavation requirements, tile probes may be used instead of or in addition to hand-augers. Tile probes must be performed to the same depth requirements as hand-augers. Depending upon the site conditions and intended probe usage, tile probes should be made of non-conductive material such as fiberglass.

7.0 INTRUSIVE ACTIVITIES SUMMARY

The following list summarizes the activities that must be performed prior to beginning subsurface activities:

1. Map and mark all subsurface locations and excavation boundaries using white paint or markers specified by the client or property owner.

2. Notify the property owner and/or client that the locations are marked. At this point, drawings of locations or excavation boundaries shall be provided to the property owner and/or client so they may initiate (if applicable) utility clearance.

   Note: Drawings with confirmed locations should be provided to the property owner and/or client as soon as possible to reduce potential time delays.

3. Notify "One Call" service. If possible, arrange for an appointment to show the One Call representative the subsurface locations or excavation boundaries in person. This will provide a better location designation to the utilities they represent. You should have additional drawings should you need to provide plot plans to the One Call service.

4. Complete Attachment 3, Utility Clearance Form. This form should be completed for each excavation location. In situations where multiple subsurface locations exist within the close proximity of one another, one form may be used for multiple locations provided those locations are noted on the Utility Clearance Form. Upon completion, the Utility Clearance Form and revised/annotated utility location map becomes part of the project file.

8.0 REFERENCES

TtNUS Utility Locating and Clearance Policy
TtNUS SOP GH-3.1; Resistivity and Electromagnetic Induction
TtNUS SOP GH-3.2; Magnetic and Metal Detection Surveys
TtNUS SOP GH-3.4; Ground-penetrating Radar Surveys

ATTACHMENT 1
LISTING OF UNDERGROUND UTILITY CLEARANCE RESOURCES

ALABAMA Alabama Line Location (800) 292-8525 Tucson Blue Stake Center (800) 782-5348
Alaska Locate Call Center of Alaska Inc. (800) 478-3121
Arizona Arizona Blue Stake Inc. (800) 782-5348
Arkansas Arkansas One Call System Inc. (800) 482-8998
California Underground Service Alert North (800) 227-2600 Underground Service Alert South (800) 227-2600
Colorado Utility Notification Center of Colorado (800) 922-1987
Connecticut Call Before You Dig (800) 922-4455
Delaware Miss Utility of Delmarva (800) 282-8555
District of Columbia Miss Utility (800) 257-7777
Florida Call Sunshine (800) 432-4770
Georgia Utilities Protection Center Inc. (800) 282-7411
Idaho Palouse Empire Underground Coordinating Council (800) 882-1974 Utilities Underground Location Center (800) 424-5555 Kootenai Country Utility Coordinating Council (800) 428-4950 Shoshone County One Call (800) 398-3285 Dig Line (800) 342-1585 One Call Concepts (800) 626-4950
Illinois Julie Inc. (800) 892-0123 Digger (Chicago Utility Alert Network) (312) 744-7000
Indiana Indiana Underground Plant Protection Services (800) 382-5544
Iowa Underground Plant Location Service Inc. (800) 292-8989
Kansas Kansas One-Call Center (800) 344-7233
Kentucky Kentucky Underground Protection Inc. (800) 752-6007
Louisiana Louisiana One Call (800) 272-3020

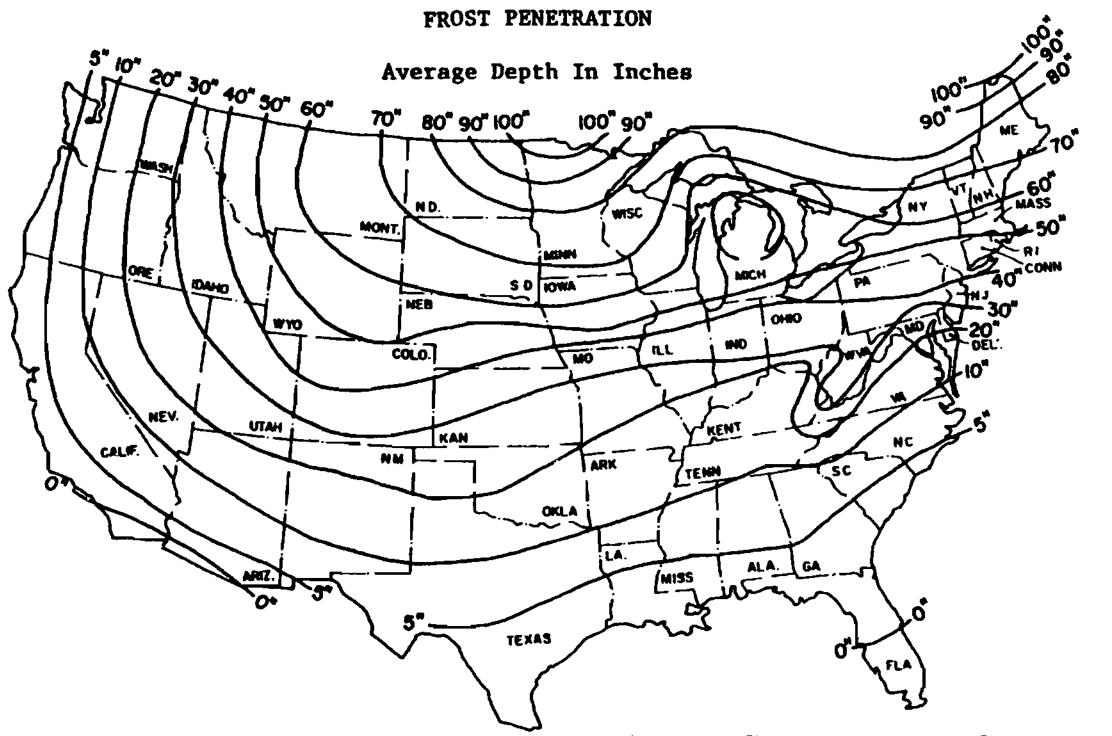
Maine Dig Safe – Maine (800) 225-4977
Maryland Miss Utility (800) 257-777 Miss Utility of Delmarva (800) 282-8555
Massachusetts Dig Safe – Massachusetts (800) 322-4844
Michigan Miss Dig System (800) 482-7171
Minnesota Gopher State One Call (800) 252-1166
Mississippi Mississippi One-Call System Inc. (800) 227-6477
Missouri Missouri One Call System Inc. (800) 344-7483
Montana Utilities Underground Location Center (800) 424-5555 Montana One Call Center (800) 551-8344
Nebraska Diggers Hotline of Nebraska (800) 331-5666
Nevada Underground Service Alert North (800) 227-2600
New Hampshire Dig Safe – New Hampshire (800) 225-4977
New Jersey New Jersey One Call (800) 272-1000
New Mexico New Mexico One Call System Inc. (800) 321-ALERT Las Cruces-Dona Utility Council (505) 526-0400
New York Underground Facilities Protection Organization (800) 962-7962 New York City: Long Island One Call Center (800) 272-4480
North Carolina The North Carolina One-Call Center Inc. (800) 632-4949
North Dakota Utilities Underground Location Center (800) 795-0555
Ohio Ohio Utilities Protection Service (800) 362-2764 Oil & Gas Producers Underground Protection Service (800) 925-0988
Oklahoma Call Okie (800) 522-6543

Oregon Utilities Underground Location Center (800) 424-5555 Douglas Utilities Coordinating Council (503) 673-6676 Josephine Utilities Coordinating Council (503) 476-6676 Rogue Basin Utility Coordinating Council (503) 779-6676 Utilities Notification Center (800) 332-2344
Pennsylvania Pennsylvania One Call System Inc. (800) 242-1776
Rhode Island Dig Safe – Rhode Island (800) 225-4977
South Carolina Palmetto Utility Protection Service Inc. (800) 922-0983
South Dakota South Dakota One Call (800) 781-7474
Tennessee Tennessee One-Call System (800) 351-1111
Texas Texas One Call System (800) 245-4545 Texas Excavation Safety System (800) 344-8377 Lone Star Notification Center (800) 669-8344
Utah Blue Stakes Location Center (800) 662-4111
Vermont Dig Safe – Vermont (800) 225-4977
Virginia Miss Utility of Virginia (800) 552-7001 Miss Utility (800) 257-7777 Miss Utility of Delmarva (800) 441-8355
Washington Utilities Underground Location Center (800) 424-5555 Grays Harbor & Pacific County Utility Coordinating Council (206) 535-3550 Utilities County of Cowlitz County (360) 425-2506 Chelan-Douglas Utilities Coordinating Council (509) 663-6111 Upper Yakima County Underground Utilities Council (800) 553-4344 Inland Empire Utility Coordinating Council (509) 456-8000 Palouse Empire Utilities Coordinating Council (800) 822-1974 Utilities Notification Center (800) 332-2344
West Virginia Miss Utility of West Virginia Inc. (800) 245-4848
Wisconsin Diggers Hotline Inc. (800) 242-8511

Wyoming West Park Utility Coordinating Council (307) 587-4800 Call-In Dig-In Safety Council (800) 300-9811 Fremont County Utility Coordinating Council (800) 489-8023 Central Wyoming Utilities Coordinating Council (800) 759-8035 Southwest Wyoming One Call (307) 362-8888 Carbon County Utility Utility Coordinating Council (307) 324-6666 Albany County Utility Coordinating Council (307) 742-3615 Southeast Wyoming Utilities Coordinating Council (307) 638-6666 Wyoming One-Call (800) 348-1030 Utilities Underground Location Center (800) 454-5555 Converse County Utility Coordination Council (800) 562-5561

ATTACHMENT 2

FROST LINE PENETRATION DEPTHS BY GEOGRAPHIC LOCATION



Courtesy U.S. Department Of Commerce

ATTACHMENT 3
UTILITY CLEARANCE FORM

Client: ____________________ Project Name: ______________________________

Project No.: ______________________ Completed By: ______________________________

Location Name: _________________________ Work Date: ___________________________

Excavation Method/Overhead Equipment: ____

1. Underground Utilities — Circle One

a)	Review of existing maps?	yes no N/A
b)	Interview local personnel?	yes no N/A
c)	Site visit and inspection?	yes no N/A
d)	Excavation areas marked in the field?	yes no N/A
e)	Utilities located in the field?	yes no N/A
f)	Located utilities marked/added to site maps?	yes no N/A
g)	Client contact notified Name ______________ Telephone: ____________ Date: ____________	yes no N/A
g)	State One-Call agency called? Caller: ___________________________ Ticket Number: _________________________ Date: ____________	yes no N/A
h)	Geophysical survey performed? Survey performed by: ___________________ Method: ______________________________ Date: ____________	yes no N/A
i)	Hand augering performed? Augering completed by: ___________________ Total depth: __________ feet Date: _______	yes no N/A
j)	Trench/excavation probed? Probing completed by: ___________________ Depth/frequency: _______________________ Date: ____________	yes no N/A

2. Overhead Utilities — Present Absent

a)	Determination of nominal voltage	yes no N/A
b)	Marked on site maps	yes no N/A
c)	Necessary to lockout/insulate/re-route	yes no N/A
d)	Document procedures used to lockout/insulate/re-route	yes no N/A
e)	Minimum acceptable clearance (SOP Section 5.2): ________________	

3. Notes:

____

____

____

Approval:

______________________________ ______________

Site Manager/Field Operations Leader Date

c: PM/Project File
Program File

ATTACHMENT III

EQUIPMENT INSPECTION CHECKLISTS
AND
LOAD INSPECTION REPORT

EQUIPMENT INSPECTION FOR DRILL RIGS

COMPANY:_______________________________________ **UNIT NO.**______________

FREQUENCY: Inspect at the initiation of the project, after repairs, once every 10-day shift.

Inspection Date: ____/____/____ Time: _______ Equipment Type:________________________

(e.g., **Drill Rigs** Hollow Stem, Mud Rotary, Direct Push)

Item	Good	Need Repair	N/A
Emergency Stop Devices (At points of operation)	☐	☐	☐
Tires (Tread) or tracks	☐	☐	☐
Hoses and belts	☐	☐	☐
Cab, mirrors, safety glass	☐	☐	☐
- Turn signals, lights, brake lights, etc. (front/rear) for equipment approved for highway use?	☐	☐	☐
- Is the equipment equipped with audible back-up alarms and back-up lights?	☐	☐	☐
Horn and gauges	☐	☐	☐
Brake condition (dynamic, park, etc.)	☐	☐	☐
Fire extinguisher (Type/Rating -___________)	☐	☐	☐
Fluid Levels:			
- Engine oil	☐	☐	☐
- Transmission fluid	☐	☐	☐
- Brake fluid	☐	☐	☐
- Cooling system fluid	☐	☐	☐
- Windshield wipers	☐	☐	☐
- Hydraulic oil	☐	☐	☐
Oil leak/lube	☐	☐	☐
Coupling devices and connectors	☐	☐	☐
Exhaust system	☐	☐	☐
Mast condition (Mast Height______)	☐	☐	☐
Access-ways: Frame, hand holds, ladders, walkways (non-slip surfaces), guardrails?	☐	☐	☐
Steering (standard and emergency)	☐	☐	☐
Power cable and/or hoist cable	☐	☐	☐
➢ Hooks			
- Safety Latch	☐	☐	☐
- Wear in excess of 10% original dimension	☐	☐	☐
- A bend or twist exceeding 10% from the plane of an unbent hook	☐	☐	☐
- Increase in throat opening exceeding 15% from new condition	☐	☐	☐
- Excessive nicks and/or gouges	☐	☐	☐
➢ Wire Rope (Hoist Mechanism)			
- Reduction in Rope diameter (5/16 wire rope>1/64 reduction nominal size -replace) (3/8 to 1/2 wire rope>1/32 reduction nominal size-replace) (9/16 to 3/4 wire rope>3/64 reduction nominal size-replace)	☐	☐	☐
- Number of broken wires (12 randomly broken wires in one rope lay) (4 broken wires in one strand)	☐	☐	☐
- Number of wire rope wraps left on the Running Drum at nominal use ($\geq$3 required)	☐	☐	☐
- Lead (primary) sheave is centered on the running drum	☐	☐	☐
- Lubrication of wire rope (adequate?)	☐	☐	☐

	Good	Needs Repaired	N/A
- Number of U-Type (Crosby) Clips (5/16 – 5/8 = 3 clips minimum) (3/4 – 1 inch = 4 clips minimum) (1 1/8 – 1 3/8 inch = 5 clips minimum)	❒	❒	❒
➢ Kinks, bends – Flattened to > 50% diameter	❒	❒	❒
➢ Hemp/Fiber rope (Cathead/Split Spoon Hammer)			
- Minimum ¾;maximum 1inch rope diameter (Inspect for physical damage)	❒	❒	❒
- Rope to hammer is securely fastened	❒	❒	❒

Safety Guards:	**Yes**	**No**
Around rotating apparatus (belts, pulleys, sprockets, spindles, drums, flywheels, chains) all points of operations protected from accidental contact?__________	❒	❒
Hot pipes and surfaces exposed to accidental contact?__________	❒	❒
All emergency shut offs have been identified and communicated to the field crew?__________	❒	❒
Are any structural members bent, rusted, or otherwise show signs of damage?__________	❒	❒
Are fueling cans used with this equipment approved type safety cans?__________	❒	❒
Have the attachments designed for use (as per manufacturer's recommendation) with this equipment been inspected and are considered suitable for use?__________	❒	

Cleanliness:

Overall condition (was the decontamination performed prior to arrival on-site considered acceptable)?__________

Where was this equipment used prior to its arrival on site?__________
Site Contaminants of concern at the previous site?__________
Inside debris (coffee cups, soda cans, tools and equipment) blocking free access to foot controls?__________
Flammable solvents stored in the operators cab?__________

Operator Qualifications (as applicable for all heavy equipment):

Does the operator have proper licensing where applicable, (e.g., CDL)?__________
Does the operator, understand the equipment's operating instructions?__________
Is the operator experienced with this equipment? __________
Is the operator 21 years of age or more?__________

ADDITIONAL INSPECTION REQUIRED PRIOR TO USE ON-SITE

	Yes	**No**
Does equipment emit noise levels above 90 decibels?	❒	❒
If so, has an 8-hour noise dosimetry test been performed?	❒	❒

Results of noise dosimetry:__________
Defects and repairs needed:__________
General Safety Condition: __________
Operator or mechanic signature:__________

Site Safety Officer Signature:__________

Approved for Use: ❒ Yes ❒ No

EQUIPMENT INSPECTION (Heavy Equipment)

COMPANY:____ **UNIT NO.**________________

FREQUENCY: Inspect at the initiation of the project, after repairs, once every 10-day shift.

Inspection Date: ____/____/____ Time: _______ Equipment Type:________________________
(e.g., bulldozer, generator)

	Good	Need Repair	N/A
Tires or tracks	☐	☐	☐
Hoses and belts	☐	☐	☐
Cab, mirrors, safety glass	☐	☐	☐
- Turn signals, lights, brake lights, etc. (front/rear) for equipment approved for highway use?	☐	☐	☐
- Is the equipment equipped with audible back-up alarms and back-up lights?	☐	☐	☐
Horn and gauges	☐	☐	☐
Brake condition (dynamic, park, etc.)	☐	☐	☐
Fire extinguisher (Type/Rating -___________)	☐	☐	☐
Fluid Levels:			
- Engine oil	☐	☐	☐
- Transmission fluid	☐	☐	☐
- Brake fluid	☐	☐	☐
- Cooling system fluid	☐	☐	☐
- Windshield wipers	☐	☐	☐
- Hydraulic oil	☐	☐	☐
Oil leak/lube	☐	☐	☐
Coupling devices and connectors	☐	☐	☐
Exhaust system	☐	☐	☐
Blade/boom/ripper condition	☐	☐	☐
Access-ways: Frame, hand holds, ladders, walkways (non-slip surfaces), guardrails?	☐	☐	☐
Power cable and/or hoist cable	☐	☐	☐
Steering (standard and emergency)	☐	☐	☐

Safety Guards:

	Yes	No
– Around rotating apparatus (belts, pulleys, sprockets, spindles, drums, flywheels, chains) all points of operations protected from accidental contact?____________________	☐	☐
– Hot pipes and surfaces exposed to accidental contact?____________________	☐	☐
– All emergency shut offs have been identified and communicated to the field crew?__________	☐	☐
– Have emergency shutoffs been field tested? ____________________	☐	☐
– Results?____________________	☐	☐
– Are any structural members bent, rusted, or otherwise show signs of damage?__________	☐	☐
– Are fueling cans used with this equipment approved type safety cans?__________	☐	☐

- Have the attachments designed for use (as per manufacturer's recommendation) with this equipment been inspected and are considered suitable for use?____________________ ❐ ❐

____

Cleanliness:

- Overall condition (was the decontamination performed prior to arrival on-site considered acceptable)?____________

____

- Where was this equipment used prior to its arrival on site?____________________
- Site Contaminants of concern at the previous site?____________________
- Inside debris (coffee cups, soda cans, tools and equipment) blocking free access to foot controls?____________

Operator Qualifications (as applicable for all heavy equipment):

- Does the operator have proper licensing where applicable, (e.g., CDL)?____________________
- Does the operator, understand the equipment's operating instructions?____________________
- Is the operator experienced with this equipment? ____________________
- Does the operator have emotional and/or physical limitations which would prevent him/her from performing this task in a safe manner?____________________
- Is the operator 21 years of age or more?____________________

Identification:

- Is a tagging system available, for positive identification, for tools removed from service?__

Additional Inspection Required Prior to Use On-Site

	Yes	No
- Does equipment emit noise levels above 90 decibels?	❐	❐
- If so, has an 8-hour noise dosimetry test been performed?	❐	❐

- Results of noise dosimetry:____________________
- Defects and repairs needed:____________________
- General Safety Condition: ____________________
- Operator or mechanic signature:____________________

Site Safety Officer Signature:____________________

Approved for Use: ❐ Yes ❐ No

LOAD INSPECTION REPORT
SOIL REMOVAL AT NCBC GULFPORT, GULFPORT MISSISSIPPI

Waste Stream: __________ Facility Disposal No.: __________ Cum Load No.: __________ (by waste stream)

Trucking Company: ______________________ Date: __________

Truck No.: ______________________ Permit No.: __________

License Plate No.: ______________________ Permit No.: __________

Is truck certified to transport hazardous waste in Mississippi? ______________________

Drivers Name (Print): ______________________

Drivers Signature: ______________________

Mississippi CDL Driver Certificate No.: ______________________

Driver Physically fit to Drive? ______________________

Driver has documentation of H&S Training (DOT HM-181): __________ CDL Designations: __________

Is the drivers log book current?: ______________________

Is a valid certificate of insurance in force?: ______________________

Manifest No.: ______________________ Bill of Lading No.: __________

Manifest complete and accurate?: ______________________

Are proper DOT approved shipping containers being used? ______________________

Is labeling in accordance with 40 CFR?: ______________________

Overall condition of trailer of shipping containers: ______________________

Is Truck properly lined (plastic) and tarped? ______________________

Is Tailgate Seal in good condition? __________ Tailgate turn buckles being used?: __________

Is trailer or containers leaking?: ______________________

Inspector Name: ______________________

Inspector Signature: ______________________

Additional comments: ______________________

____

____

____

ATTACHMENT IV

SAFE WORK PERMITS

SAFE WORK PERMIT
DECONTAMINATION ACTIVITIES
NCBC GULFPORT, GULFPORT, MISSISSIPPI

Permit No. ____________ Date: ________________ Time: From ____________ to ____________

SECTION I: General Job Scope

I. Work limited to the following (description, area, equipment used): Decontamination of sampling equipment and machinery (i.e., drill rigs, augers). Brushes and spray bottles will be used to decon small sampling equipment. Pressure washers or steam cleaning units will be used to decon the augers and drilling rig.

II. Required Monitoring Instrument(s): None

III. Field Crew: ________________________________

IV. On-site Inspection conducted ☒ Yes ☐ No Initials of Inspector ____________ TtNUS ____________

SECTION II: General Safety Requirements (To be filled in by permit issuer)

IV. Protective equipment required

Level D ☒ Level B ☐
Level C ☐ Level A ☐
Detailed on Reverse

Respiratory equipment required

Full face APR	☐	Escape Pack	☐
Half face APR	☐	SCBA	☐
SKA-PAC SAR	☐	Bottle Trailer	☐
Skid Rig	☐	None	☒

Modifications/Exceptions: When using pressure washers, steam cleaners field crews will wear hearing protection, and face shields.

V. Chemicals of Concern	Action Level(s)	Response Measures
TCDD	>2 mg/m^3	Dust Suppression/Area Wetting
Decontamination Solvent		Per MSDS

VI. Additional Safety Equipment/Procedures

Item	Yes	No	Item	Yes	No
Hard-hat	☒	☐	Hearing Protection (Plugs/Muffs)	☐	☐
Safety Glasses	☒	☐	Safety belt/harness	☐	☒
Chemical/splash goggles	☐	☒	Radio	☐	☒
Splash Shield	☒	☐	Barricades	☐	☒
Splash suits/coveralls	☒	☐	Gloves (Type - Nitrile)	☒	☐
Steel toe Work shoes or boots	☒	☐	Work/rest regimen	☐	☒
Chemical Resistant Boot Covers	☒	☐	Impermeable apron	☒	☐

Modifications/Exceptions: PVC rain suits or PE or PVC coated Tyvek for protection against splashes and overspray. Chemical resistant boot covers if excessive liquids are generated or to protected footwear. Hearing protection when operating the steam cleaner or pressure washer. Impermeable aprons are acceptable when cleaning sampling equipment instead of a splash suit.

VII. Procedure review with permit acceptors

Item	Yes	NA	Item	Yes	NA
Safety shower/eyewash (Location & Use)	☐	☐	Emergency alarms	☒	☐
Procedure for safe job completion	☐	☐	Evacuation routes	☐	☐
Contractor tools/equipment/PPE inspected	☐	☐	Assembly points	☐	☐

VIII. Site Preparation

Item	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☒
Vehicle and Foot Traffic Routes Cleared and Established	☐	☐	☐
Physical Hazards Barricaded and Isolated	☐	☐	☒
Emergency Equipment Staged	☐	☐	☐

IX. Additional Permits required (Hot work, confined space entry, excavation etc.). ☐ Yes ☒ No
If yes, complete permit required or contact Health Sciences, Pittsburgh Office

X. Special instructions, precautions: Chemical hazards with decontamination because of use of fluids such as isopropyl alcohol, etc. To minimize the potential for exposure, site personnel will use PPE and prevent contact with potentially contaminated equipment. Refer to the manufacturer's MSDS regarding PPE, handling, storage, and first-aid measures related to decontamination fluids. For pressure washers or steam cleaners in excess of 3,000 psi a fan tip of 25° or greater will be used to control potential for water cuts or lacerations. All hoses and fittings will be inspected to insure structural integrity prior to use. Decontamination Pad construction – sloped a sufficient degree to allow collection at a sump away from the work area; the temporary pad contructed of 10-30 mil polyethylene sheeting should be covered in a light coating of sand if the surface becomes to slippery.

Permit Issued by: ________________________ Permit Accepted by: ________________________

SAFE WORK PERMIT
MOBILIZATION AND DEMOBILIZATION ACTIVITIES
NCBC GULFPORT, GULFPORT, MISSISSIPPI

Permit No. ______________ Date: __________________ Time: From ____________ to ____________

SECTION I: General Job Scope

I. Work limited to the following (description, area, equipment used): Mobilization and demobilization activities.

II. Required Monitoring Instruments: None

III. Field Crew: ______________________________

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector ____________ ____________
TtNUS

SECTION II: General Safety Requirements (To be filled in by permit issuer)

IV. Protective equipment required
Level D ☒ Level B ☐
Level C ☐ Level A ☐
Detailed on Reverse

Respiratory equipment required

Full face APR	☐	Escape Pack	☐
Half face APR	☐	SCBA	☐
SKA-PAC SAR	☐	Bottle Trailer	☐
Skid Rig	☐	None	☒

Modifications/Exceptions: Minimum requirement include sleeved shirt and long pants, or coveralls, safety glasses and safety footwear. Hard hats and hearing protection will be worn when working near operating equipment

V. Chemicals of Concern	Action Level(s)	Response Measures
None anticipated		

VI. Additional Safety Equipment/Procedures

Hard-hat	☐ Yes ☐ No	Hearing Protection (Plugs/Muffs)	☐ Yes ☐ No
Safety Glasses	☒ Yes ☐ No	Safety belt/harness	☐ Yes ☒ No
Chemical/splash goggles	☐ Yes ☒ No	Radio	☐ Yes ☒ No
Splash Shield	☐ Yes ☒ No	Barricades	☐ Yes ☒ No
Splash suits/coveralls	☐ Yes ☒ No	Gloves (Type -)	☐ Yes ☒ No
Steel toe Work shoes or boots	☒ Yes ☐ No	Work/rest regimen	☐ Yes ☒ No

Modifications/Exceptions: Pant legs taped to work boots if in an area of heavy vegetation. Tyvek coverall may also be used to protect against natural hazards (e.g., ticks). If working in areas where snakes are a threat, wear snake chaps to protect against bites. Area which are frequented by alligators should also take the necessary precautions listed in Section 6.3 of this HASP

VII. Procedure review with permit acceptors

	Yes	NA		Yes	NA
Safety shower/eyewash (Location & Use)	☐	☒	Emergency alarms	☒	☐
Procedure for safe job completion	☐	☒	Evacuation routes	☐	☐
Contractor tools/equipment/PPE inspected	☐	☐	Assembly points	☐	☐

VIII. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☒
Vehicle and Foot Traffic Routes Cleared and Established	☐	☐	☐
Physical Hazards Barricaded and Isolated	☐	☐	☐
Emergency Equipment Staged	☐	☐	☐

IX. Additional Permits required (Hot work, confined space entry, excavation etc.). ☐ Yes ☒ No
If yes, complete permit required or contact Health Sciences, Pittsburgh Office

X. Special instructions, precautions: Preview work locations to identify potential hazards (slips, trips, and falls, natural hazards, etc.) Avoid potential nesting areas. Wear light colored clothing so that ticks and other biting insects can be easily visible and can be removed. Inspect clothing and body for ticks. Minimize contact with potentially contaminated media. Suspend site activities in the event of inclement weather. Employ proper lifting techniques as described on Table 5-1 for this task.

Permit Issued by:______________________ Permit Accepted by:______________________

SAFE WORK PERMIT
MULTI-MEDIA SAMPLING
NCBC GULFPORT, GULFPORT, MISSISSIPPI

Permit No. ____________ Date: ________________ Time: From __________ to __________

SECTION I: General Job Scope

I. Work limited to the following (description, area, equipment used): Multi media sampling including soils (surface and sub surface); sediments; groundwater and IDW.

II. Required Monitoring Instrument(s): Mini-Ram Dust Monitor, as necessary (See Table 5-1)

III. Field Crew: ______________________________

IV. On-site Inspection conducted ☒ Yes ☐ No Initials of Inspector __________ TtNUS __________

SECTION II: General Safety Requirements (To be filled in by permit issuer)

IV. Protective equipment required
Level D ☒ Level B ☐
Level C ☐ Level A ☐
Detailed on Reverse

Respiratory equipment required
Full face APR ☐ Escape Pack ☐
Half face APR ☐ SCBA ☐
SKA-PAC SAR ☐ Bottle Trailer ☐
Skid Rig ☐ None ☒

Modifications/Exceptions: Minimum requirement are stated below. Ascension to Level C protection will be based on measured or visible dust concentrations >2 mg/m3. Level C protection will consist of Full-face APR with organic vapor/HEPA cartridges for protection against airborne dust concentrations. It should be noted that this is not anticipated as much of this activity is not mechanically disruptive by nature to cause airborne dusts. This precaution is based on working in and around operations that are more prone to generate dusts/particulates.

V. Chemicals of Concern	Action Level(s)	Response Measures
TCDD	>2 mg/m^3 (visible dust)	Dust Suppression/Area Wetting

VI. Additional Safety Equipment/Procedures

Item	Yes	No	Item	Yes	No
Hard hat	☐	☐	Hearing Protection (Plugs/Muffs)	☐	☐
Safety Glasses	☒	☐	Safety belt/harness	☐	☒
Chemical/splash goggles	☐	☒	Radio	☐	☐
Splash Shield	☐	☒	Barricades	☐	☒
Splash suits/coveralls	☐	☐	Gloves (Type - Nitrile)	☒	☐
Steel toe Work shoes or boots	☒	☐	Work/rest regimen	☐	☒
Chemical Resistant Boot Covers	☒	☐	Impermeable apron	☒	☐

Modifications/Exceptions: Tyvek coverall if there is a potential for soiling work clothes and PVC or PE coated Tyvek if saturation or work clothes may occur. Impermeable aprons may be used in lieu of the coveralls if it can be demonstrated that it offers as much protection as the coveralls. This modification may be made to support measures against effects of heat stress

VII. Procedure review with permit acceptors	Yes	NA		Yes	NA
Safety shower/eyewash (Location & Use)	☐	☐	Emergency alarms	☒	☐
Procedure for safe job completion	☐	☐	Evacuation routes	☐	☐
Contractor tools/equipment/PPE inspected	☐	☐	Assembly points	☐	☐

VIII. Site Preparation	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Vehicle and Foot Traffic Routes Cleared and Established	☐	☐	☐
Physical Hazards Barricaded and Isolated	☐	☐	☐
Emergency Equipment Staged	☐	☐	☐

IX. Additional Permits required (Hot work, confined space entry, excavation etc.) ☐ Yes ☐ No
If yes, complete permit required or contact Health Sciences, Pittsburgh Office

X. Special instructions, precautions: Avoid potential nesting areas. Snake chaps or leggings should be worn in areas prone to snakes. Remote sampling devices should be used for sample acquisition of surface waters and obstructed view areas due to potential for alligators and snakes. The FOL and/or the SSO shall preview work areas for signs of habitation, nesting, or foraging in remote areas where sampling is to be conducted. Wear light colored clothing so that ticks and other biting insects can be easily visible and can be removed. Inspect clothing and body for ticks upon exiting wooded areas and high brush. Personal decontamination for this task shall include efforts at remote locations such as bagging contaminated PPE and reusable sampling tools and using hygienic wipes for hands and face until persons can reach the structured decontamination unit. Minimize contact with potentially contaminated media. Suspend site activities in the event of inclement weather. Employ proper lifting techniques as described on Table 5-1 for mobilization/demobilization.

Permit Issued by: ______________________ Permit Accepted by: ______________________

SAFE WORK PERMIT
SOIL BORING AND SUBSURFACE SOIL SAMPLING OPERATIONS
NCBC GULFPORT, GULFPORT, MISSISSIPPI

Permit No. ______________ Date: __________________ Time: From ____________ to ____________

SECTION I: General Job Scope

I. Work limited to the following (description, area, equipment used): Subsurface soil sample collected via hollow stem auger.

II. Required Monitoring Instruments: Mini-Ram Dust Monitor

III. Field Crew: ____

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector ____________ TtNUS ____________

SECTION II: General Safety Requirements (To be filled in by permit issuer)

IV. Protective equipment required

Level D ☒ Level B ☐
Level C ☐ Level A ☐
Detailed on Reverse

Respiratory equipment required

Full face APR	☐	Escape Pack	☐
Half face APR	☐	SCBA	☐
SAR	☐	Bottle Trailer	☐
Skid Rig	☐	None	☒

Modifications/Exceptions: Minimum requirements stated below. Upgrade to Level C protection - full-face APR with organic vapor/HEPA cartridges if dust suppression is unsuccessful. This is not anticipated given the concentration of the contaminant in the soils.

V. Chemicals of Concern	Action Level(s)	Response Measures
TCDD	>2 mg/m^3	Dust Suppression/Area Wetting

VI. Additional Safety Equipment/Procedures

Hard-hat	☒ Yes ☐ No	Hearing Protection (Plugs/Muffs)	☒ Yes ☐ No
Safety Glasses	☒ Yes ☐ No	Safety belt/harness	☐ Yes ☒ No
Chemical/splash goggles	☐ Yes ☒ No	Radio	☐ Yes ☐ No
Splash Shield	☐ Yes ☒ No	Barricades	☐ Yes ☐ No
Splash suits/coveralls	☐ Yes ☒ No	Gloves (Type - Nitrile)	☒ Yes ☐ No
Steel toe Work shoes or boots	☒ Yes ☐ No	Work/rest regimen	☐ Yes ☒ No
Chemical Resistant Boot Covers	☒ Yes ☐ No	Impermeable apron	☒ Yes ☐ No

Modifications/Exceptions: Reflective vests for high traffic areas. Tyvek coverall if there is a potential for soiling work clothes. PVC or PE coated Tyvek, if saturation or work clothes may occur. It is recommended that the Driller and the Driller's helper wear impermeable aprons to prevent soiling of work clothes when handling auger flights against the body. This measure can be used in place of the Tyvek or PE or PVC coated Tyvek if heat stress is an issue. Safety harnesses will be employed for activities greater than 6 feet above ground surface without support of safety handrail.

VII. Procedure review with permit acceptors	Yes	NA		Yes	NA
Safety shower/eyewash (Location & Use)	☐	☐	Emergency alarms	☒	☐
Procedure for safe job completion	☐	☐	Evacuation routes	☐	☐
Contractor tools/equipment/PPE inspected	☐	☐	Assembly points	☐	☐

VIII. Site Preparation	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Vehicle and Foot Traffic Routes Cleared and Established	☐	☐	☐
Physical Hazards Barricaded and Isolated	☐	☐	☐
Emergency Equipment Staged	☐	☐	☐

IX. Additional Permits required (Utility Locating and Excavation Clearance – Attachment II) ☒ Yes ☐ No
If yes, complete permit required or contact Health Sciences, Pittsburgh Office

X. Special instructions, precautions: Follow the safe work practices for drilling specified in Section 5.0 of this HASP. Use proper lifting techniques defined in Table 5-1 for mobilization/demobilization. Complete an Equipment Inspection Checklist for the Drill Rig upon arrival to the site, and then every 10 day shift thereafter or after major repairs. Test all emergency stop devices initially then periodically to insure operational status. Decontamination of equipment will consist of soap and water wash and rinse with the use of a pressure washer until visibly clean. Personnel decontamination will consist of vacuuming outer garments and soap and water wash and rinse of outer PPE and hands and face prior to breaks or meals. As the material in question is a solid potential for exposure can occur only through mechanical dispersion (inhalation) or hand to mouth contact (ingestion) through poor work hygiene practices.

Permit Issued by: ______________________________ Permit Accepted by: ______________________

SAFE WORK PERMIT
EXCAVATION OPERATIONS
NCBC GULFPORT, GULFPORT, MISSISSIPPI

Permit No. ______________ Date: __________________ Time: From ____________ to _____________

SECTION I: General Job Scope

I. Work limited to the following (description, area, equipment used): Excavation of soils from on and off-site will occur utilizing earth moving equipment (i.e., track-hoes, back-hoes, skid loaders, high-lifts, etc.). It is estimated that 1,000 cubic yards of soil will be collected and moved to a designated location

II. Required Monitoring Instruments: Mini-Ram Dust Monitor

III. Field Crew: ____

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector ____________ ____________ TtNUS

SECTION II: General Safety Requirements (To be filled in by permit issuer)

IV. Protective equipment required
- Level D ☒ Level B ☐
- Level C ☐ Level A ☐
- Detailed on Reverse

Respiratory equipment required
- Full face APR ☐
- Half face APR ☐
- SAR ☐
- Skid Rig ☐
- Escape Pack ☐
- SCBA ☐
- Bottle Trailer ☐
- None ☒

Modifications/Exceptions: Minimum requirement include sleeved shirt and long pants, safety footwear, safety glasses, hard hats, and hearing protection will be worn when working near or in the vicinity of the operating equipment. Upgrade to Level C protection - full-face APR with organic vapor/HEPA cartridges if dust suppression is unsuccessful. This is not anticipated given the concentration of the contaminant in the soils.

V. Chemicals of Concern	Action Level(s)	Response Measures
TCDD	>2 mg/m^3	Dust Suppression/Area Wetting

VI. Additional Safety Equipment/Procedures
- Hard-hat ☒ Yes ☐ No
- Safety Glasses ☒ Yes ☐ No
- Chemical/splash goggles ☐ Yes ☒ No
- Splash Shield ☐ Yes ☒ No
- Splash suits/coveralls ☐ Yes ☐ No
- Steel toe Work shoes or boots ☒ Yes ☐ No
- Chemical Resistant Boot Covers ☒ Yes ☐ No
- Hearing Protection (Plugs/Muffs) ☒ Yes ☐ No
- Safety belt/harness(Seat Belts) ☒ Yes ☐ No
- Radio ☐ Yes ☐ No
- Barricades ☐ Yes ☐ No
- Gloves (Type - Nitrile) ☒ Yes ☐ No
- Work/rest regimen ☐ Yes ☒ No

Modifications/Exceptions: Reflective vests for high traffic areas (Ground Spotters or operators who will leave their cab). Tyvek or cotton coverall if there is a potential for soiling work clothes. PVC or PE coated Tyvek, if saturation or work clothes may occur. All operators and truck drivers will employ seat belts when operating designated equipment

VII. Procedure review with permit acceptors (Yes / NA)
- Safety shower/eyewash (Location & Use) ☐ Yes ☐ NA
- Procedure for safe job completion ☐ Yes ☐ NA
- Contractor tools/equipment/PPE inspected ☐ Yes ☐ NA
- Emergency alarms ☒ Yes ☐ NA
- Evacuation routes ☐ Yes ☐ NA
- Assembly points ☐ Yes ☐ NA

VIII. Site Preparation (Yes / No / NA)
- Utility Locating and Excavation Clearance completed ☐ Yes ☐ No ☐ NA
- Vehicle and Foot Traffic Routes Cleared and Established ☐ Yes ☐ No ☐ NA
- Physical Hazards Barricaded and Isolated ☐ Yes ☐ No ☐ NA
- Emergency Equipment Inspected and Staged (Fire Extinguishers, etc.) ☐ Yes ☐ No ☐ NA

IX. Additional Permits required (Utility Locating and Excavation Clearance – Attachment II) ☒ Yes ☐ No

If yes, complete permit required or contact Health Sciences, Pittsburgh Office

X. Special instructions, precautions: Follow the safe work practices for excavation specified in Section 5.0 of this HASP. Use proper lifting techniques defined in Table 5-1 for mobilization/demobilization. Complete an Equipment Inspection Checklist for the heavy equipment used in the excavation upon arrival to the site, and then every 10 day shift thereafter or after major repairs. The Ground Spotter will exercise complete control over the area in which the excavation activities are being conducted. No one will enter those areas without the expressed permission of the ground spotter. Traffic patterns will be constructed to facilitate one-way travel to minimize backing where possible. All operators will wear seat belts when operating equipment or trucks. Decontamination will include vacuuming outer garments to remove residual dusts, washing face and hands prior to breaks and or lunch. A Load Inspection Report will be completed for each truck loaded for transport across the base or over public thoroughfares when exiting established exclusion zone(s).

Permit Issued by:________________________ Permit Accepted by:____________________

Permit No. ______________ Date: __________________ Time: From ____________ to ______________

SECTION I: General Job Scope

I. Work limited to the following (description, area, equipment used): Geographical Surveying

II. Required Monitoring Instruments: None

III. Field Crew: ____________________

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector ____________ ____________ TtNUS

SECTION II: General Safety Requirements (To be filled in by permit issuer)

IV. Protective equipment required

Level D ☒ Level B ☐
Level C ☐ Level A ☐
Detailed on Reverse

Respiratory equipment required

Full face APR	☐	Escape Pack	☐
Half face APR	☐	SCBA	☐
SAR	☐	Bottle Trailer	☐
Skid Rig	☐	None	☒

Modifications/Exceptions: Minimum requirements include sleeved shirt and long pants and safety footwear.(except for magnetometer, geophysical surveys) Safety glasses, hard hats, and hearing protection will be worn when working near operating equipment.

V.

Chemicals of Concern	Action Level(s)	Response Measures
None anticipated given the nature of surveying activities and limited contact w/ media.	None	

VI. Additional Safety Equipment/Procedures

	Yes	No		Yes	No
Hard-hat	☐	☐	Hearing Protection (Plugs/Muffs)	☐	☒
Safety Glasses	☐	☐	Safety belt/harness	☐	☒
Chemical/splash goggles	☐	☒	Radio	☐	☒
Splash Shield	☐	☒	Barricades	☐	☒
Splash suits/coveralls	☐	☐	Gloves (Type - Work)	☒	☐
Steel toe Work shoes or boots	☐	☐	Work/rest regimen	☐	☒

Modifications/Exceptions: Pant legs are to taped to work boots to prevent entry under the clothing by ticks and other insects. Use repellants applied directly to the clothing at all entry points(pants to boots, shirt to pants, etc.) Tyvek coveralls may be used in heavy brush to protect against natural hazards (e.g., ticks) and also to make identification easier. If working in areas where snakes are a threat, wear snake chaps to protect against bites.

VII. Procedure review with permit acceptors

	Yes	NA		Yes	NA
Safety shower/eyewash (Location & Use)	☐	☒	Emergency alarms	☒	☐
Procedure for safe job completion	☐	☒	Evacuation routes	☒	☐
Contractor tools/equipment/PPE inspected	☐	☒	Assembly points	☒	☐

VIII. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☒
Vehicle and Foot Traffic Routes Cleared and Established	☐	☐	☒
Physical Hazards Barricaded and Isolated	☐	☐	☒
Emergency Equipment Staged	☐	☐	☒

IX. Additional Permits required (Hot work, confined space entry, excavation etc.). ☐ Yes ☒ No
If yes, complete permit required or contact Health Sciences, Pittsburgh Office

X. Special instructions, precautions: Preview work locations to identify potential hazards (slips, trips, and falls, natural hazards, etc.) Avoid potential nesting areas. Wear light colored clothing so that ticks and other biting insects can be easily visible and can be removed. Decontamination is not required for this operation, it is however, required that persons perform a close body inspection upon exiting wooded or brush areas for ticks prior to entering vehicles and work trailers, etc.. Minimize contact with potentially contaminated media. Suspend site activities in the event of inclement weather. Inspect all hand tools to insure in good condition prior to use (i.e., cutting tools are sharp, handles are free from defects, etc.) Maintain a ten foot radius around anyone clearing brush using a brush hook or machete

Permit Issued by: ______________________ Permit Accepted by: ______________________

ATTACHMENT V

MEDICAL DATA SHEET

MEDICAL DATA SHEET

This Medical Data Sheet must be completed by all on-site personnel and kept in a central location during the execution of site operations. This data sheet will accompany any personnel when medical assistance is needed or if transport to hospital facilities is required.

Project ______________________________

Name ______________________ Home Telephone ______________

Address ______________________________

Age __________ Height ______________ Weight ______________

Name of Next Kin ______________________________

Drug or other Allergies ______________________________

Particular Sensitivities ______________________________

Do You Wear Contacts? ______________________________

Provide a Checklist of Previous Illnesses or Exposure to Hazardous Chemicals __________

____

____

What medications are you presently using? ______________________________

____

____

Do you have any medical restrictions? ______________________________

____

____

Name, Address, and Phone Number of personal physician: ______________________

____

____

I am the individual described above. I have read and understand this HASP.

______________________________ ______________

Signature Date

ATTACHMENT VI

HEARING CONSERVATION PROGRAM

HEARING CONSERVATION PROGRAM

1.0 PROGRAM OBJECTIVE

To protect Tetra Tech NUS and Subcontractor employees from the harmful effects of exposure to excessive noise levels. Excessive noise in this case will be considered employee noise exposures at or above an 8-hour Time Weighted Average (TWA) of 85 decibels measured on the A-Weighted scale.

This objective will be accomplished through

- Establishing administrative and site-specific hearing conservation procedures and guidelines for employees.
- Audiometric testing of affected employees.
- Site specific monitoring of representative job classifications and operations to determine noise levels and appropriate protective measures.
- Establishment of procedures and guidelines for the selection care and use of hearing protection.
- Warning signs and information.
- Training.

This Hearing Conservation Program (HCP) is divided into two sections. The first section presents the responsibilities of individuals associated with this program and a description of the program's key elements. The second section provides a fill-in the blank tool that is to be used to implement a site-specific HCP on projects where noise exposure is a concern. This second section is presented in Attachment A and must be completed by the Site Safety Officer (SSO) or the Field Operations Leader (FOL) on projects where noise exposure is a recognized potential hazard. The completed fill-in the blank portion, administrative guidelines, and a copy of 29 CFR 1910.95 must be on-site and available to site personnel to ensure regulatory compliance.

2.0 SCOPE

This program applies to all Tetra Tech NUS operations and other support activities where exposure above specified action levels may occur. This program has been developed to comply with OSHA General Industry Standard 29 CFR 1910.95 (Occupational Noise Exposure, retrievable at http://www.osha-slc.gov/OshStd_data/1910_0095.html).

3.0 RESPONSIBILITIES

Corporate Health and Safety Manager (HSM): Serve as HCP Administrator and provide technical management and oversight of this program, as well as technical support to aid all Tetra Tech NUS office locations in effectively implementing these requirements. The HSM is also responsible for monitoring the overall effectiveness of this program. This will be accomplished by:

- Periodically reviewing random completed Sound Level Measurement and/or Noise Dosimetry Logs.
- Performing field audits of select project sites where the HCP elements are implemented.
- Eliciting feedback from office health and safety Points of Contact.
- Modifying elements of this program, when or as appropriate.
- Establishing minimum components and content of the HCP training course material.
- Maintaining appropriate record-keeping for this program.
- Regularly communicating with Tetra Tech, Inc. Corporate Health and Safety, to satisfy overall company requirements.

Project Health and Safety Officer (PHSO) - The PHSO shall ensure that hearing conservation measures are adequately addressed in the Site Specific Health and Safety Plan for assigned projects. In addition, it is the PHSO's responsibility to provide technical assistance to the Site Safety Officer and/or the Field Operations Leader.

Site Safety Officer (SSO) - The SSO will serve as the Site HCP Administrator and is responsible for the implementation of this HCP at project specific locations. This activity may also include on-site evaluations of noise levels. The SSO shall be responsible for the enforcement of the elements of this program to prevent excessive exposure to high levels of noise.

Field Operations Leader (FOL) – The FOL will share responsibility with the SSO or in the absence of an SSO ensure the implementation of this program for all operations conducted under their direction employing hearing protection.

Project Manager (PM)/Task Order Manager(TOM) - The PM/TOM is also ultimately responsible for the effective compliance with these requirements. The PM/TOM will ensure that sufficient information has been provided to the PHSO to develop a site-specific HCP appropriate for the nature of the planned activities. This is to be accomplished in conjunction with the preparation of the site-specific Health and Safety Plan (HASP).

Tetra Tech NUS Employees - The employees are responsible for following the tenets of this hearing conservation program and/or conditions or modifications of this program, that may be site-specific in nature.

In addition the employees are responsible for reporting any deficiencies or inadequacies of these program or site-specific elements to the SSO and/or the FOL.

4.0 NOISE LEVEL MONITORING

Noise level monitoring will be accomplished using quantitative and qualitative principles to determine potential high noise areas. Quantitative monitoring will be accomplished using portable sound level survey meters and noise dosimeters. The monitoring results will be used for the following purposes:

- Identifying and defining high operational noise areas and high noise job classifications.
- Identification of personnel for inclusion into the Site-Specific HCP.
- Determining employee exposure to noise.

In addition, qualitative monitoring of work areas may be employed by the FOL and/or SSO or field personnel to determine approximate noise level conditions and the need for hearing protection. This involves observing a common simple rule of thumb. This rule of thumb is that, if you must raise your voice to be heard by someone who is standing within arm's length of you to be heard, then noise levels are likely to exceed 85 dBA. Therefore, hearing protection would be required. This rule of thumb may be used for short duration or intermittent activities, or for activities which have been previously quantified.

Quantitative monitoring may be performed for longer-term projects or for tasks that have not been previously characterized. This will be performed using a sound level meter (SLM), noise dosimeters, or both.

Representative data may be used when appropriate from one project to the next to preclude the necessity to monitor similar tasks and activities .

4.1.1 Noise Level Monitoring Data Accumulation and Record-keeping

The Sound Level Measurement Log and the Noise Dosimetry Log provided in Attachment A will be completed to document quantitative measurements recorded on-site. Upon completion copies of these documents will be

1. Attached to their applicable Safe Work Permits
2. Forwarded to the PHSO for review

Direction for the completion of these documents will be provided through the site-specific HASP. If information is not requested it may be assumed that quantitative measurements for the operations in question are not necessary, or that representative data already exists.

4.1.2 Noise Monitoring Frequency

Depending on the nature of planned operations, the SSO and/or the FOL, may be tasked to perform an initial noise survey on Tetra Tech NUS and subcontractors operations and work areas by the use of a sound level meter and/or noise dosimeters.

Repeat noise monitoring will be conducted should operations, productions, or processes change which could impact noise levels that are generated.

4.2 Health and Safety Plan (HASP)

The HASP will set policy on mandatory use of hearing protection in affected areas, and while performing certain operations such as drilling, excavation, operation of motorized and electrical hand tools and equipment, and/or other activities that can be anticipated to generate excessive noise levels. The FOL and/or SSO will notify all Tetra Tech NUS and subcontractor personnel of high noise areas and operations, prior to work initiation. Notification of these personnel will take place in the following manner:

- Site-specific training – Review of the scope of work inherent hazards and control measures to be employed to minimize the effects of these hazards.
- Personnel will be notified through issuance of the Safe Work Permit.
- Information concerning hearing protection for operations not conducted under a Safe Work Permit will be conveyed verbally and documented within the project logbook.
- Information on high noise areas and hearing protection requirements is most effectively conveyed to Tetra Tech NUS and subcontractor personnel through the use of signs. The FOL and/or the SSO will post or otherwise identify areas of operations that exceed 85 dBA. If significant changes in noise levels occur (such as a shutdown or modification of an operating unit), the noise levels shall be re-evaluated by the SSO and/or the FOL to determine hearing protection needs.

5.0 HEARING PROTECTION

The following information establishes responsibility for the acquisition, selection, dispersal, training, care, storage and use, and evaluation of hearing protection.

5.1 Acquisition

When engineering and/or administrative controls are not feasible to control noise levels, hearing protection will be required. These hearing protection devices will be provided to employees

- Who may be exposed to noise levels in excess of 85 dBA.
- Employees who have not yet had a baseline audiogram.
- Employees who have experienced a >10 dB Standard Threshold Shift (STS) at frequencies of 2,000, 3,000, or 4,000 hertz range in either ear.

The FOL will arrange for hearing protection in the following manner

- Complete an Equipment Requisition indicating the types of hearing protection required and amounts. Remember additional quantities of protective devices may be required for site visitors. Approved site visitors should be equipped to the same level of protection as field personnel.

- When arranging for hearing protection device purchases through procurement the following actions should be taken

  1. Contact the PHSO for assistance in identifying the appropriate hearing protection types and performance criteria.

  2. Complete a Material Requisition sheet describing the type, attenuation capabilities, and quantities required.

  3. Turn in the completed Material Requisition to the Contract Procurement Officer.

5.2 Selection/Dispersal

Employees will be provided with a variety of hearing protection devices to choose from. They will select from these hearing protection devices, unless specific medical restrictions and/or qualifications have been established through the medical surveillance program. All hearing devices made available and approved for use will provide attenuation to lower noise exposures to no more than an 8-Hour TWA of 85 dBA.

The SSO and/or the PHSO will evaluate the attenuation factors of hearing protection devices and may modify selections based on sound level monitoring or personal dosimetry results. These completed documents are to be copied and forwarded to the PHSO upon completion.

The FOL and/or the SSO will be responsible for ensuring adequate stock of hearing protection is maintained and available at the project site for employees and approved site visitors.

Hearing protectors shall be replaced as necessary (per the manufacturer's recommendation).

Employees will be responsible for the care, cleaning, storage, and inspection of hearing protection issued.

5.3 Training

The Health Sciences Group will institute and maintain a training program in support of the HCP covering the following subject matter

- The elements of this HCP
- The mechanism of hearing
- The deleterious effects of excessive noise on hearing
- Medical surveillance of the participants of this program (i.e., audiometric testing).
- Controlling excessive noise through engineering, administrative, and Personal Protective Equipment (PPE)
- PPE – Types, selection, limitations and advantages
- Use, care, and storage of hearing protective devices
- Noise monitoring methodologies and reporting
- Record-keeping – Documentation, retention, and access

Training will be provided to all effected employees through mechanisms including, but not limited to, 40-Hour Hazardous Waste Site General Site Worker Training, 8-Hour Hazardous Waste Site General Site Worker Refresher Training, 8-Hour Management/Supervisory Training, annual Hearing Conservation Program refresher, and Project or Site-Specific training. In addition, training materials may be obtained from the HSM.

Note: Course curriculum for training obtained from outside vendors must be approved by the HSM.

5.4 Care

Individuals issued reusable hearing protection such as earmuffs and plugs will be responsible for the care and of those devices. This includes the removal of any debris using a light detergent with a water rinse, or as directed using manufacturer's instructions.

Disposable plugs are to be disposed of after each use.

5.5 Storage

Hearing protection approved for use will be stored in their individual manufacturer supplied packaging. When this is not possible, storage within suitable containers such as Ziplock bags after cleaning and drying is acceptable.

Hearing protective devices should be stored to

- Prevent distortion
- Prevent contact from chemicals and/or contaminants
- Away from direct sunlight and heat sources which may cause photolytic or thermal degradation

5.6 Use

Hearing protection shall be used in accordance with the employee's training, and as directed within the HASP, Safe Work Permits, as directed by signs, or as directed by the FOL and/or the SSO. Failure to comply with these requirements will result in disciplinary action. The FOL and/or the SSO are responsible for the enforcing the use of hearing protection at project specific locations.

5.7 Evaluation

The elements of this hearing conservation program and the implementation at project sites will be evaluated periodically through the existing health and safety audit function under the direction of the Health and Safety Manager. In addition to this function the program will be evaluated under the following conditions

- STS is indicated within a protected body of employees.
- Normal auditing procedures indicate discrepancies within the implementation of the HCP.

6.0 RECORD KEEPING

The following records will be maintained in support of this HCP

- Exposure measurements - This includes Sound Level Measurement Logs and/or the Noise Dosimetry Logs, and related records. Copies will be kept at the site while the originals are forwarded to the PHSO for review and record retention in the project file. Exposure measurement records will be maintained for a minimum of two years.

- Audiometric Testing Records – These records are maintained as part of the medical surveillance program and all employees who receive an audiogram will be provided a written copy of the results. These records will be retained the duration of the effected employees employment.

- Training Records – Training records for the 40-Hour, 8-Hour Refresher, 8-Hour Management/Supervisory course content is maintained by the HSM and at the project level. The FOL and/or the SSO will be responsible for obtaining from identified field personnel certificates of the most recent successful completion of these courses to be maintained at the site. Site-specific training concerning the elements of this HCP will be maintained at the project site.

Record retention will be performed in accordance with the time periods stated in 29 CFR 1910.95 (retrievable at http://www.osha-slc.gov/OshStd_data/1910_0095.html and 1910.1020 http://www.osha-slc.gov/OshStd_data/1910_1020.html).

7.0 AUDIOMETRIC TESTING

Audiometric testing will be performed on all participants of this HCP based on measured or anticipated noise levels that they may be exposed. The purpose of this testing will be as follows

- Establish an initial or revised baseline audiogram, as applicable, of the participant's current hearing condition.
- Repeat audiograms, in order to track any changes within the participants hearing measured under the baseline examination.
- Provide a mechanism for exit audiograms for personnel leaving the employment of Tetra Tech NUS, or a change in job duties where participation in the HCP is no longer necessary.

These audiograms and documentation pertaining to these tests are administered and maintained under the Tetra Tech NUS Medical Surveillance Program.

ATTACHMENT A

WORK SITE
HEARING CONSERVATION PROGRAM

HEARING CONSERVATION PROGRAM

The following information pertaining to the use of hearing protection is to be completed by the Site Safety Officer (SSO), their duly appointed representative, or the Field Operations Leader (FOL). This work site portion of the Hearing Conservation Program (HCP) will be completed only if hearing protection is to be used in the completion of the assigned tasks as identified per the scope of work, in the work plan, the health and safety plan, bid specifications, or as determined through hazard assessment of the tasks and potential hazards which may be involved. Upon completion of the site-specific elements of this HCP, the Sound Level Measurement Log and/or the Noise Dosimetry Log should be copied and attached to the Safe Work Permit(s) for each activity directed by the HASP to be monitored. Permits and logs should then be forwarded to the Project Health and Safety Officer (PHSO) for evaluation.

Personnel Responsible For Program Completion

The following persons are available to provide assistance in all elements of this program including question/conflict resolution and modification variances. These persons exercise the primary responsibility for the implementation of this site-specific program.

I) **Site Safety Officer (Site HCP Administrator):**______________________ **Phone #:**__________

Field Operations Leader: ______________________ **Phone #:**__________

Project Health and Safety Officer:______________________ **Phone #:**__________

Health and Safety Manager: ______________________ **Phone #:**__________

Personnel Who (by Way of Assignment) Will Wear Hearing Protection

The following list represents TtNUS or subcontractor personnel working under the provisions of this HCP. The persons listed below are included in this site-specific HCP and are required to wear hearing protection when performing tasks producing excessive noise.

II)

Personnel	Make/Model of Hearing Protective Devices to be used	Hearing Protection Noise Reduction Rating (NRR #)

III) Noise Evaluation Technique or Quantitative Noise Evaluations

Noise level monitoring performed on-site will be done to quantify noise levels generated during certain operations. Documentation of these measurements will be performed using either the Sound Level Measurement Log or the Noise Dosimetry Log provided in Figure 1 and Figure 2.

The Sound Level Monitoring

Sound level measurements can be used in establishing noise levels for persons working within the exclusion zone. Sound level monitoring will be performed using a Type II Sound Level Meter (SLM) set on the A-Weighted scale and on the SLOW response setting. This type of SLM survey is necessary when the general rule of thumb for noise levels is exceeded, in order to determine if hearing conservation is an issue, and if so, to set the boundaries for where hearing protection will be required. SLM surveys are also used to identify areas or operations where more specific noise exposure evaluations (using noise dosimetry) are appropriate.

General Rule of Thumb for Determining That Noise Levels May Be Excessive

> *If noise levels are loud enough that you need to raise your voice in order to communicate with another person who is within two feet of you, then noise levels may be excessive. In this case, hearing conservation issues must be considered and hearing protection must be used until and unless sound level monitoring or noise dosimetry indicate that it is not necessary.*

To perform a SLM survey, first make sure that the SLM is on the proper settings as noted above, and ensure that it is properly calibrated in accordance with the manufacturer's instructions. Then, take **at least 3 random readings at each location** starting at the spot where the noise source is loudest and working your way away from the noise source, until you have readings that are below an average of 85 decibels on the A-weighted scale (dBA). You should position the SLM so that it is pointing perpendicular to the noise source (do not point the microphone directly at the noise source. This can result in inaccurate readings). "Random readings" means that you should hold the SLM in place and occasionally glance at the readout and record the reading that you see. You should not watch the readout and record the highest peak reading that you see. Pay particular attention to taking readings at any employee or subcontractor employee typical work locations (such as at the controls of a drill rig, at the area where samples are taken, etc.). Record your readings on a draft sketch of the work area (or on a floorplan if working inside of a building).

After you have taken enough readings to adequately characterize the work area, post calibrate the SLM and record the distance from the noise source where the average of the 3 readings was no more than 85 dBA (using Figure 1). All areas inside of the 85 dBA boundary line are to be designated as requiring hearing protection, and this must be communicated to all members of the field team. This can be accomplished by placing appropriate signs at the boundary line, posting Figure 1 at the work area, and by reviewing Figure 1 with the field team as part of a daily tailgate meeting or Safe Work Permit review.

Also, areas where average sound levels are 85 dBA or greater should be brought to the attention of the PHSO for considerations for noise dosimetry.

The Sound Level Measurement Log will be used in the following circumstances

- Setting exclusion zone boundaries based on noise levels generated.
- Establishing noise contours surrounding operations.

Noise Dosimetry Log

Noise dosimetry is used to accurately characterize the noise exposure that a person actually experiences during a working period. Dosimetry is much simpler to perform than a SLM survey, but it does involve the participation and cooperation of more people (namely, the workers who will wear the dosimeters). As with the use of any instrumentation, you need to closely follow the recommendations of the dosimeter manufacturer. Complete a Noise Dosimetry Log (Figure 2) for each dosimetry evaluation. In general, make sure that each dosimeter is properly calibrated before use, then attach the device to the worker so that the microphone is near the area of their head (i.e., at the collar). The worker should wear the device for the entire day, including breaks, and you should periodically check the device and record any notations of activities performed during the shift, using the Worker Activity Log in Figure 3. At the end of the shift, remove the dosimeter from the worker and post-calibrate it.

Noise Monitoring Results - Notification

The results of the noise monitoring (Sound Level Measurement Log and/or the Noise Dosimetry Log) will be copied and attached to the applicable Safe Work Permit(s). Copies of these documents will be forwarded to the PHSO for evaluation. In addition, a copy or the original shall be posted to inform personnel involved in the test as to the results. The SSO will also provide a narrative of the results to all personnel and subcontractor personnel who wish further explanation.

Calibration

All instruments used for sound level measurements and noise dosimetry will require calibration prior to use. All calibration will proceed as per manufacturer's instructions provided with the instruments. Information required for calibration is provided on the Sound Level and Noise Dosimetry Logs. Pre-and post-calibrations must be performed and recorded for all noise evaluations performed.

IIIA) Sound Level Measurement Log

The Sound Level Measurement Log (Figure 1) is to be used as a general record for sound level measurements recorded during operations. The diagram of the work area is to be completed by the SSO and/or the FOL. Information should include operator/helpers positions, support functions (sample tables, etc.), and noise measurements along the contours provided below. When designating the 85 dBA boundary line, make the approximate distance from the noise source so that it is clearly evident to site personnel where hearing protection is needed. A better approach would be to put signs in place where noise levels are above 85 dBA that hearing protection is required in this area. The contours provided below are set at ten feet intervals from the center, if alternate distances are desired indicate as such on the contour boundaries.

FIGURE 1

SOUND LEVEL MEASUREMENT LOG

Date of Survey	Location of Survey		Surveyed By
Sound Level Meter(Type)		Model #	Serial #
Calibration Date		Calibrated By	
Pre-Calibration Reading		Post-Calibration Reading	
Activity Being Conducted:__________ __________ Equipment Used:__________ Duration of Activity:__________			
Hearing Protection Used?______Type:__________NRR:__________			
Comments:__________ __________			

IIIB) Noise Dosimetry Log (Figure 2)

This log will be employed when conducting Noise Dosimetry of operations or job classifications. This log contains the necessary information queues for worker information as well as calibration of the noise dosimeters to insure complete documentation. On the reverse side a running log of worker activity is provided. Upon completion of this log, a copy should be made for the file on site, and the original sent to the PHSO for evaluation.

NOISE DOSIMETRY LOG

DATE OF SAMPLE:___________

Individuals conducting the dosimetry initials below indicate that noise dosimeter(s) were calibrated, and the unit(s) test parameters verified, prior to sampling:

________ 90 dB Criterion

________ 5 dB Exchange

________ 80 dB Cut-off Threshold

______ Pre-sample Calibration @ _____dBA

______ Post-sample Calibration @____dBA

Calibrator:__________________

Type of Noise Dosimeter employed:______________________________

Worker Sampled:____________________Dosimeter Identification No.____________

S.S. Number:______________________

Job Classification:______________________________

Job/Task being performed:______________________________

Equipment/Tools used:______________________________

Type of Hearing Protection Employed:________________ Noise Reduction Rating:________

Representative Exposure: ____________ ____________ ____________

For: ____________ ____________ ____________

Start-time: ___:___ Lmax.______ Lavg.________ Lpk.________

Stop-time: ___:___

Elapsed-time: ___:___ Dose: ________% Projected Dose: _________%

Comments:______________________________

____

____

______________________________ ______________________________

Supervisor in Charge SSO and/or FOL

ALSO COMPLETE WORKER ACTIVITY LOG ON REVERSE SIDE

FIGURE 3
WORKER ACTIVITY LOG

TEST HOUR	TASK(S)	*	LOCATION(S)
1			
2			
3			
4			
5			
6			
7			
8			

IV) Audiometric Testing

Audiometric testing is a standard part of the examination protocol in the Tetra Tech NUS Medical Surveillance Program. If based on scope of work, personnel or subcontractor personnel are required to wear hearing protection as part of their task assignment, it will be the SSO's or the FOL's responsibility to inquire whether their medical evaluation included audiometric testing. At all Tetra Tech NUS, Inc. project sites where hearing protection is required it is imperative that personnel be in a program of audiometric testing. For those who have not had even an initial (or baseline) evaluation, hearing protection will be required if Time-weighted are 8 hour exposure > 85 dBA.

V) Information Access

The implementation of this HCP requires information be made available to the participants of this program. Information to be made available include the following:

- Code of Federal Regulations, Subsection 1910.95 - This standard shall be posted on site accessible to all personnel. (retrievable at http://www.osha-slc.gov/OshStd_data/1910_0095.html).
- Monitoring Results – Information concerning quantitative monitoring will be posted accessible to all site personnel.
- Informational materials pertaining to the standard supplied to the employer by the Department of Labor.

IV) Record-Keeping

The following information will be maintained at the project site by the SSO and/or the FOL during the course of on-site activities.

- Exposure monitoring documentation (Sound Level Measurement and Noise Dosimetry Logs shall be maintained with the applicable Safe Work Permit). This information at project completion will be maintained in the project files for a period of no less than two years.
- Medical Surveillance information – Information concerning the individual's fitness for duty should include a declaration that the medical evaluation included establishing a baseline quantification of that persons hearing capabilities.
- Training – On project sites where noise is recognized as a potential hazard (either in the HASP, by following the general rule-of-thumb, or as a result of noise monitoring), hearing conservation training must be provided to al personnel working in these areas. This can be accomplished using Attachment 2.. If training is provided, in part or in whole regarding the subject matter minimum content documentation should be provided attesting to such.

ATTACHMENT VII

FIRE EXTINGUISHER

USE AND INSPECTION

FIRE EXTINGUISHER

USE AND INSPECTION

Fire Extinguisher Use and Inspection procedures will be conducted in support of the activities to be conducted at NCBC Gulfport. The following text is intended to provide general instruction to the field personnel charged with this responsibility.

Fire Extinguisher Use

All personnel trained in incidental response measures may be required to use and operate a fire extinguisher in response to an incipient stage fire. Therefore, the following instruction is provided and will be conveyed to all field personnel as part of site-specific training.

To use a portable fire extinguisher, the user should be familiar with the operation of the specific fire extinguisher located in the workplace. The following procedure will properly extinguish a small fire.

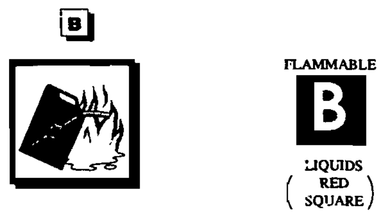
1) IDENTIFY THE TYPE OF FIRE (CLASS A, B, C, D).

CLASSES OF FIRE/FIRE EXTINGUISHER IDENTIFICATION

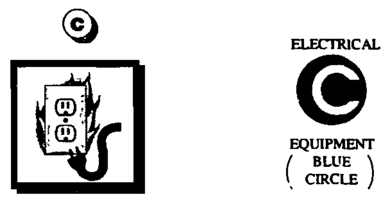
Fire is divided into four classes for easy identification and extinguishment. The type of fuel or ignition source will determine the type of extinguishing medium required.

Class A - Ordinary combustibles (wood, paper, rubber, plastic, and cloth). Extinguishers suitable for Class A fires should be identified by a triangle containing the letter "A." If colored, the triangle is green.

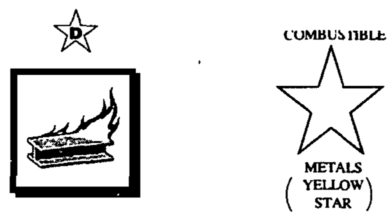
Class B - Flammable liquids, gases, and greases. Extinguishers suitable for Class B fires should be identified by a square containing the letter "B." If colored, the square is red. This type of extinguisher is effective on small petroleum product fires.



Class C - Electrically energized systems. Extinguishers suitable for Class C fires should be identified by a circle containing the letter "C." If colored, the circle is blue.



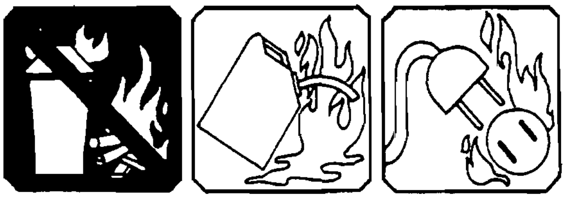
Class D - Combustible metals (sodium, magnesium, phosphorus). Extinguishers suitable for fires involving metals should be identified by a five-pointed star containing the letter "D." If colored, the star is yellow.



Note: Water and other extinguishing media, such as carbon dioxide and dry chemicals, are ineffective on metal fires.

New NFPA Markings

Class A, B, C



Class B, C

Class A, B

Class A

Mutli-class (ABC) Fire extinguishers will be provided for use on site. If you will buy a Fire Extinguisher, this is the type recommended. Size or rating recommended is 2 1/2 to 5 lbs.

1. Determine whether the extinguisher is adequate for this fire.

Rating number – The rating number assigned to a fire extinguisher is based on the capabilities of that fire class, for example

Class 5 A – Will provide extinguishing capabilities equal to that of 5 gallons of water.

Class 20 B - Will provide extinguishing capabilities equal to 20 square feet of flammable liquid burning.

Class C & D are not rated as to their limitations.

2. If adequate, hold the extinguisher upright and pull the ring pin.
3. Stand back 10 feet and aim at base of fire. Be careful not to spread burning material with pressurized extinguishing material.
4. Squeeze lever; sweep extinguisher in a side-to-side motion.

Portable Fire Extinguisher Placement/Mounting

Portable Fire Extinguishers will be placed/mounted in clear view in the areas where flammable materials are stored and/or dispensed. Mounting and placement of fire extinguishers will follow the following requirements

Fixed Locations (Flammable Storage)

- Extinguisher location will be marked by a red painted post to indicate extinguisher location
- The travel distance to access a fire extinguisher shall be no greater than 50 feet.
- The fire extinguisher will be mounted at a maximum height of four feet.

Mobile Locations (Drill Rigs, Support Vehicles)

All vehicles carrying fuel containers or used in the dispensing of fuel will carry at a minimum a 5 pound rated fire extinguisher.

Portable Fire Extinguisher Inspection

All fire extinguishers used in support of this field effort will be inspected on the following frequencies:

- A certified provider will perform maintenance checks of fire extinguishers at least once a year. A tag attached to the neck of the fire extinguisher will indicate documentation of the maintenance check.

- All fire extinguishers will have a current hydrostatic inspection. For the type of extinguishers selected for use at NCBC Gulfport hydrostatic inspections are required every 5 years.

- All fire extinguishers will be inspected monthly. The monthly inspection will cover the following
  - Are the fire extinguisher(s) placed in their designated location(s)?
  - Is the location conspicuously marked (Top 18 inches of the mounting pole to be painted red)?
  - Is the access impeding travel to the fire extinguisher blocked or restricted in any way?
  - Has the fire extinguisher been partially or completely discharged?
  - Is there signs of obvious physical damage?
  - Does the fire extinguisher shows sufficient pressure and are all of the tamper indicators are in place?

This inspection shall be documented on the attached tag provided by the maintenance/hydrostatic inspection service.

FIRE EXTINGUISHER CHECKLIST
NCBC GULFPORT

Project Name: NCBC Gulfport	CTO 0143	Date of Inspection:______________
Fire Extinguisher Identification Number:____________		**Fire Extinguisher Location:** ______________________

Measurement Criteria	Yes	No	N/A	Needs Repaired
Are the fire extinguisher(s) placed in their designated location(s)?				
Is the location conspicuously marked (Top 18 inches of the mounting pole to be painted red)?				
Is the access impeding travel to the fire extinguisher blocked or restricted in any way?				
Has the fire extinguisher been partially or completely discharged?				
Is there signs of obvious physical damage?				
Does the fire extinguisher shows sufficient pressure and are all of the tamper indicators are in place?				

Project Name: NCBC Gulfport	CTO 0143	Date of Inspection:______________
Fire Extinguisher Identification Number:____________		**Fire Extinguisher Location:** ______________________

Measurement Criteria	Yes	No	N/A	Needs Repaired
ARE THE FIRE EXTINGUISHER(S) PLACED IN THEIR DESIGNATED LOCATION(S)?				
Is the location conspicuously marked (Top 18 inches of the mounting pole to be painted red)?				
Is the access impeding travel to the fire extinguisher blocked or restricted in any way?				
Has the fire extinguisher been partially or completely discharged?				
Is there signs of obvious physical damage?				
Does the fire extinguisher shows sufficient pressure and are all of the tamper indicators are in place?				

ATTACHMENT VIII

MATHEMATICAL CALCULATIONS
POTENTIAL TCDD LADEN
DUST/PARTICULATE EXPOSURE

The following information represents mathematical computations reflecting a maximum actual soil concentration 5 ppb and projected concentrations (See column 2). As indicated on the following spread sheets (in column 3) the estimated concentrations of airborne dust necessary to present an inhalation exposure hazard if concentrations in the soils equal that value indicated in column 2.

Per the information presented the concentration of dioxin contaminated soils could be greater than 100 mg/kg and still not present an airborne inhalation exposure hazard until airborne dust concentrations equal or exceed 5 mg/m^3. Visible dusts are detectable at a concentration of approximately 2 mg/m^3. This provides ample warning and a benchmark to control airborne dusts long before exposure would become a concern.

DUST EXPOSURE CALCULATION WORKSHEET				
DustLevel		Safety Factor for this site = 2		
Chemical	Exposure Limit (mg/m3)	Maximum Soil Concentration (mg/kg)	Exposure Limit Based on Single Compound (EL Mix, mg/m3)	Dust Quotient for Each Compound (level/limit)
Aluminum	5	1.E-9	2.5E+15	2.00E-10
Antimony	0.5	1.E-9	2.5E+14	2.00E-09
Arsenic	0.01	1.E-9	5.E+12	1.00E-07
Barium	0.5	1.E-9	2.5E+14	2.00E-09
Beryllium	0.002	1.E-9	1.E+12	5.00E-07
Cadmium	0.005	1.E-9	2.5E+12	2.00E-07
Chlordane	0.5	1.E-9	2.5E+14	2.00E-09
Chromium	0.5	1.E-9	2.5E+14	2.00E-09
Chrome (hex)	0.01	1.E-9	5.E+12	1.00E-07
Cobalt	0.02	1.E-9	1.E+13	5.00E-08
Copper	1	1.E-9	5.E+14	1.00E-09
Cyanides	5	1.E-9	2.5E+15	2.00E-10
Dioxins	0.001	0.005	1.E+5	5.00E+00
Endosulfan	0.1	1.E-9	5.E+13	1.00E-08
Fluorides	2.5	1.E-9	1.25E+15	4.00E-10
Lead	0.05	1.E-9	2.5E+13	2.00E-08
Manganese	0.2	1.E-9	1.E+14	5.00E-09
Mercury	0.05	1.E-9	2.5E+13	2.00E-08
Nickel	1	1.E-9	5.E+14	1.00E-09
Oil Mist	5	1.E-9	2.5E+15	2.00E-10
PCBs	0.5	1.E-9	2.5E+14	2.00E-09
PNAs	0.2	1.E-9	1.E+14	5.00E-09
Phthalates	5	1.E-9	2.5E+15	2.00E-10
RDX	1.5	1.E-9	7.5E+14	6.67E-10
Selenium	0.2	1.E-9	1.E+14	5.00E-09
Silica	0.05	1.E-9	2.5E+13	2.00E-08
Silver	0.01	1.E-9	5.E+12	1.00E-07
Strontium- 90	8	1.E-9	4.0E+15	1.25E-10
Thallium	0.1	1.E-9	5.E+13	1.00E-08
Tin	2	1.E-9	1.E+15	5.00E-10
Titanium	10	1.E-9	5.E+15	1.00E-10
Trinitrotoluene	0.5	1.E-9	2.5E+14	2.00E-09
Vanadium	0.05	1.E-9	2.5E+13	2.00E-08
Zinc	10	1.E-9	5.E+15	1.00E-10
			Sum	5.00E+00
	Dust Exposure Level at Mixture PEL =		99,999.976	

DUST EXPOSURE CALCULATION WORKSHEET				
DustLevel		Safety Factor for this site = 2		
Chemical	Exposure Limit (mg/m3)	Maximum Soil Concentration (mg/kg)	Exposure Limit Based on Single Compound (EL Mix, mg/m3)	Dust Quotient for Each Compound (level/limit)
Aluminum	5	1.E-9	2.5E+15	2.00E-10
Antimony	0.5	1.E-9	2.5E+14	2.00E-09
Arsenic	0.01	1.E-9	5.E+12	1.00E-07
Barium	0.5	1.E-9	2.5E+14	2.00E-09
Beryllium	0.002	1.E-9	1.E+12	5.00E-07
Cadmium	0.005	1.E-9	2.5E+12	2.00E-07
Chlordane	0.5	1.E-9	2.5E+14	2.00E-09
Chromium	0.5	1.E-9	2.5E+14	2.00E-09
Chrome (hex)	0.01	1.E-9	5.E+12	1.00E-07
Cobalt	0.02	1.E-9	1.E+13	5.00E-08
Copper	1	1.E-9	5.E+14	1.00E-09
Cyanides	5	1.E-9	2.5E+15	2.00E-10
Dioxins	0.001	1.	500.	1.00E+03
Endosulfan	0.1	1.E-9	5.E+13	1.00E-08
Fluorides	2.5	1.E-9	1.25E+15	4.00E-10
Lead	0.05	1.E-9	2.5E+13	2.00E-08
Manganese	0.2	1.E-9	1.E+14	5.00E-09
Mercury	0.05	1.E-9	2.5E+13	2.00E-08
Nickel	1	1.E-9	5.E+14	1.00E-09
Oil Mist	5	1.E-9	2.5E+15	2.00E-10
PCBs	0.5	1.E-9	2.5E+14	2.00E-09
PNAs	0.2	1.E-9	1.E+14	5.00E-09
Phthalates	5	1.E-9	2.5E+15	2.00E-10
RDX	1.5	1.E-9	7.5E+14	6.67E-10
Selenium	0.2	1.E-9	1.E+14	5.00E-09
Silica	0.05	1.E-9	2.5E+13	2.00E-08
Silver	0.01	1.E-9	5.E+12	1.00E-07
Strontium- 90	8	1.E-9	4.0E+15	1.25E-10
Thallium	0.1	1.E-9	5.E+13	1.00E-08
Tin	2	1.E-9	1.E+15	5.00E-10
Titanium	10	1.E-9	5.E+15	1.00E-10
Trinitrotoluene	0.5	1.E-9	2.5E+14	2.00E-09
Vanadium	0.05	1.E-9	2.5E+13	2.00E-08
Zinc	10	1.E-9	5.E+15	1.00E-10
			Sum	1.00E+03
Dust Exposure Level at Mixture PEL =			500.000	

DUST EXPOSURE CALCULATION WORKSHEET				
DustLevel		Safety Factor for this site = 2		
Chemical	Exposure Limit (mg/m3)	Maximum Soil Concentration (mg/kg)	Exposure Limit Based on Single Compound (EL Mix, mg/m3)	Dust Quotient for Each Compound (level/limit)
Aluminum	5	1.E-9	2.5E+15	2.00E-10
Antimony	0.5	1.E-9	2.5E+14	2.00E-09
Arsenic	0.01	1.E-9	5.E+12	1.00E-07
Barium	0.5	1.E-9	2.5E+14	2.00E-09
Beryllium	0.002	1.E-9	1.E+12	5.00E-07
Cadmium	0.005	1.E-9	2.5E+12	2.00E-07
Chlordane	0.5	1.E-9	2.5E+14	2.00E-09
Chromium	0.5	1.E-9	2.5E+14	2.00E-09
Chrome (hex)	0.01	1.E-9	5.E+12	1.00E-07
Cobalt	0.02	1.E-9	1.E+13	5.00E-08
Copper	1	1.E-9	5.E+14	1.00E-09
Cyanides	5	1.E-9	2.5E+15	2.00E-10
Dioxins	0.001	2.	250.	2.00E+03
Endosulfan	0.1	1.E-9	5.E+13	1.00E-08
Fluorides	2.5	1.E-9	1.25E+15	4.00E-10
Lead	0.05	1.E-9	2.5E+13	2.00E-08
Manganese	0.2	1.E-9	1.E+14	5.00E-09
Mercury	0.05	1.E-9	2.5E+13	2.00E-08
Nickel	1	1.E-9	5.E+14	1.00E-09
Oil Mist	5	1.E-9	2.5E+15	2.00E-10
PCBs	0.5	1.E-9	2.5E+14	2.00E-09
PNAs	0.2	1.E-9	1.E+14	5.00E-09
Phthalates	5	1.E-9	2.5E+15	2.00E-10
RDX	1.5	1.E-9	7.5E+14	6.67E-10
Selenium	0.2	1.E-9	1.E+14	5.00E-09
Silica	0.05	1.E-9	2.5E+13	2.00E-08
Silver	0.01	1.E-9	5.E+12	1.00E-07
Strontium- 90	8	1.E-9	4.0E+15	1.25E-10
Thallium	0.1	1.E-9	5.E+13	1.00E-08
Tin	2	1.E-9	1.E+15	5.00E-10
Titanium	10	1.E-9	5.E+15	1.00E-10
Trinitrotoluene	0.5	1.E-9	2.5E+14	2.00E-09
Vanadium	0.05	1.E-9	2.5E+13	2.00E-08
Zinc	10	1.E-9	5.E+15	1.00E-10
			Sum	2.00E+03
Dust Exposure Level at Mixture PEL =			250.000	

DUST EXPOSURE CALCULATION WORKSHEET				
DustLevel		Safety Factor for this site = 2		
Chemical	Exposure Limit (mg/m3)	Maximum Soil Concentration (mg/kg)	Exposure Limit Based on Single Compound (EL Mix, mg/m3)	Dust Quotient for Each Compound (level/limit)
Aluminum	5	1.E-9	2.5E+15	2.00E-10
Antimony	0.5	1.E-9	2.5E+14	2.00E-09
Arsenic	0.01	1.E-9	5.E+12	1.00E-07
Barium	0.5	1.E-9	2.5E+14	2.00E-09
Beryllium	0.002	1.E-9	1.E+12	5.00E-07
Cadmium	0.005	1.E-9	2.5E+12	2.00E-07
Chlordane	0.5	1.E-9	2.5E+14	2.00E-09
Chromium	0.5	1.E-9	2.5E+14	2.00E-09
Chrome (hex)	0.01	1.E-9	5.E+12	1.00E-07
Cobalt	0.02	1.E-9	1.E+13	5.00E-08
Copper	1	1.E-9	5.E+14	1.00E-09
Cyanides	5	1.E-9	2.5E+15	2.00E-10
Dioxins	0.001	5.	100.	5.00E+03
Endosulfan	0.1	1.E-9	5.E+13	1.00E-08
Fluorides	2.5	1.E-9	1.25E+15	4.00E-10
Lead	0.05	1.E-9	2.5E+13	2.00E-08
Manganese	0.2	1.E-9	1.E+14	5.00E-09
Mercury	0.05	1.E-9	2.5E+13	2.00E-08
Nickel	1	1.E-9	5.E+14	1.00E-09
Oil Mist	5	1.E-9	2.5E+15	2.00E-10
PCBs	0.5	1.E-9	2.5E+14	2.00E-09
PNAs	0.2	1.E-9	1.E+14	5.00E-09
Phthalates	5	1.E-9	2.5E+15	2.00E-10
RDX	1.5	1.E-9	7.5E+14	6.67E-10
Selenium	0.2	1.E-9	1.E+14	5.00E-09
Silica	0.05	1.E-9	2.5E+13	2.00E-08
Silver	0.01	1.E-9	5.E+12	1.00E-07
Strontium- 90	8	1.E-9	4.0E+15	1.25E-10
Thallium	0.1	1.E-9	5.E+13	1.00E-08
Tin	2	1.E-9	1.E+15	5.00E-10
Titanium	10	1.E-9	5.E+15	1.00E-10
Trinitrotoluene	0.5	1.E-9	2.5E+14	2.00E-09
Vanadium	0.05	1.E-9	2.5E+13	2.00E-08
Zinc	10	1.E-9	5.E+15	1.00E-10
			Sum	5.00E+03
Dust Exposure Level at Mixture PEL =			100.000	

DUST EXPOSURE CALCULATION WORKSHEET

DustLevel | **Safety Factor for this site = 2**

Chemical	Exposure Limit (mg/m3)	Maximum Soil Concentration (mg/kg)	Exposure Limit Based on Single Compound (EL Mix, mg/m3)	Dust Quotient for Each Compound (level/limit)
Aluminum	5	1.E-9	2.5E+15	2.00E-10
Antimony	0.5	1.E-9	2.5E+14	2.00E-09
Arsenic	0.01	1.E-9	5.E+12	1.00E-07
Barium	0.5	1.E-9	2.5E+14	2.00E-09
Beryllium	0.002	1.E-9	1.E+12	5.00E-07
Cadmium	0.005	1.E-9	2.5E+12	2.00E-07
Chlordane	0.5	1.E-9	2.5E+14	2.00E-09
Chromium	0.5	1.E-9	2.5E+14	2.00E-09
Chrome (hex)	0.01	1.E-9	5.E+12	1.00E-07
Cobalt	0.02	1.E-9	1.E+13	5.00E-08
Copper	1	1.E-9	5.E+14	1.00E-09
Cyanides	5	1.E-9	2.5E+15	2.00E-10
Dioxins	0.001	10.	50.	1.00E+04
Endosulfan	0.1	1.E-9	5.E+13	1.00E-08
Fluorides	2.5	1.E-9	1.25E+15	4.00E-10
Lead	0.05	1.E-9	2.5E+13	2.00E-08
Manganese	0.2	1.E-9	1.E+14	5.00E-09
Mercury	0.05	1.E-9	2.5E+13	2.00E-08
Nickel	1	1.E-9	5.E+14	1.00E-09
Oil Mist	5	1.E-9	2.5E+15	2.00E-10
PCBs	0.5	1.E-9	2.5E+14	2.00E-09
PNAs	0.2	1.E-9	1.E+14	5.00E-09
Phthalates	5	1.E-9	2.5E+15	2.00E-10
RDX	1.5	1.E-9	7.5E+14	6.67E-10
Selenium	0.2	1.E-9	1.E+14	5.00E-09
Silica	0.05	1.E-9	2.5E+13	2.00E-08
Silver	0.01	1.E-9	5.E+12	1.00E-07
Strontium- 90	8	1.E-9	4.0E+15	1.25E-10
Thallium	0.1	1.E-9	5.E+13	1.00E-08
Tin	2	1.E-9	1.E+15	5.00E-10
Titanium	10	1.E-9	5.E+15	1.00E-10
Trinitrotoluene	0.5	1.E-9	2.5E+14	2.00E-09
Vanadium	0.05	1.E-9	2.5E+13	2.00E-08
Zinc	10	1.E-9	5.E+15	1.00E-10
			Sum	1.00E+04
		Dust Exposure Level at Mixture PEL =	50.000	

DUST EXPOSURE CALCULATION WORKSHEET

DustLevel Safety Factor for this site = **2**

Chemical	Exposure Limit (mg/m3)	Maximum Soil Concentration (mg/kg)	Exposure Limit Based on Single Compound (EL Mix, mg/m3)	Dust Quotient for Each Compound (level/limit)
Aluminum	5	1.E-9	2.5E+15	2.00E-10
Antimony	0.5	1.E-9	2.5E+14	2.00E-09
Arsenic	0.01	1.E-9	5.E+12	1.00E-07
Barium	0.5	1.E-9	2.5E+14	2.00E-09
Beryllium	0.002	1.E-9	1.E+12	5.00E-07
Cadmium	0.005	1.E-9	2.5E+12	2.00E-07
Chlordane	0.5	1.E-9	2.5E+14	2.00E-09
Chromium	0.5	1.E-9	2.5E+14	2.00E-09
Chrome (hex)	0.01	1.E-9	5.E+12	1.00E-07
Cobalt	0.02	1.E-9	1.E+13	5.00E-08
Copper	1	1.E-9	5.E+14	1.00E-09
Cyanides	5	1.E-9	2.5E+15	2.00E-10
Dioxins	0.001	100	5.	1.00E+05
Endosulfan	0.1	1.E-9	5.E+13	1.00E-08
Fluorides	2.5	1.E-9	1.25E+15	4.00E-10
Lead	0.05	1.E-9	2.5E+13	2.00E-08
Manganese	0.2	1.E-9	1.E+14	5.00E-09
Mercury	0.05	1.E-9	2.5E+13	2.00E-08
Nickel	1	1.E-9	5.E+14	1.00E-09
Oil Mist	5	1.E-9	2.5E+15	2.00E-10
PCBs	0.5	1.E-9	2.5E+14	2.00E-09
PNAs	0.2	1.E-9	1.E+14	5.00E-09
Phthalates	5	1.E-9	2.5E+15	2.00E-10
RDX	1.5	1.E-9	7.5E+14	6.67E-10
Selenium	0.2	1.E-9	1.E+14	5.00E-09
Silica	0.05	1.E-9	2.5E+13	2.00E-08
Silver	0.01	1.E-9	5.E+12	1.00E-07
Strontium- 90	8	1.E-9	4.0E+15	1.25E-10
Thallium	0.1	1.E-9	5.E+13	1.00E-08
Tin	2	1.E-9	1.E+15	5.00E-10
Titanium	10	1.E-9	5.E+15	1.00E-10
Trinitrotoluene	0.5	1.E-9	2.5E+14	2.00E-09
Vanadium	0.05	1.E-9	2.5E+13	2.00E-08
Zinc	10	1.E-9	5.E+15	1.00E-10
			Sum	1.00E+05
		Dust Exposure Level at Mixture PEL =	5.000	

B

APPENDIX B

ASTM TEST METHODS

Designation: D 698 – 91 (Reapproved 1998)

Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3(600 kN-m/m^3))[1]

This standard is issued under the fixed designation D 698; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers laboratory compaction procedures used to determine the relationship between water content and dry unit weight of soils (compaction curve) compacted in a 4 or 6-in. (101.6 or 152.4-mm) diameter mold with a 5.5-lbf (24.4-N) rammer dropped from a height of 12 in. (305 mm) producing a compactive effort of 12,400 ft-lbf/ft^3(600 kN-m/m^3).

NOTE 1—The equipment and procedures are similar as those proposed by R. R. Proctor (*Engineering News Record*—September 7, 1933) with this one major exception: his rammer blows were applied as "12 inch firm strokes" instead of free fall, producing variable compactive effort depending on the operator, but probably in the range 15,000 to 25,000 ft-lbf/ft^3 (700 to 1,200 kN-m/m^3). The standard effort test (see 3.2.2) is sometimes referred to as the Proctor Test.

NOTE 2—Soils and soil-aggregate mixtures should be regarded as natural occurring fine- or coarse-grained soils or composites or mixtures of natural soils, or mixtures of natural and processed soils or aggregates such as silt, gravel, or crushed rock.

1.2 This test method applies only to soils that have 30 % or less by weight of particles retained on the ¾-inch (19.0-mm) sieve.

NOTE 3—For relationships between unit weights and water contents of soils with 30 % or less by weight of material retained on the ¾-in. (19.0-mm) sieve to unit weights and water contents of the fraction passing ¾-in. (19.0-mm) sieve, see Practice D 4718.

1.3 Three alternative procedures are provided. The procedure used shall be as indicated in the specification for the material being tested. If no procedure is specified, the choice should be based on the material gradation.

1.3.1 *Procedure A*:

1.3.1.1 *Mold*—4-in. (101.6-mm) diameter.

1.3.1.2 *Material*—Passing No. 4 (4.75-mm) sieve.

1.3.1.3 *Layers*—Three.

1.3.1.4 *Blows per layer*—25.

1.3.1.5 *Use*—May be used if 20 % or less by weight of the material is retained on the No. 4 (4.75-mm) sieve.

1.3.1.6 *Other Use*—If this procedure is not specified, materials that meet these gradation requirements may be tested using Procedures B or C.

1.3.2 *Procedure B*:

1.3.2.1 *Mold*—4-in. (101.6-mm) diameter.

1.3.2.2 *Material*—Passing ⅜-in. (9.5-mm) sieve.

1.3.2.3 *Layers*—Three.

1.3.2.4 *Blows per layer*—25.

1.3.2.5 *Use*—Shall be used if more than 20 % by weight of the material is retained on the No. 4 (4.75-mm) sieve and 20 % or less by weight of the material is retained on the ⅜-in. (9.5-mm) sieve.

1.3.2.6 *Other Use*—If this procedure is not specified, materials that meet these gradation requirements may be tested using Procedure C.

1.3.3 *Procedure C*:

1.3.3.1 *Mold*—6-in. (152.4-mm) diameter.

1.3.3.2 *Material*—Passing ¾-inch (19.0-mm) sieve.

1.3.3.3 *Layers*—Three.

1.3.3.4 *Blows per layer*—56.

1.3.3.5 *Use*—Shall be used if more than 20 % by weight of the material is retained on the ⅜-in. (9.5-mm) sieve and less than 30 % by weight of the material is retained on the ¾-in. (19.0-mm) sieve.

1.3.4 The 6-in. (152.4-mm) diameter mold shall not be used with Procedure A or B.

NOTE 4—Results have been found to vary slightly when a material is tested at the same compactive effort in different size molds.

1.4 If the test specimen contains more than 5 % by weight oversize fraction (coarse fraction) and the material will not be included in the test, corrections must be made to the unit weight and water content of the specimen or to the appropriate field in place density test specimen using Practice D 4718.

1.5 This test method will generally produce a well defined maximum dry unit weight for non-free draining soils. If this test method is used for free draining soils the maximum unit weight may not be well defined, and can be less than obtained using Test Methods D 4253.

1.6 The values in inch-pound units are to be regarded as the standard. The values stated in SI units are provided for information only.

1.6.1 In the engineering profession it is customary practice to use, interchangeably, units representing both mass and force, unless dynamic calculations ($F = Ma$) are involved. This implicitly combines two separate systems of units, that is, the absolute system and the gravimetric system. It is scientifically

[1] This test method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.03 on Texture, Plasticity and Density Characteristics of Soils.

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undesirable to combine the use of two separate systems within a single standard. This test method has been written using inch-pound units (gravimetric system) where the pound (lbf) represents a unit of force. The use of mass (lbm) is for convenience of units and is not intended to convey the use is scientifically correct. Conversions are given in the SI system in accordance with Practice E 380. The use of balances or scales recording pounds of mass (lbm), or the recording of density in lbm/ft^3 should not be regarded as nonconformance with this standard.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 127 Test Method for Specific Gravity and Absorption of Coarse Aggregate[2]

C 136 Method for Sieve Analysis of Fine and Coarse Aggregate[2]

D 422 Test Method for Particle Size Analysis of Soils[3]

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[3]

D 854 Test Method for Specific Gravity of Soils[3]

D 1557 Test Methods for Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10-lb (4.54-kg.) Rammer and 18-in. (457 mm) Drop[3]

D 2168 Test Methods for Calibration of Laboratory Mechanical-Rammer Soil Compactors[3]

D 2216 Test Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock and Soil-Aggregate Mixtures[3]

D 2487 Test Method for Classification of Soils for Engineering Purposes[3]

D 2488 Practice for Description of Soils (Visual-Manual Procedure)[3]

D 4220 Practices for Preserving and Transporting Soil Samples[3]

D 4253 Test Methods for Maximum Index Density of Soils Using a Vibratory Table[3]

D 4718 Practice for Correction of Unit Weight and Water Content for Soils Containing Oversize Particles[3]

D 4753 Specification for Evaluating, Selecting and Specifying Balances and Scales For Use in Soil and Rock Testing[3]

E 1 Specification for ASTM Thermometers[4]

E 11 Specification for Wire-Cloth Sieves for Testing Purposes[5]

E 319 Practice for the Evaluation of Single-Pan Mechanical Balances[5]

E 380 Practice for Use of the International System of Units (SI) (the Modernized Metric System)[5]

3. Terminology

3.1 *Definitions:* See Terminology D 653 for general definitions.

3.2 *Description of Terms Specific to This Standard:*

3.2.1 *oversize fraction (coarse fraction), P_c* in %—the portion of total sample not used in performing the compaction test; it may be the portion of total sample retained on the No. 4 (4.75-mm), ⅜-in. (9.5-mm), or ¾-in. (19.0-mm) sieve.

3.2.2 *standard effort*—the term for the 12,400 ft-lbf/ft^3(600 kN-m/m^3) compactive effort applied by the equipment and procedures of this test.

3.2.3 *standard maximum dry unit weight, γ_{dmax}* in lbf/ft^3 (kN/m^3)—the maximum value defined by the compaction curve for a compaction test using standard effort.

3.2.4 *standard optimum water content, w_o* in %—the water content at which a soil can be compacted to the maximum dry unit weight using standard compactive effort.

3.2.5 *test fraction (finer fraction), P_F* in %—the portion of the total sample used in performing the compaction test; it is the fraction passing the No. 4 (4.75-mm) sieve in Procedure A, minus ⅜-in. (9.5-mm) sieve in Procedure B, or minus ¾-in. (19.0-mm) sieve in Procedure C.

4. Summary of Test Method

4.1 A soil at a selected water content is placed in three layers into a mold of given dimensions, with each layer compacted by 25 or 56 blows of a 5.5-lbf (24.4-N) rammer dropped from a distance of 12-in. (305-mm), subjecting the soil to a total compactive effort of about 12,400 ft-lbf/ft^3 (600 kN-m/m^3). The resulting dry unit weight is determined. The procedure is repeated for a sufficient number of water contents to establish a relationship between the dry unit weight and the water content for the soil. This data, when plotted, represents a curvilinear relationship known as the compaction curve. The values of optimum water content and standard maximum dry unit weight are determined from the compaction curve.

5. Significance and Use

5.1 Soil placed as engineering fill (embankments, foundation pads, road bases) is compacted to a dense state to obtain satisfactory engineering properties such as, shear strength, compressibility, or permeability. Also, foundation soils are often compacted to improve their engineering properties. Laboratory compaction tests provide the basis for determining the percent compaction and water content needed to achieve the required engineering properties, and for controlling construction to assure that the required compaction and water contents are achieved.

5.2 During design of an engineered fill, shear, consolidation, permeability, or other tests require preparation of test specimens by compacting at some water content to some unit weight. It is common practice to first determine the optimum water content (w_o) and maximum dry unit weight (γ_{dmax}) by means of a compaction test. Test specimens are compacted at a selected water content (w), either wet or dry of optimum (w_o) or at optimum (w_o), and at a selected dry unit weight re[illegible] a percentage of maximum dry unit weight (γ_{dmax}). [illegible] selection of water content (w), either wet or dry of optimum (w_o) or at optimum (w_o) and the dry unit weight (γ_{dmax}) may be

[2] *Annual Book of ASTM Standards*, Vol 04.02.
[3] *Annual Book of ASTM Standards*, Vol 04.08.
[4] *Annual Book of ASTM Standards*, Vol 14.03.
[5] *Annual Book of ASTM Standards*, Vol 14.02.

based on past experience, or a range of values may be investigated to determine the necessary percent of compaction.

6. Apparatus

6.1 *Mold Assembly*—The molds shall be cylindrical in shape, made of rigid metal and be within the capacity and dimensions indicated in 6.1.1 or 6.1.2 and Fig. 1 and Fig. 2. The walls of the mold may be solid, split, or tapered. The "split" type may consist of two half-round sections, or a section of pipe split along one element, which can be securely locked together to form a cylinder meeting the requirements of this section. The "tapered" type shall an internal diameter taper that is uniform and not more than 0.200 in./ft (16.7- mm/m) of mold height. Each mold shall have a base plate and an extension collar assembly, both made of rigid metal and constructed so they can be securely attached and easily detached from the mold. The extension collar assembly shall have a height extending above the top of the mold of at least 2.0 in. (50.8-mm) which may include an upper section that flares out to form a funnel provided there is at least a 0.75 in. (19.0-mm) straight cylindrical section beneath it. The extension collar shall align with the inside of the mold. The bottom of the base plate and bottom of the centrally recessed area that accepts the cylindrical mold shall be planar.

6.1.1 *Mold, 4 in.*—A mold having a 4.000 ± 0.016-in. (101.6 ± 0.4-mm) average inside diameter, a height of 4.584 ± 0.018-in. (116.4 ± 0.5-mm) and a volume of 0.0333 ± 0.0005 ft^3 (944 ± 14 cm^3). A mold assembly having the minimum required features is shown in Fig. 1.

6.1.2 *Mold, 6 in.*—A mold having a 6.000 ± 0.026-in. (152.4 ± 0.7-mm) average inside diameter, a height of 4.584 ± 0.018-in. (116.4 ± 0.5-mm), and a volume of 0.075 ± 0.0009 ft^3 (2124 ± 25 cm^3). A mold assembly having the minimum required features is shown in Fig. 2.

6.2 *Rammer*—A rammer, either manually operated as described further in 6.2.1 or mechanically operated as described in 6.2.2. The rammer shall fall freely through a distance of 12 ± 0.05-in. (304.8 ± 1.3-mm) from the surface of the specimen. The mass of the rammer shall be 5.5 ± 0.02-lbm (2.5 ± 0.01-kg), except that the mass of the mechanical rammers may be adjusted as described in Test Methods D 2168, see Note 5. The striking face of the rammer shall be planar and circular, except as noted in 6.2.2.1, with a diameter when new of 2.000 ± 0.005-in. (50.80 ± 0.13-mm). The rammer shall be replaced

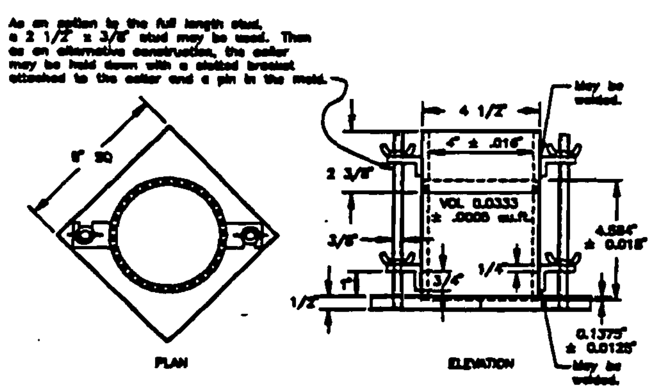

FIG. 1 4.0-in. Cylindrical Mold

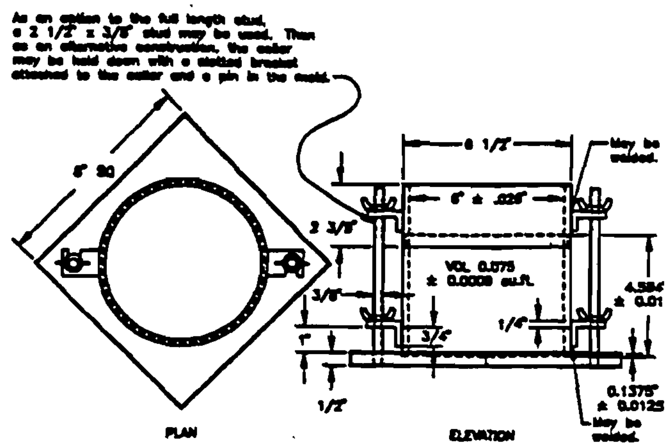

FIG. 2 6.0-in. Cylindrical Mold

if the striking face becomes worn or bellied to the extent that the diameter exceeds 2.000 ± 0.01-in. (50.80 ± 0.25-mm).

NOTE 5—It is a common and acceptable practice in the inch-pound system to assume that the mass of the rammer is equal to its mass determined using either a kilogram or pound balance and 1 lbf is equal to 1 lbm or 0.4536 kg. or 1 N is equal to 0.2248 lbm or 0.1020 kg.

6.2.1 *Manual Rammer*—The rammer shall be equipped with a guide sleeve that has sufficient clearance that the free fall of the rammer shaft and head is not restricted. The guide sleeve shall have at least four vent holes at each end (eight holes total) located with centers ¾ ± 1/16-in. (19.0 ± 1.6-mm) from each end and spaced 90 degrees apart. The minimum diameter of the vent holes shall be ⅜-in. (9.5-mm). Additional holes or slots may be incorporated in the guide sleeve.

6.2.2 *Mechanical Rammer-Circular Face*—The rammer shall operate mechanically in such a manner as to provide uniform and complete coverage of the specimen surface. There shall be 0.10 ± 0.03-in. (2.5 ± 0.8-mm) clearance between the rammer and the inside surface of the mold at its smallest diameter. The mechanical rammer shall meet the calibration requirements of Test Methods D 2168. The mechanical rammer shall be equipped with a positive mechanical means to support the rammer when not in operation.

6.2.2.1 *Mechanical Rammer-Sector Face*—When used with the 6-in. (152.4-mm) mold, a sector face rammer may be used in place of the circular face rammer. The specimen contact face shall have the shape of a sector of a circle of radius equal to 2.90 ± 0.02-in. (73.7 ± 0.5-mm). The rammer shall operate in such a manner that the vertex of the sector is positioned at the center of the specimen.

6.3 *Sample Extruder (optional)*—A jack, frame or other device adapted for the purpose of extruding compacted specimens from the mold.

6.4 *Balance*—A class GP5 balance meeting the requirements of Specification D 4753 for a balance of 1-g readability.

6.5 *Drying Oven*—Thermostatically controlled, preferably of a forced-draft type and capable of maintaining a uniform temperature of 230 ± 9°F (110 ± 5°C) throughout the drying chamber.

6.6 *Straightedge*—A stiff metal straightedge of any convenient length but not less than 10-in. (254-mm). The total length of the straightedge shall be machined straight to a tolerance of

±0.005-in. (±0.1-mm). The scraping edge shall be beveled if it is thicker than ⅛-in. (3-mm).

6.7 *Sieves*—¾-in. (19.0-mm), ⅜-in. (9.5-mm), and No. 4 (4.75-mm), conforming to the requirements of Specification E 11.

6.8 *Mixing Tools*—Miscellaneous tools such as mixing pan, spoon, trowel, spatula, etc., or a suitable mechanical device for thoroughly mixing the sample of soil with increments of water.

7. Calibration

7.1 Perform calibrations before initial use, after repairs or other occurrences that might affect the test results, at intervals not exceeding 1,000 test specimens, or annually, whichever occurs first, for the following apparatus:

7.1.1 *Balance*—Evaluate in accordance with Specification D 4753.

7.1.2 *Molds*—Determine the volume as described in Annex A1.

7.1.3 *Manual Rammer*—Verify the free fall distance, rammer mass, and rammer face in accordance with Section 6.2. Verify the guide sleeve requirements in accordance with Section 6.2.1.

7.1.4 *Mechanical Rammer*—Calibrate and adjust the mechanical rammer in accordance with Test Methods D 2168. In addition, the clearance between the rammer and the inside surface of the mold shall be verified in accordance with 6.2.2.

8. Test Sample

8.1 The required sample mass for Procedures A and B is approximately 35-lbm (16-kg), and for Procedure C is approximately 65-lbm (29-kg) of dry soil. Therefore, the field sample should have a moist mass of at least 50-lbm (23-kg) and 100-lbm (45-kg), respectively.

8.2 Determine the percentage of material retained on the No. 4 (4.75-mm), ⅜-in. (9.5-mm), or ¾-in. (19.0-mm) sieve as appropriate for choosing Procedure A, B, or C. Make this determination by separating out a representative portion from the total sample and determining the percentages passing the sieves of interest by Test Methods D 422 or Method C 136. It is only necessary to calculate percentages for the sieve or sieves for which information is desired.

9. Preparation of Apparatus

9.1 Select the proper compaction mold in accordance with the procedure (A, B, or C) being used. Determine and record its mass to the nearest gram. Assemble the mold, base and extension collar. Check the alignment of the inner wall of the mold and mold extension collar. Adjust if necessary.

9.2 Check that the rammer assembly is in good working condition and that parts are not loose or worn. Make any necessary adjustments or repairs. If adjustments or repairs are made, the rammer must be recalibrated.

10. Procedure

10.1 *Soils*:

10.1.1 Do not reuse soil that has been previously laboratory compacted.

10.1.2 When using this test method for soils containing hydrated halloysite, or where past experience with a particular soil indicates that results will be altered by air drying, use the moist preparation method (see 10.2).

10.1.3 Prepare the soil specimens for testing in accordance with 10.2 (preferred) or with 10.3.

10.2 *Moist Preparation Method (preferred)*—Without previously drying the sample, pass it through a No. 4 (4.75-mm), ⅜-in. (9.5-mm), or ¾-in. (19.0-mm) sieve, depending on the procedure (A, B, or C) being used. Determine the water content of the processed soil.

10.2.1 Prepare at least four (preferably five) specimens having water contents such that they bracket the estimated optimum water content. A specimen having a water content close to optimum should be prepared first by trial additions of water and mixing (see Note 6). Select water contents for the rest of the specimens to provide at least two specimens wet and two specimens dry of optimum, and water contents varying by about 2 %. At least two water contents are necessary on the wet and dry side of optimum to accurately define the dry unit weight compaction curve (see 10.5). Some soils with very high optimum water content or a relatively flat compaction curve may require larger water content increments to obtain a well defined maximum dry unit weight. Water content increments should not exceed 4 %.

NOTE 6—With practice it is usually possible to visually judge a point near optimum water content. Typically, soil at optimum water content can be squeezed into a lump that sticks together when hand pressure is released, but will break cleanly into two sections when "bent". At water contents dry of optimum soils tend to crumble; wet of optimum soils tend to stick together in a sticky cohesive mass. Optimum water content is typically slightly less than the plastic limit.

10.2.2 Use approximately 5-lbm (2.3-kg) of the sieved soil for each specimen to be compacted using Procedure A or B, or 13-lbm (5.9-kg) using Procedure C. To obtain the specimen water contents selected in 10.2.1, add or remove the required amounts of water as follows: to add water, spray it into the soil during mixing; to remove water, allow the soil to dry in air at ambient temperature or in a drying apparatus such that the temperature of the sample does not exceed 140°F (60°C). Mix the soil frequently during drying to maintain an even water content distribution. Thoroughly mix each specimen to ensure even distribution of water throughout and then place in a separate covered container and allow to stand in accordance with Table 1 prior to compaction. For the purpose of selecting a standing time, the soil may be classified using Test Method D 2487, Practice D 2488 or data on other samples from the same material source. For referee testing, classification shall be by Test Method D 2487.

10.3 *Dry Preparation Method*—If the sample is too damp to be friable, reduce the water content by air drying until the material is friable. Drying may be in air or by the use of drying apparatus such that the temperature of the sample does not exceed 140°F (60°C). Thoroughly break up the aggregations in such a manner as to avoid breaking individual particles. Pass

TABLE 1 Required Standing Times of Moisturized Specimens

Classification	Minimum Standing Time, h
GW, GP, SW, SP	No Requirement
GM, SM	3
All other soils	16

TABLE 2 Metric Equivalents for Figs. 1 and 2

in.	mm
0.016	0.41
0.026	0.66
0.032	0.81
0.028	0.71
½	12.70
2½	63.50
2⅝	66.70
4	101.60
4½	114.30
4.584	116.43
4¾	120.60
6	152.40
6½	165.10
6⅝	168.30
6¾	171.40
8¼	209.60
ft^3	cm^3
1/30 (0.0333)	943
0.0005	14
(0.0750)	2,124
0.0011	31

the material through the appropriate sieve: No. 4 (4.75-mm), ⅜-in. (9.5-mm), or ¾-in. (19.0-mm). When preparing the material by passing over the ¾-in. sieve for compaction in the 6-in. mold, break up aggregations sufficiently to at least pass the ⅜-in. sieve in order to facilitate the distribution of water throughout the soil in later mixing.

10.3.1 Prepare at least four (preferably five) specimens in accordance with 10.2.1.

10.3.2 Use approximately 5-lbm (2.3-kg) of the sieved soil for each specimen to be compacted using Procedure A or B, or 13-lbm (5.9-kg) using Procedure C. Add the required amounts of water to bring the water contents of the specimens to the values selected in 10.3.1. Follow the specimen preparation procedure specified in 10.2.2 for drying the soil or adding water into the soil and curing each test specimen.

10.4 *Compaction*—After curing, if required, each specimen shall be compacted as follows:

10.4.1 Determine and record the mass of the mold or mold and base plate.

10.4.2 Assemble and secure the mold and collar to the base plate. The mold shall rest on a uniform rigid foundation, such as provided by a cylinder or cube of concrete with a mass of not less than 200-lbm (91-kg). Secure the base plate to the rigid foundation. The method of attachment to the rigid foundation shall allow easy removal of the assembled mold, collar and base plate after compaction is completed.

10.4.3 Compact the specimen in three layers. After compaction, each layer should be approximately equal in thickness. Prior to compaction, place the loose soil into the mold and spread into a layer of uniform thickness. Lightly tamp the soil prior to compaction until it is not in a fluffy or loose state, using either the manual compaction rammer or a 2-in. (5-mm) diameter cylinder. Following compaction of each of the first two layers, any soil adjacent to the mold walls that has not been compacted or extends above the compacted surface shall be trimmed. The trimmed soil may be included with the additional soil for the next layer. A knife or other suitable device may be used. The total amount of soil used shall be such that the third compacted layer slighly extends into the collar, but does not exceed ¼-in. (6-mm) above the top of the mold. If the third layer does extend above the top of the mold by more than ¼-in. (6-mm), the specimen shall be discarded. The specimen shall be discarded when the last blow on the rammer for the third layer results in the bottom of the rammer extending below the top of the compaction mold.

10.4.4 Compact each layer with 25 blows for the 4-in. (101.6-mm) mold or with 56 blows for the 6-in. (152.4-mm) mold.

NOTE 7—When compacting specimens wetter than optimum water content, uneven compacted surfaces can occur and operator judgement is required as to the average height of the specimen.

10.4.5 In operating the manual rammer, take care to avoid lifting the guide sleeve during the rammer upstroke. Hold the guide sleeve steady and within 5° of vertical. Apply the blows at a uniform rate of approximately 25 blows/min and in such a manner as to provide complete, uniform coverage of the specimen surface.

10.4.6 Following compaction of the last layer, remove the collar and base plate from the mold, except as noted in 10.4.7. A knife may be used to trim the soil adjacent to the collar to loosen the soil from the collar before removal to avoid disrupting the soil below the top of the mold.

10.4.7 Carefully trim the compacted specimen even with the top of the mold by means of the straightedge scraped across the top of the mold to form a plane surface even with the top of the mold. Initial trimming of the specimen above the top of the mold with a knife may prevent the soil from tearing below the top of the mold. Fill any holes in the top surface with unused or trimmed soil from the specimen, press in with the fingers, and again scrape the straightedge across the top of the mold. Repeat the appropriate preceding operations on the bottom of the specimen when the mold volume was determined without the base plate. For very wet or dry soils, soil or water may be lost if the base plate is removed. For these situations, leave the base plate attached to the mold. When the base plate is left attached, the volume of the mold must be calibrated with the base plate attached to the mold rather than a plastic or glass plate as noted in Annex A1, A1.4.

10.4.8 Determine and record the mass of the specimen and mold to the nearest gram. When the base plate is left attached, determine and record the mass of the specimen, mold and base plate to the nearest gram.

10.4.9 Remove the material from the mold. Obtain a specimen for water content by using either the whole specimen (preferred method) or a representative portion. When the entire specimen is used, break it up to facilitate drying. Otherwise, obtain a portion by slicing the compacted specimen axially through the center and removing about 500-g of material from the cut faces. Obtain the water content in accordance with Test Method D 2216.

10.5 Following compaction of the last specimen, compare the wet unit weights to ensure that a desired pattern of obtaining data on each side of the optimum water content will be attained for the dry unit weight compaction curve. Plotting the wet unit weight and water content of each compacted specimen can be an aid in making the above evaluation. If the desired pattern is not obtained, additional compacted specimens will be required. Generally, one water content value wet of the water content defining the maximum wet unit weight is sufficient to ensure data on the wet side of optimum water content for the maximum dry unit weight.

11. Calculation

11.1 Calculate the dry unit weight and water content of each compacted specimen as explained in 11.3 and 11.4. Plot the values and draw the compaction curve as a smooth curve through the points (see example, Fig. 3). Plot dry unit weight to the nearest 0.1 lbf/ft^3 (0.2 kN/m^3) and water content to the nearest 0.1 %. From the compaction curve, determine the optimum water content and maximum dry unit weight. If more than 5 % by weight of oversize material was removed from the sample, calculate the corrected optimum water content and maximum dry unit weight of the total material using Practice D 4718. This correction may be made to the appropriate field in place density test specimen rather than to the laboratory test specimen.

11.2 Plot the 100 % saturation curve. Values of water content for the condition of 100 % saturation can be calculated as explained in 11.5 (see example, Fig. 3).

NOTE 8—The 100 % saturation curve is an aid in drawing the compaction curve. For soils containing more than approximately 10 % fines at water contents well above optimum, the two curves generally become roughly parallel with the wet side of the compaction curve between 92 % to 95 % saturation. Theoretically, the compaction curve cannot plot to the right of the 100 % saturation curve. If it does, there is an error in specific gravity, in measurements, in calculations, in test procedures, or in plotting.

NOTE 9—The 100 % saturation curve is sometimes referred to as the zero air voids curve or the complete saturation curve.

11.3 *Water Content, w*—Calculate in accordance with Test Method D 2216.

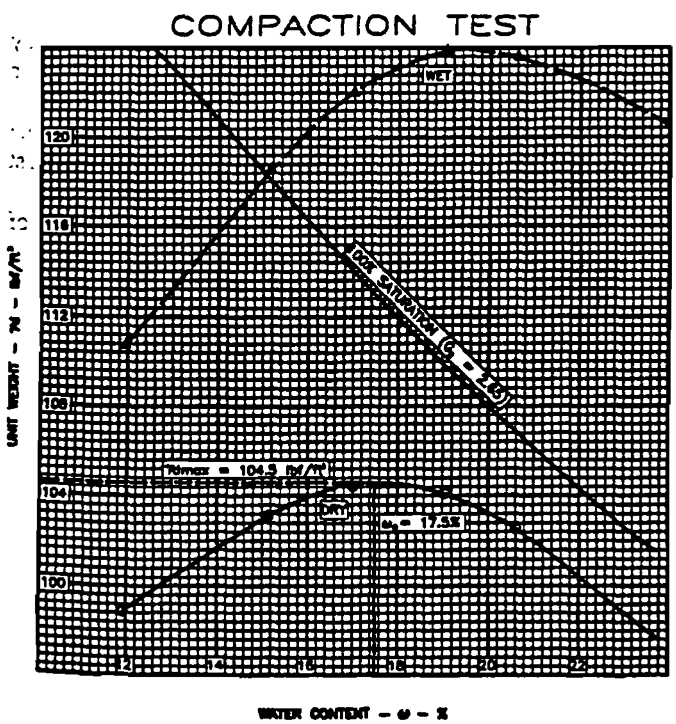

FIG. 3 Example Compaction Curve Plotting

11.4 *Dry Unit Weights*—Calculate the moist density (Eq 1), the dry density (Eq 2), and then the dry unit weight (Eq 3) as follows:

$$\rho_m = \frac{(M_t - M_{md})}{1000\,V}$$

where:

ρ_m = moist density of compacted specimen, Mg/m^3,
M_t = mass of moist specimen and mold, kg,
M_{md} = mass of compaction mold, kg, and
V = volume of compaction mold, m^3(see Annex A1)

$$\rho_d = \rho_m/(1 + w/100) \quad (2)$$

where:

ρ_d = dry density of compacted specimen, Mg/m^3, and
w = water content,% .

$$\gamma_d = 62.43\ \rho_d \text{ in lbf/ft}^3 \quad (3)$$

or

$$\gamma_d = 9.807\ \rho_d \text{ in kN/m}^3 \quad (4)$$

where:

γ_d = dry unit weight of compacted specimen.

11.5 To calculate points for plotting the 100 % saturation curve or zero air voids curve select values of dry unit weight, calculate corresponding values of water content corresponding to the condition of 100 % saturation as follows:

$$w_{sat} \frac{(\gamma_w)(G_s) - \gamma_d}{(\gamma_d)(G_s)} \times 100 \quad (5)$$

where:

w_{sat} = water content for complete saturation, %,
γ_w = unit weight of water, 62.43 lbf/ft^3 (9.807 kn/m^3),
γ_d = dry unit weight of soil, and
G_s = specific gravity of soil.

NOTE 10—Specific gravity may be estimated for the test specimen on the basis of test data from other samples of the same soil classification and source. Otherwise, a specific gravity test (Test Method C 127, Test Method D 854, or both) is necessary.

12. Report

12.1 The report shall contain the following information:

12.1.1 Procedure used (A, B, or C).

12.1.2 Preparation method used (moist or dry).

12.1.3 As received water content if determined.

12.1.4 Standard optimum water content, to the nearest 0.5 %.

12.1.5 Standard maximum dry unit weight, to the nearest 0.5 lbf/ft^3.

12.1.6 Description of rammer (manual or mechanical).

12.1.7 Soil sieve data when applicable for determination of procedure (A, B, or C) used.

12.1.8 Description of material used in test, by Practice D 2488, or classification by Test Method D 2487.

12.1.9 Specific gravity and method of determination.

12.1.10 Origin of material used in test, for example, pro location, depth, and the like.

12.1.11 Compaction curve plot showing compaction points used to establish compaction curve, and 100 % saturation curve, point of maximum dry unit weight and optimum water content.

12.1.12 Oversize correction data if used, including the oversize fraction (coarse fraction), P_c in %.

13. Precision and Bias

13.1 *Precision*—Data are being evaluated to determine the precision of this test method. In addition, pertinent data is being solicited from users of the test method.

13.2 *Bias*—It is not possible to obtain information on bias because there is no other method of determining the values of standard maximum dry unit weight and optimum water content.

14. Keywords

14.1 NT—impact compaction using standard effort; RT—density; RT—moisture-density curves; RT—proctor test; UF—compaction characteristics; UF—soil compaction; USE—laboratory tests

ANNEX

(Mandatory Information)

A1. VOLUME OF COMPACTION MOLD

A1.1 Scope

A1.1.1 This annex describes the procedure for determining the volume of a compaction mold.

A1.1.2 The volume is determined by a water-filled method and checked by a linear-measurement method.

A1.2 Apparatus

A1.2.1 In addition to the apparatus listed in Section 6 the following items are required:

A1.2.1.1 *Vernier or Dial Caliper*—having a measuring range of at least 0 to 6 in. (0 to 150 mm) and readable to at least 0.001 in. (0.02 mm).

A1.2.1.2 *Inside Micrometer*—having a measuring range of at least 2 to 12 in. (50 to 300 mm) and readable to at least 0.001 in. (0.02 mm).

A1.2.1.3 *Plastic or Glass Plates*—Two plastic or glass plates approximately 8 in. square by ¼ in. thick (200 by 200 mm by 6 mm).

A1.2.1.4 *Thermometer*—0 to 50°C range, 0.5°C graduations, conforming to the requirements of Specification E 1.

A1.2.1.5 *Stopcock grease* or similar sealant.

A1.2.1.6 *Miscellaneous equipment*—Bulb syringe, towels, etc.

A1.3 Precautions

A1.3.1 Perform this procedure in an area isolated from drafts or extreme temperature fluctuations.

A1.4 Procedure

A1.4.1 *Water-Filling Method*:

A1.4.1.1 Lightly grease the bottom of the compaction mold and place it on one of the plastic or glass plates. Lightly grease the top of the mold. Be careful not to get grease on the inside of the mold. If it is necessary to use the base plate, as noted in 10.4.7, place the greased mold onto the base plate and secure with the locking studs.

A1.4.1.2 Determine the mass of the greased mold and both plastic or glass plates to the nearest 0.01-lbm (1-g) and record. When the base plate is being used in lieu of the bottom plastic or glass plate determine the mass of the mold, base plate and a single plastic or glass plate to be used on top of the mold to the nearest 0.01-lbm (1-g) and record.

A1.4.1.3 Place the mold and the bottom plastic or glass plate on a firm, level surface and fill the mold with water to slightly above its rim.

A1.4.1.4 Slide the second plate over the top surface of the mold so that the mold remains completely filled with water and air bubbles are not entrapped. Add or remove water as necessary with a bulb syringe.

A1.4.1.5 Completely dry any excess water from the outside of the mold and plates.

A1.4.1.6 Determine the mass of the mold, plates and water and record to the nearest 0.01-lbm (1-g).

A1.4.1.7 Determine the temperature of the water in the mold to the nearest 1°C and record. Determine and record the absolute density of water from Table A1.1.

A1.4.1.8 Calculate the mass of water in the mold by subtracting the mass determined in A1.4.1.2 from the mass determined in A1.4.1.6.

A1.4.1.9 Calculate the volume of water by dividing the mass of water by the density of water and record to the nearest 0.0001 ft^3 (1 cm^3).

A1.4.1.10 When the base plate is used for the calibration of the mold volume repeat A1.4.1.3-A1.4.1.9.

A1.4.2 *Linear Measurement Method*:

A1.4.2.1 Using either the vernier caliper or the inside micrometer, measure the diameter of the mold 6 times at the

TABLE A1.1 Density of Water[A]

Temperature, °C (°F)	Density of Water, g/ml
18 (64.4)	0.99862
19 (66.2)	0.99843
20 (68.0)	0.99823
21 (69.8)	0.99802
22 (71.6)	0.99779
23 (73.4)	0.99756
24 (75.2)	0.99733
25 (77.0)	0.99707
26 (78.8)	0.99681

[A]Values other than shown may be obtained by referring to the Handbook of Chemistry and Physics, Chemical Rubber Publishing Co., Cleveland, Ohio.

top of the mold and 6 times at the bottom of the mold, spacing each of the six top and bottom measurements equally around the circumference of the mold. Record the values to the nearest 0.001-in. (0.02-mm).

A1.4.2.2 Using the vernier caliper, measure the inside height of the mold by making three measurements equally spaced around the circumference of the mold. Record values to the nearest 0.001-in. (0.02-mm).

A1.4.2.3 Calculate the average top diameter, average bottom diameter and average height.

A1.4.2.4 Calculate the volume of the mold and record to the nearest 0.0001 ft^3 (1 cm^3) as follows:

$$V = \frac{(\pi)(h)(d_t + d_b)^2}{(16)(1728)} \text{ (inch-pound)} \quad (A1.1)$$

$$V = \frac{(\pi)(h)(d_t + d_b)^2}{(16)(10^3)} (SI) \quad (A1.2)$$

where:

V = volume of mold, ft^3 (cm^3),
h = average height, in. (mm),
d_t = average top diameter, in. (mm),
d_b = average bottom diameter, in. (mm),
$1/1728$ = constant to convert in^3 to ft^3, and
$1/10^3$ = constant to convert mm^3 to cm^3.

A1.5 Comparison of Results

A1.5.1 The volume obtained by either method should be within the volume tolerance requirements of 6.1.1 and 6.1.2.

A1.5.2 The difference between the two methods should not exceed 0.5 % of the nominal volume of the mold.

A1.5.3 Repeat the determination of volume if these criteria are not met.

A1.5.4 Failure to obtain satisfactory agreement between the two methods, even after several trials, is an indication that the mold is badly deformed and should be replaced.

A1.5.5 Use the volume of the mold determined using the water-filling method as the assigned volume value for calculating the moist and dry density (see 11.4).

Standard Test Method for CBR (California Bearing Ratio) of Laboratory-Compacted Soils[1]

This standard is issued under the fixed designation D 1883; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope *

1.1 This test method covers the determination of the CBR (California Bearing Ratio) of pavement subgrade, subbase, and base/course materials from laboratory compacted specimens. The test method is primarily intended for but not limited to, evaluating the strength of cohesive materials having maximum particle sizes less than ¾ in. (19 mm).

NOTE 1—The agency performing this test can be evaluated in accordance with Practice D 3740.

Not withstanding statements on precision and bias contained in this Standard: The precision of this test method is dependent on the competence of the personnel performing it and the suitability of the equipment and facilities used. Agencies which meet the criteria of Practice D 3740 are generally considered capable of competent and objective testing. Users of this method are cautioned that compliance with Practice D 3740 does not in itself assure reliable testing. Reliable testing depends on many factors; Practice D 3740 provides a means of evaluating some of those factors.

1.2 When materials having maximum particle sizes greater than ¾ in. (19 mm) are to be tested, this test method provides for modifying the gradation of the material so that the material used for tests all passes the ¾-in. sieve while the total gravel (+No. 4 to 3 in.) fraction remains the same. While traditionally this method of specimen preparation has been used to avoid the error inherent in testing materials containing large particles in the CBR test apparatus, the modified material may have significantly different strength properties than the original material. However, a large experience base has developed using this test method for materials for which the gradation has been modified, and satisfactory design methods are in use based on the results of tests using this procedure.

1.3 Past practice has shown that CBR results for those materials having substantial percentages of particles retained on the No. 4 sieve are more variable than for finer materials. Consequently, more trials may be required for these materials to establish a reliable CBR.

1.4 This test method provides for the determination of the CBR of a material at optimum water content or a range of water content from a specified compaction test and a specified dry unit weight. The dry unit weight is usually given as a percentage of maximum dry unit weight from the compaction tests of Test Methods D 698 or D 1557.

1.5 The agency requesting the test shall specify the water content or range of water content and the dry unit weight for which the CBR is desired.

1.6 Unless specified otherwise by the requesting agency, or unless it has been shown to have no effect on test results for the material being tested, all specimens shall be soaked prior to penetration.

1.7 For the determination of CBR of field compacted materials, see Test Method D 4429.

1.8 The values stated in inch-pound units are to be regarded as the standard. The SI equivalents shown in parentheses may be approximate.

1.9 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 422 Test Method for Particle-Size Analysis of Soils[2]

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 698 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))[2]

D 1557 Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3))[2]

D 2168 Test Methods for Calibration of Laboratory Mechanical-Rammer Soil Compactors[2]

D 2216 Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock[2]

D 2487 Classification of Soils for Engineering Purposes (Unified Soil Classification System)[2]

D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)[2]

[1] This test method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.08 on Special and Construction Control Tests.

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[2] *Annual Book of ASTM Standards*, Vol 04.08.

*A Summary of Changes section appears at the end of this standard.

D 3740 Practice for Minimum Requirements of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction[2]

D 4318 Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils[2]

D 4429 Test Method for CBR (California Bearing Ratios) of Soils in Place[2]

3. Summary of Test Method

3.1 For tests performed on materials compacted to one water content, three specimens are prepared. The specimens are compacted using three different compactive efforts to obtain unit weights both above and below the desired unit weight. After allowing specimens to take on water by soaking, or other specified treatment such as curing, each specimen is subjected to penetration by a cylindrical rod. Results of stress (load) versus penetration depth are plotted to determine the CBR for each specimen. The CBR at the specified density is determined from a graph of CBR versus dry unit weight.

3.2 For tests in which the result is to be determined for a water content range, a series of specimens at each of three compactive efforts are prepared over the range of water content of interest. The compactive efforts are chosen to produce unit weights above and below the desired unit weight. After allowing the specimens to take on water by soaking, or other specified treatment such as curing, each specimen is penetrated. Results are plotted to obtain the CBR for each specimen. A plot of CBR versus unit weight for each water content is made to determine the minimum CBR for the water content range of interest.

4. Significance and Use

4.1 This test method is used to evaluate the potential strength of subgrade, subbase, and base course material, including recycled materials for use in road and airfield pavements. The CBR value obtained in this test forms an integral part of several flexible pavement design methods.

4.2 For applications where the effect of compaction water content on CBR is small, such as cohesionless, coarse-grained materials, or where an allowance is made for the effect of differing compaction water contents in the design procedure, the CBR may be determined at the optimum water content of a specified compaction effort. The dry unit weight specified is normally the minimum percent compaction allowed by the using agency's field compaction specification.

4.3 For applications where the effect of compaction water content on CBR is unknown or where it is desired to account for its effect, the CBR is determined for a range of water content, usually the range of water content permitted for field compaction by using agency's field compaction specification.

4.4 The criteria for test specimen preparation of self cementing (and other) materials which gain strength with time must be based on a geotechnical engineering evaluation. As directed by the engineer, self cementing materials shall be properly cured until bearing ratios representing long term service conditions can be measured.

5. Apparatus

5.1 *Loading Machine*—The loading machine shall be equipped with a movable head or base that travels at a uniform (not pulsating) rate of 0.05 in. (1.27 mm)/min for use in forcing the penetration piston into the specimen. The machine shall be equipped with a load-indicating device that can be read to 10 lbf (44 N) or less. The minimum capacity of the loading machine shall be based on the requirements indicated in Table 1.

5.2 *Mold*—The mold shall be a rigid metal cylinder with an inside diameter of 6 ± 0.026 in. (152.4 ± 0.66 mm) and a height of 7 ± 0.018 in. (177.8 ± 0.46 mm). It shall be provided with a metal extension collar at least 2.0 in. (50.8 mm) in height and a metal base plate having at least twenty eight 1⁄16-in. (1.59-mm) diameter holes uniformly spaced over the plate within the inside circumference of the mold. When assembled with spacer disc in place in the bottom of the mold, the mold shall have an internal volume (excluding extension collar) of 0.075 ± 0.0009 ft (2124 ± 25 cm). Fig. 1 shows a satisfactory mold design. A calibration procedure should be used to confirm the actual volume of the mold with the spacer disk inserted. Suitable calibrations are contained in Test Methods D 698 and D 1557.

5.3 *Spacer Disk*—A circular metal spacer disc (see Fig. 1) having a minimum outside diameter of 5^15⁄16 in. (150.8 mm) but no greater than will allow the spacer to easily slip into the mold. The spacer disc shall be 2.416± 0.005 in. (61.37 ± 0.127 mm) in height.

5.4 *Rammer*—A rammer as specified in either Test Methods D 698 or D 1557 except that if a mechanical rammer is used it must be equipped with a circular foot, and when so equipped, must provide a means for distributing the rammer blows uniformly over the surface of the soil when compacting in a 6-in. (152.4-mm) diameter mold. The mechanical rammer must be calibrated and adjusted in accordance with Test Methods D 2168.

5.5 *Expansion-Measuring Apparatus*— An adjustable metal stem and perforated metal plate, similar in configuration to that shown in Fig. 1. The perforated plate shall be 5⅞ to 5^15⁄16 in. (149.23 to 150.81 mm) in diameter and have at least forty-two 1⁄16-in. (1.59-mm) diameter holes uniformly spaced over the plate. A metal tripod to support the dial gage for measuring the amount of swell during soaking is also required.

5.6 *Weights*—One or two annular metal weights having a total mass of 4.54 ± 0.02 kg and slotted metal weights each having masses of 2.27 ± 0.02 kg. The annular weight shall be 5⅞ to 5^15⁄16 in. (149.23 to 150.81 mm) in diameter and shall have a center hole of approximately 2⅛in. (53.98 mm).

5.7 *Penetration Piston*—A metal piston 1.954 ± 0.005 in. (49.63 ± 0.13 mm) in diameter and not less than 4 in. (101.6 mm) long (see Fig. 1). If, from an operational standpoint, it is advantageous to use a piston of greater length, the longer piston may be used.

5.8 *Gages*—Two dial gages reading to 0.001 in. (0.025 mm

TABLE 1 Minimum Load Capacity

Maximum Measurable CBR	Minimum Load Capacity (lbf)	(kN)
20	2500	11.2
50	5000	22.3
>50	10 000	44.5

TABLE 2 Metric Equivalents

Inch-Pound Units, in.	Metric Equivalent, mm	Inch-Pound Units, in.	Metric Equivalent, mm	Inch-Pound Units, in.	Metric Equivalent, mm
0.003	0.076	19/32	15.08	3 1/2	88.90
0.005	0.127	5/8	15.88	3 3/4	95.25
0.135	3.43	3/4	19.10	4 1/4	108.0
0.201	5.11	15/16	23.81	4 1/2	114.3
0.4375	11.11	1	25.40	4 3/4	120.7
0.4378	11.12	1 1/8	28.58	5 7/8	149.2
0.510	12.95	1 1/4	31.8	5 15/16	150.8
0.633	16.08	1 3/8	34.9	6	152.0
1.370	34.60	1 1/2	38.10	6 7/32	158.0
1.375	34.93	1 3/4	44.5	6 1/2	165.1
1.954	49.63	1 13/16	46.04	7	177.8
2.416	61.37	1 15/16	49.21	7 1/2	190.1
1/16	1.59	2	50.80	8 3/8	212.7
7/32	5.56	2 1/8	53.98	8 1/2	215.9
1/4	6.35	2 1/8	55.9	9 3/8	238.1
3/8	9.53	2 1/4	57.2	14 1/4	362.0
7/16	11.11	2 1/2	63.50	18	457.2
15/32	11.91	2 3/4	69.85	32 1/4	719.2
1/2	12.70	2 31/32	75.41	36 5/8	930.3
17/32	13.49	3	76.20	39	990.6

Inch-Pound Units, lb	Metric Equivalent, kg	Inch-Pound Units, psi	Metric Equivalent, MPa
0.04	0.02	200	1.4
0.05	0.02	400	2.8
0.12	0.05	600	4.1
0.59	0.27	800	5.5
0.71	0.32	1000	6.9
0.75	0.34	1200	8.3
3.20	1.45	1400	9.7
5.00	2.27		
10.00	4.54		

with a range of 0.200 minimum.

5.9 *Miscellaneous Apparatus*—Other general apparatus such as a mixing bowl, straightedge, scales, soaking tank or pan, oven, fast filtering high wet strength filter paper, dishes, and 2-in., 3/4-in. and No. 4 sieves.

6. Sample

6.1 The sample shall be handled and specimen(s) for compaction shall be prepared in accordance with the procedures given in Test Methods D 698 or D 1557 for compaction in a 6-in. (152.4-mm) mold except as follows:

6.1.1 If all material passes a 3/4-in. (19-mm) sieve, the entire gradation shall be used for preparing specimens for compaction without modification. If there is material retained on the 3/4-in. (19-mm) sieve, the material retained on the 3/4-in. (19-mm) sieve shall be removed and replaced by an equal amount of material passing the 3/4-in. (19-mm) sieve and retained on the No. 4 sieve obtained by separation from portions of the sample not otherwise used for testing.

7. Test Specimens

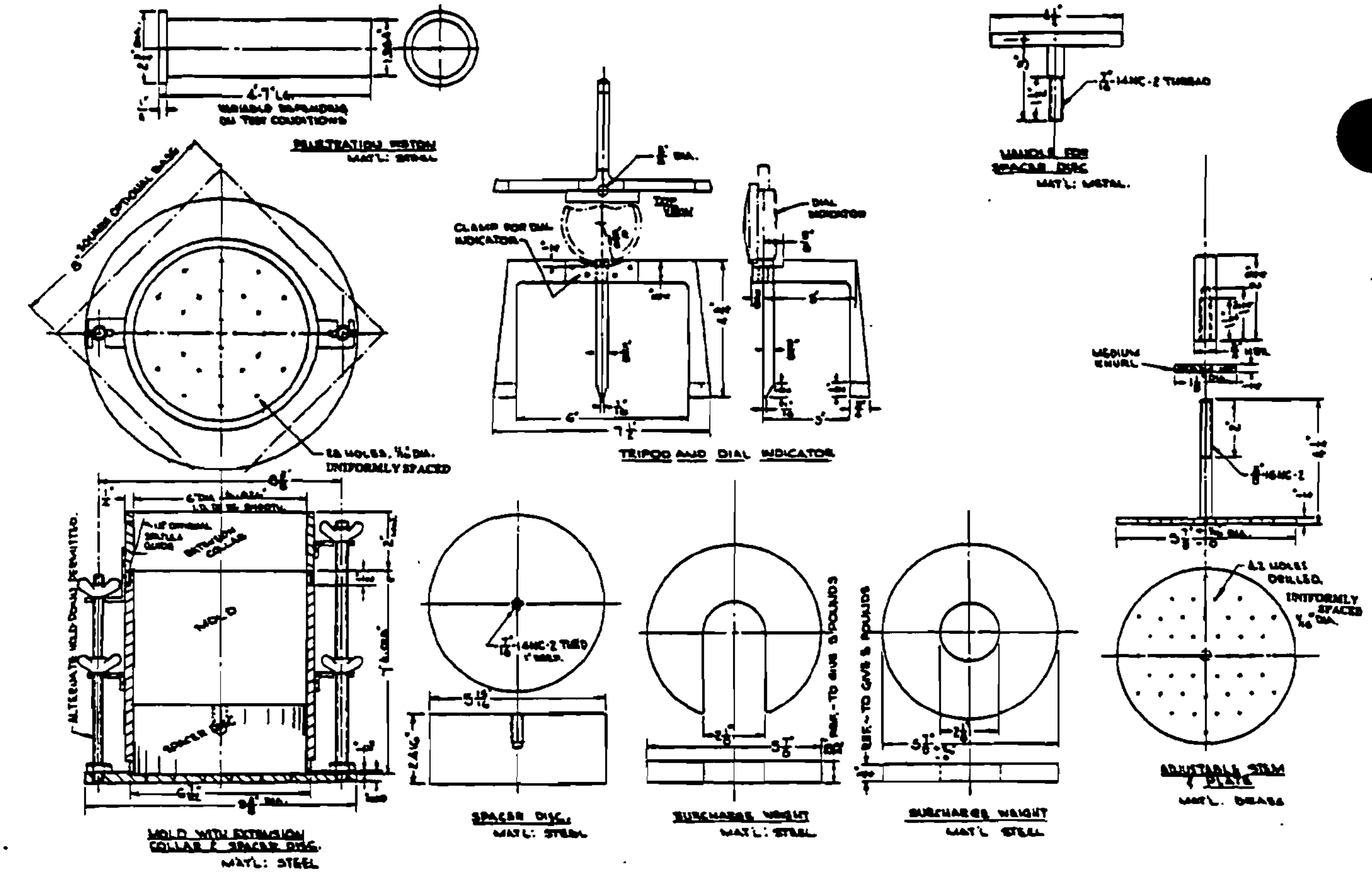
7.1 *Bearing Ratio at Optimum Water Content Only*—Using material prepared as described in 6.1, conduct a control compaction test with a sufficient number of test specimens to definitely establish the optimum water content for the soil using the compaction method specified, either Test Methods D 698 or D 1557. A previously performed compaction test on the same material may be substituted for the compaction test just described, provided that if the sample contains material retained on the 3/4-in. (19-mm) sieve, soil prepared as described in 6.1 is used (Note 1).

NOTE 2—Maximum dry unit weight obtained from a compaction test performed in a 4-in. (101.6-mm) diameter mold may be slightly greater than the maximum dry unit weight obtained from compaction in the 6-in. (152.4-mm) compaction mold or CBR mold.

7.1.1 For cases where the CBR is desired at 100 % maximum dry unit weight and optimum water content, compact a specimen using the specified compaction procedure, either Test Methods D 698 or D 1557, from soil prepared to within ±0.5 percentage point of optimum water content in accordance with Test Method D 2216.

NOTE 3—Where the maximum dry unit weight was determined from compaction in the 4-in. (101.6-mm) mold, it may be necessary to compact specimens as described in 7.1.2, using 75 blows per layer or some other value sufficient to produce a specimen having a density equal to or greater than that required.

7.1.2 Where the CBR is desired at optimum water content and some percentage of maximum dry unit weight, compact three specimens from soil prepared to within ±0.5 percentage point of optimum water content and using the specified compaction but using a different number of blows per layer for each specimen. The number of blows per layer shall be varied as necessary to prepare specimens having unit weights above and below the desired value. Typically, if the CBR for soil at 95 % of maximum dry unit is desired, specimens compacted using 56, 25, and 10 blows per layer is satisfactory. Penetration shall be performed on each of these specimens.



NOTE 1—See Table 2 for metric equivalents.

FIG. 1 Bearing Ratio Test Apparatus

7.2 *Bearing Ratio for a Range of Water Content*—Prepare specimens in a manner similar to that described in 7.1 except that each specimen used to develop the compaction curve shall be penetrated. In addition, the complete water content-unit weight relation for the 25-blow and 10-blow per layer compactions shall be developed and each test specimen compacted shall be penetrated. Perform all compaction in the CBR mold. In cases where the specified unit weight is at or near 100 % maximum dry unit weight, it will be necessary to include a compactive effort greater than 56-blows per layer (Note 3).

NOTE 4—A semilog log plot of dry unit weight versus compactive effort usually gives a straight line relation when compactive effort in ft-lb/ft^3 is plotted on the log scale. This type of plot is useful in establishing the compactive effort and number of blows per layer needed to bracket the specified dry unit weight and water content range.

7.2.1 If the sample is to be soaked, take a representative sample of the material, for the determination of moisture, at the beginning of compaction and another sample of the remaining material after compaction. Use Test Method D 2216 to determine the moisture content. If the sample is not to be soaked, take a moisture content sample in accordance with Test Methods D 698 or D 1557 if the average moisture content is desired.

7.2.2 Clamp the mold (with extension collar attached) to the base plate with the hole for the extraction handle facing down. Insert the spacer disk over the base plate and place a disk of filter paper on top of the spacer disk. Compact the soil-water mixture into the mold in accordance with 7.1, 7.1.1, or 7.1.2.

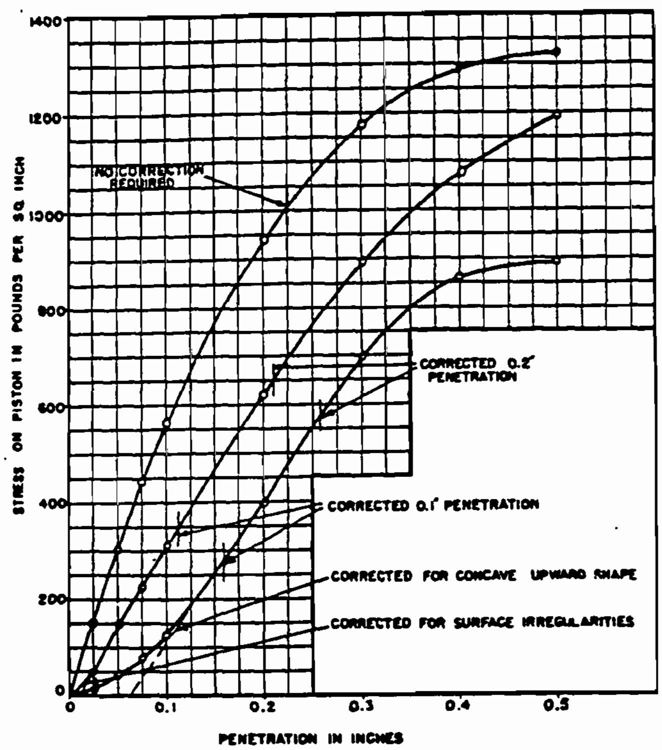
7.2.3 Remove the extension collar and carefully trim the compacted soil even with the top of the mold by means of a straightedge. Patch with smaller size material any holes that may have developed in the surface by the removal of coarse material. Remove the perforated base plate and spacer disk, weigh, and record the mass of the mold plus compacted soil. Place a disk of coarse filter paper on the perforated base plate, invert the mold and compacted soil, and clamp the perforated base plate to the mold with compacted soil in contact with the filter paper.

7.2.4 Place the surcharge weights on the perforated plate and adjustable stem assembly and carefully lower onto the compacted soil specimen in the mold. Apply a surcharge equal to the weight of the base material and pavement within 2.27 kg (5 lb), but in no case shall the total weight used be less than 4.54 kg (10 lb). If no pavement weight is specified, use 4.54 kg. Immerse the mold and weights in water allowing free access of water to the top and bottom of the specimen. Take initial measurements for swell and allow the specimen to soak for 96 h. Maintain a constant water level during this period. A shorter immersion period is permissible for fine grained soils or granular soils that take up moisture readily, if tests show the shorter period does not affect the results. At the end of 96 h, take final swell measurements and calculate the swell as a percentage of the initial height of the specimen.

7.2.5 Remove the free water and allow the specimen to drain downward for 15 min. Take care not to disturb the surface of the specimen during the removal of the water. It may be necessary to tilt the specimen in order to remove the surface water. Remove the weights, perforated plate, and filter paper, and determine and record the mass.

8. Procedure for Bearing Test

8.1 Place a surcharge of weights on the specimen sufficient to produce an intensity of loading equal to the weight of the base material. If no pavement weight is specified, use 4.54 kg mass. If the specimen has been soaked previously, the surcharge shall be equal to that used during the soaking period. To prevent upheaval of soil into the hole of the surcharge weights, place the 2.27 kg annular weight on the soil surface prior to seating the penetration piston, after which place the remainder of the surcharge weights.



NOTE 1—See Table 2 for metric equivalents.

FIG. 2 Correction of Load-Penetration Curves

8.2 Seat the penetration piston with the smallest possible load, but in no case in excess of 10 lbf (44 N). Set both the stress and penetration gages to zero. This initial load is required to ensure satisfactory seating of the piston and shall be considered as the zero load when determining the load penetration relation. Anchor the strain gage to the load measuring device, if possible; in no case attach it to the testing machines support bars (legs).

NOTE 5—At high loads the supports may torque and affect the reading of the penetration gage. Checking the depth of piston penetration is one means of checking for erroneous strain indications.

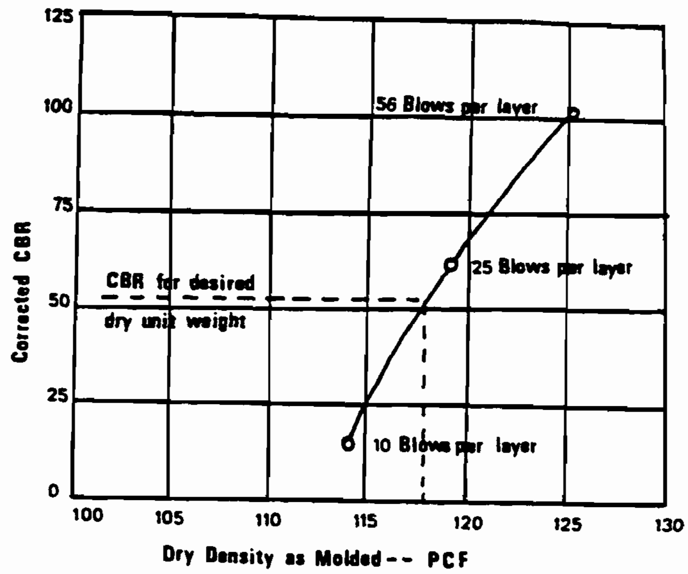


FIG. 3 Dry Density Versus CBR

8.3 Apply the load on the penetration piston so that the rate of penetration is approximately 0.05 in. (1.27 mm)/min. Record the load readings at penetrations of 0.025 in. (0.64 mm), 0.050 in. (1.27 mm), 0.075 in. (1.91 mm), 0.100 in. (2.54 mm), 0.125 in. (3.18 mm), 0.150 in. (3.81 mm), 0.175 in. (4.45 mm), 0.200 in. (5.08 mm), 0.300 in. (7.62 mm), 0.400 in. (10.16 mm) and 0.500 in. (12.70 mm). Note the maximum load and penetration if it occurs for a penetration of less than 0.500 in. (12.70 mm). With manually operated loading devices, it may be necessary to take load readings at closer intervals to control the rate of penetration. Measure the depth of piston penetration into the soil by putting a ruler into the indentation and measuring the difference from the top of the soil to the bottom of the indentation. If the depth does not closely match the depth of penetration gage, determine the cause and test a new sample.

8.4 Remove the soil from the mold and determine the moisture content of the top 1-in. (25.4-mm) layer. Take a moisture content sample in accordance with Test Methods D 698 or D 1557 if the average moisture content is desired. Each moisture content sample shall weigh not less than 100 g for fine-grained soils nor less than 500 g for granular soils.

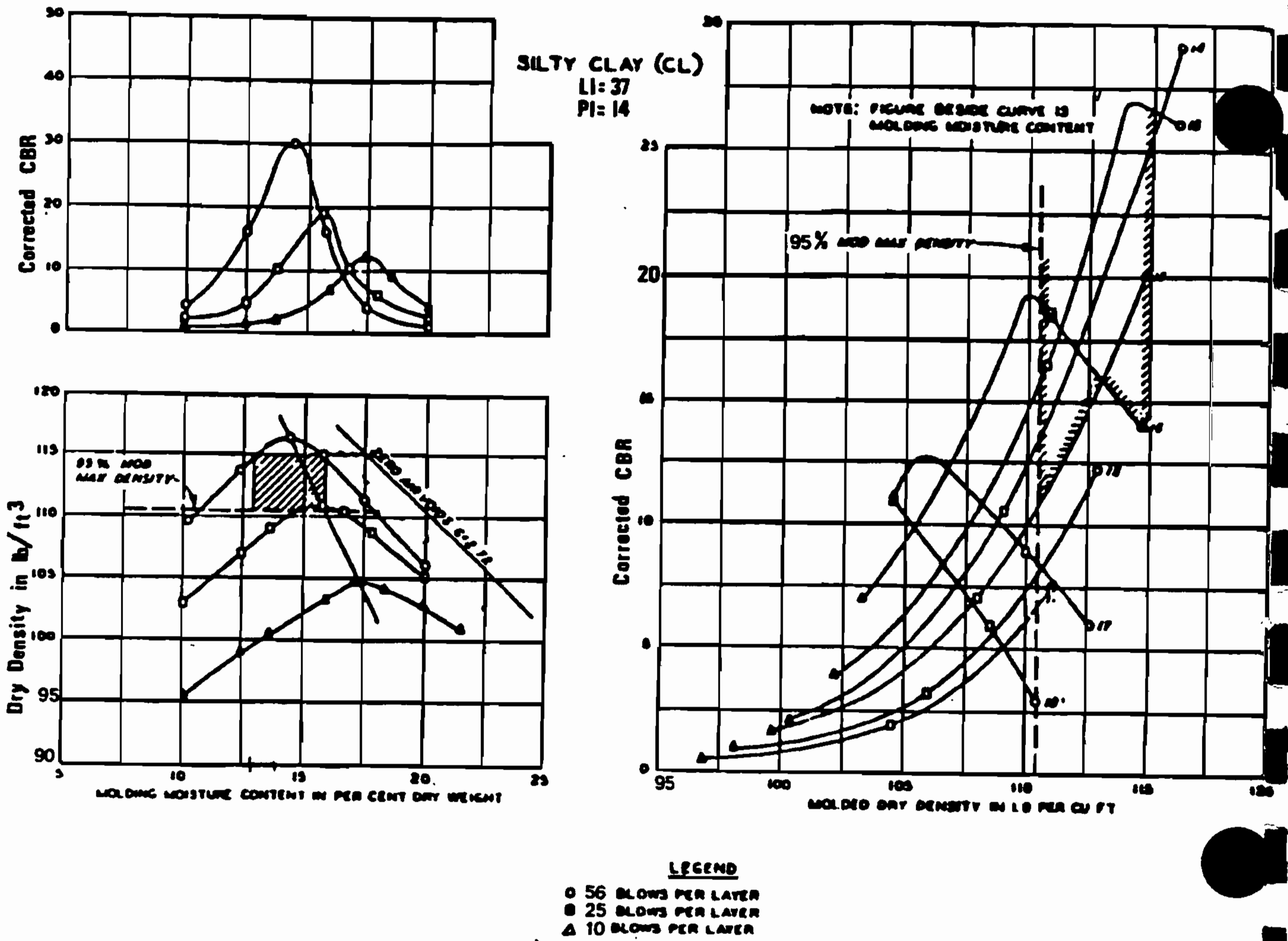
NOTE 6—The load readings at penetrations of over 0.300 in. (7.6 mm) may be omitted if the testing machine's capacity has been reached.

9. Calculation

9.1 *Load-Penetration Curve*—Calculate the penetration stress in pounds per square inch or megapascals and plot the stress-penetration curve. In some instances, the stresspenetration curve may be concave upward initially, because of surface irregularities or other causes, and in such cases the zero point shall be adjusted as shown in Fig. 2.

NOTE 7—Fig. 2 should be used as an example of correction of load-penetration curves only. It is not meant to imply that the 0.2-in. penetration is always more than the 0.1-in. penetration.

9.2 *Bearing Ratio*—Using corrected stress values taken from the stress penetration curve for 0.100 in. (2.54 mm) and



NOTE 1—Surcharge = 50 lb soaking and penetration. All samples soaked top and bottom four days. All samples compacted in 5 layers, 10-lb hammer, 18-in. drop in CBR mold.

FIG. 4 Determining CBR for Water Content Range and Minimum Dry Unit Weight

0.200 in. (5.08 mm) penetrations, calculate the bearing ratios for each by dividing the corrected stresses by the standard stresses of 1000 psi (6.9 MPa) and 1500 psi (10.3 MPa) respectively, and multiplying by 100. Also, calculate the bearing ratios for the maximum stress, if the penetration is less than 0.200 in. (5.08 mm) interpolating the standard stress. The bearing ratio reported for the soil is normally the one at 0.100 in. (2.54 mm) penetration. When the ratio at 0.200 in. (5.08 mm) penetration is greater, rerun the test. If the check test gives a similar result, use the bearing ratio at 0.200 in. (5.08 mm) penetration.

NOTE 8—If bearing ratio values at penetrations of 0.300 (7.62 mm), 0.400 (10.16 mm) and 0.500 in. (12.7 mm) are desired, the corrected stress values of these penetrations should be divided by the standard stresses of 1900 psi (13.1 MPa), 2300 psi (15.9 MPa), 2600 psi (17.9 MPa), respectively, and multiplied by 100.

9.3 *Design CBR for One Water Content Only*—Using the data obtained from the three specimens, plot the CBR versus molded dry unit weight relation as illustrated in Fig. 3. Determine the design CBR at the percentage of the maximum dry unit weight requested.

9.4 *Design CBR for Water Content Range*— Plot the data from the tests at the three compactive efforts as shown in Fig. 4. The data plotted as shown represents the response of the CBR over the range of water content specified. Select the CBR for reporting as the lowest CBR within the specified water content range having a dry unit weight between the specified minimum and the dry unit weight produced by compaction within the water content range.

10. Report

10.1 The report shall include the following:

10.1.1 Method used for preparation and compaction of specimen: Test Methods D 698 or D 1557, or other, with description.

10.1.2 Condition of sample (unsoaked or soaked).

10.1.3 Dry density (unit weight) of sample before soaking, kg/m³ (lb/ft³).

10.1.4 Dry density (unit weight) of sample after soaking, kg/m³ (lb/ft³).

10.1.5 Moisture content of sample in percent:

10.1.5.1 Before compaction.

10.1.5.2 After compaction.

10.1.5.3 Top 1-in (25.4-mm) layer after soaking.

10.1.5.4 Average after soaking.

10.1.6 Swell (percentage of initial height).

10.1.7 Bearing ratio of sample (unsoaked or soaked), percent.

10.1.8 Surcharge amount.

10.1.9 Any special sample preparation and testing procedures (for example: for self cementing materials).

10.1.10 Sample identification (location, boring number, etc.).

10.1.11 Any pertinent testing done to identify the sample such as: soil classifications per Test Method D 2487, visual classification per Practice D 2488, Atterberg limits per Test Method D 4318, gradation per Method D 422 etc.

10.1.12 The percent material retained on the ln[]-in. (19-mm) sieve for those cases where scalping and replacement is used.

11. Precision and Bias

11.1 No available methods provide absolute values for the soil bearing strength derived by this test method; therefore, there is no meaningful way to obtain an evaluation of bias.

11.2 At present, sufficient data for determining the precision of this test method has not been gathered. Users are encouraged to submit data to the subcommittee for inclusion in the statement. One user, based on seven repetitions, has developed a IS % of 8.2 % (compacted per Test Method D 698) and 5.9 % (compacted per Test Method D 1557). See Appendix X1 for the data used.

12. Keywords

12.1 This standard is indexed under the following terms:

California Bearing Ratio	Used For, Narrower Term
Pavement Subgrade	Used For, Narrower Term
Subgrade	Related Term, Broader Term
Pavement Subbase	Used For, Narrower Term
Subbase	Used For, Broader Term
Pavement Base Course	Used For, Narrower Term
Base Course	Used For, Broader Term
Strength of Soil	Used For
Pavement Design	Used For, Narrower Term
Acceptance Tests	Used For
Bearing Capacity	Used For
Materials Evaluations	Used For
Bearing Ratio	Used For, Broader Term
Load Penetration Curve	Used For
Design	Used For, Broader Term
Earthfill	Related To
Cohesive Soils	Used For
Compressive Strength	Used For
Flexible Pavements	Used For
Foundation Investigations	Used For
Soil Tests	Used For

APPENDIX

(Nonmandatory Information)

X1. Compactive Effort

STANDARD (D698) CBR

(x)	(x-x)	$(x-x)^2$
16.7	.5	.25
15.7	1.5	2.25
18.2	1.0	1
18.2	1.0	1
18.8	1.6	2.56
19.3	2.1	4.41
17.9	0.7	.49

Σx = 124.8 $\Sigma(x-x)^2$ 11.96

x̄ = 17.2

$$S = \frac{11.96}{6}$$

IS (one sigma) = 1.41

$$IS\ \% = \frac{1.41}{17.2} \times 100 = 8.2\%$$

D2S % = 22.6%

MODIFIED (D1557) CBR

(x)	(x-x)	$(x-x)^2$
77.0	3	9
70.2	3.8	14.44
80.8	6.8	46.24
68.2	5.8	33.64
76.7	2.7	7.29
71.7	2.3	5.29
73.3	0.7	.49

Σx = 517.9 $\Sigma(x-x)^2$ 116.39

x̄ = 74.0

$$S = \frac{116.39}{6} = 19.39$$

IS = 4.4

$$IS\ \% = \frac{4.4}{74} \times 100 = 5.9\%$$

D2S % = 16.7%

NOTES:
- All Material passed the #10 sieve
- Over 90% of all material passed the #40 sieve
- Method A of AASHTO T99 & T180 used
- Unit weights were 110 PCF ± (D698) and 122 PCF ± (D1557)
- 7 test repetitions
- The above data is from one user
- The (IS) and (D2S) limits represent the limits as described in ASTM Practice C670.

FIG. X1.1 Compactive Effort

SUMMARY OF CHANGES

(*1*) Terminology D 653 was added to Section 2.
(2) Wording in Fig. 1 was changed from "equally spaced" to "uniformly spaced" to match the wording in the text.
(*3*) Section 5.1 was revised and a new Table 1 was added. Table 2 is the former Table 1.
(*4*) This Summary of Changes section has been added.

Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass[1]

This standard is issued under the fixed designation D 2216; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope *

1.1 This test method covers the laboratory determination of the water (moisture) content by mass of soil, rock, and similar materials where the reduction in mass by drying is due to loss of water except as noted in 1.4, 1.5, and 1.7. For simplicity, the word "material" hereinafter also refers to either soil or rock, whichever is most applicable.

1.2 Some disciplines, such as soil science, need to determine water content on the basis of volume. Such determinations are beyond the scope of this test method.

1.3 The water content of a material is defined in 3.2.1.

1.4 The term "solid material" as used in geotechnical engineering is typically assumed to mean naturally occurring mineral particles of soil and rock that are not readily soluble in water. Therefore, the water content of materials containing extraneous matter (such as cement, and the like) may require special treatment or a qualified definition of water content. In addition, some organic materials may be decomposed by oven drying at the standard drying temperature for this method (110°C). Materials containing gypsum (calcium sulfate dihydrate or other compounds having significant amounts of hydrated water) may present a special problem as this material slowly dehydrates at the standard drying temperature (110°C) and at very low relative humidities, forming a compound (calcium sulfate hemihydrate) which is not normally present in natural materials except in some desert soils. In order to reduce the degree of dehydration of gypsum in those materials containing gypsum, or to reduce decomposition in highly organic soils, it may be desirable to dry these materials at 60°C or in a desiccator at room temperature. Thus, when a drying temperature is used which is different from the standard drying temperature as defined by this test method, the resulting water content may be different from standard water content determined at the standard drying temperature.

NOTE 1—Test Methods D 2974 provides an alternate procedure for determining water content of peat materials.

1.5 Materials containing water with substantial amounts of soluble solids (such as salt in the case of marine sediments) when tested by this method will give a mass of solids which includes the previously soluble solids. These materials require special treatment to remove or account for the presence of precipitated solids in the dry mass of the specimen, or a qualified definition of water content must be used. For example, see Noorany[2] regarding information on marine soils.

1.6 This test method requires several hours for proper drying of the water content specimen. Test Method D 4643 provides for drying of the test specimen in a microwave oven which is a shorter process. Also see Gilbert[3] for details on the background of this test method.

1.7 This standard requires the drying of material in an oven at high temperatures. If the material being dried is contaminated with certain chemicals, health and safety hazards can exist. Therefore, this standard should not be used in determining the water content of contaminated soils unless adequate health and safety precautions are taken.

1.8 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[4]

D 2974 Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils[4]

D 4220 Practice for Preserving and Transporting Soil Samples[4]

D 4318 Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils[4]

D 4643 Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method[4]

D 4753 Specification for Evaluating, Selecting, and Specifying Balances and Scales for Use in Soil and Rock Testing[4]

[1] This test method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.03 on Texture, Plasticity and Density Characteristics of Soils.

Current edition approved Feb. 10, 1998. Published January 1999. Originally published as D 2216 – 63 T. Last previous edition D 2216 – 92.

[2] Noorany, I., "Phase Relations in Marine Soils", Journal of Geotechnical Engineering, ASCE, Vol. 110, No. 4, April 1984, pp. 539–543.

[3] Gilbert, P.A., "Computer Controlled Microwave Oven System for Rapid Water Content Determination", Tech. Report GL-88-21, Department of the Army, Waterways Experiment Station, Corps of Engineers, Vicksburg, MS, November 1988.

[4] *Annual Book of ASTM Standards*, Vol 04.08.

*A Summary of Changes section appears at the end of this standard.

D 6026 Guide for Using Significant Digits in Calculating and Reporting Geotechnical Test Data[5]

E 145 Specification for Gravity-Convection And Forced-Ventilation Ovens[6]

3. Terminology

3.1 Refer to Terminology D 653 for standard definitions of terms.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *water content (of a material)*—the ratio expressed as a percent of the mass of "pore" or "free" water in a given mass of material to the mass of the solid material. A standard temperature of 110° ± 5°C is used to determine these masses.

4. Summary of Test Method

4.1 A test specimen is dried in an oven at a temperature of 110° ± 5°C to a constant mass. The loss of mass due to drying is considered to be water. The water content is calculated using the mass of water and the mass of the dry specimen.

5. Significance and Use

5.1 For many materials, the water content is one of the most significant index properties used in establishing a correlation between soil behavior and its index properties.

5.2 The water content of a material is used in expressing the phase relationships of air, water, and solids in a given volume of material.

5.3 In fine-grained (cohesive) soils, the consistency of a given soil type depends on its water content. The water content of a soil, along with its liquid and plastic limits as determined by Test Method D 4318, is used to express its relative consistency or liquidity index.

6. Apparatus

6.1 *Drying Oven*, thermostatically-controlled, preferably of the forced-draft type, meeting the requirements of Specification E 145 and capable of maintaining a uniform temperature of 110 ± 5°C throughout the drying chamber.

6.2 *Balances*—All balances must meet the requirements of Specification D 4753 and this section. A Class GP1 balance of 0.01g readability is required for specimens having a mass of up to 200 g (excluding mass of specimen container) and a Class GP2 balance of 0.1g readability is required for specimens having a mass over 200 g. However, the balance used may be controlled by the number of significant digits needed (see 8.2.1 and 12.1.2).

6.3 *Specimen Containers*—Suitable containers made of material resistant to corrosion and change in mass upon repeated heating, cooling, exposure to materials of varying pH, and cleaning. Unless a dessicator is used, containers with close-fitting lids shall be used for testing specimens having a mass of less than about 200 g; while for specimens having a mass greater than about 200 g, containers without lids may be used (see Note 7). One container is needed for each water content determination.

NOTE 2—The purpose of close-fitting lids is to prevent loss of moisture from specimens before initial mass determination and to prevent absorption of moisture from the atmosphere following drying and before final mass determination.

6.4 *Desiccator*—A desiccator cabinet or large desiccator of suitable size containing silica gel or anhydrous calcium sulfate. It is preferable to use a desiccant which changes color to indicate it needs reconstitution. See 10.5.

NOTE 3—Anhydrous calcium sulfate is sold under the trade name Drierite.

6.5 *Container Handling Apparatus*, gloves, tongs, or suitable holder for moving and handling hot containers after drying.

6.6 *Miscellaneous*, knives, spatulas, scoops, quartering cloth, sample splitters, etc, as required.

7. Samples

7.1 Samples shall be preserved and transported in accordance with Practice 4220 Groups B, C, or D soils. Keep the samples that are stored prior to testing in noncorrodible airtight containers at a temperature between approximately 3 and 30°C and in an area that prevents direct contact with sunlight. Disturbed samples in jars or other containers shall be stored in such a way as to prevent or minimize moisture condensation on the insides of the containers.

7.2 The water content determination should be done as soon as practicable after sampling, especially if potentially corrodible containers (such as thin-walled steel tubes, paint cans, etc.) or plastic sample bags are used.

8. Test Specimen

8.1 For water contents being determined in conjunction with another ASTM method, the specimen mass requirement stated in that method shall be used if one is provided. If no minimum specimen mass is provided in that method then the values given below shall apply. See Howard[7] for background data for the values listed.

8.2 The minimum mass of moist material selected to be representative of the total sample shall be in accordance with the following:

Maximum particle size (100 % passing)	Standard Sieve Size	Recommended minimum mass of moist test specimen for water content reported to ±0.1 %	Recommended minimum mass of moist test specimen for water content reported to ±1 %
2 mm or less	No. 10	20 g	20 g[A]
4.75 mm	No. 4	100 g	20 g[A]
9.5 mm	3/8-in.	500 g	50 g
19.0 mm	3/4-in.	2.5 kg	250 g
37.5 mm	1½ in.	10 kg	1 kg
75.0 mm	3-in.	50 kg	5 kg

[A] To be representative not less than 20 g shall be used.

8.2.1 The minimum mass used may have to be increased to obtain the needed significant digits for the mass of water when reporting water contents to the nearest 0.1 % or as indicated in 12.1.2.

[5] *Annual Book of ASTM Standards*, Vol 04.09.
[6] *Annual Book of ASTM Standards*, Vol 14.02.

[7] Howard, A. K., "Minimum Test Specimen Mass for Moisture Co[illegible]rmination", *Geotechnical Testing Journal*, A.S.T.M., Vol. 12, No. 1, March [illegible] pp. 39-44.

8.3 Using a test specimen smaller than the minimum indicated in 8.2 requires discretion, though it may be adequate for the purposes of the test. Any specimen used not meeting these requirements shall be noted on the test data forms or test data sheets.

8.4 When working with a small (less than 200g) specimen containing a relatively large gravel particle, it is appropriate not to include this particle in the test specimen. However, any discarded material shall be described and noted on the test data forms or test data sheets.

8.5 For those samples consisting entirely of intact rock, the minimum specimen mass shall be 500 g. Representative portions of the sample may be broken into smaller particles, depending on the sample's size, the container and balance being used and to facilitate drying to constant mass, see 10.4. Specimen sizes as small as 200 g may be tested if water contents of only two significant digits are acceptable.

9. Test Specimen Selection

9.1 When the test specimen is a portion of a larger amount of material, the specimen must be selected to be representative of the water condition of the entire amount of material. The manner in which the test specimen is selected depends on the purpose and application of the test, type of material being tested, the water condition, and the type of sample (from another test, bag, block, and the likes.)

9.2 For disturbed samples such as trimmings, bag samples, and the like, obtain the test specimen by one of the following methods (listed in order of preference):

9.2.1 If the material is such that it can be manipulated and handled without significant moisture loss and segregation, the material should be mixed thoroughly and then select a representative portion using a scoop of a size that no more than a few scoopfuls are required to obtain the proper size of specimen defined in 8.2.

9.2.2 If the material is such that it cannot be thoroughly mixed or mixed and sampled by a scoop, form a stockpile of the material, mixing as much as possible. Take at least five portions of material at random locations using a sampling tube, shovel, scoop, trowel, or similar device appropriate to the maximum particle size present in the material. Combine all the portions for the test specimen.

9.2.3 If the material or conditions are such that a stockpile cannot be formed, take as many portions of the material as practical, using random locations that will best represent the moisture condition. Combine all the portions for the test specimen.

9.3 Intact samples such as block, tube, split barrel, and the like, obtain the test specimen by one of the following methods depending on the purpose and potential use of the sample.

9.3.1 Using a knife, wire saw, or other sharp cutting device, trim the outside portion of the sample a sufficient distance to see if the material is layered and to remove material that appears more dry or more wet than the main portion of the sample. If the existence of layering is questionable, slice the sample in half. If the material is layered, see 9.3.3.

9.3.2 If the material is not layered, obtain the specimen meeting the mass requirements in 8.2 by: (1) taking all or one-half of the interval being tested; (2) trimming a representative slice from the interval being tested; or (3) trimming the exposed surface of one-half or from the interval being tested.

NOTE 4—Migration of moisture in some cohesionless soils may require that the full section be sampled.

9.3.3 If a layered material (or more than one material type is encountered), select an average specimen, or individual specimens, or both. Specimens must be properly identified as to location, or what they represent, and appropriate remarks entered on the test data forms or test data sheets.

10. Procedure

10.1 Determine and record the mass of the clean and dry specimen container (and its lid, if used).

10.2 Select representative test specimens in accordance with Section 9.

10.3 Place the moist test specimen in the container and, if used, set the lid securely in position. Determine the mass of the container and moist material using a balance (see 6.2) selected on the basis of the specimen mass. Record this value.

NOTE 5—To prevent mixing of specimens and yielding of incorrect results, all containers, and lids if used, should be numbered and the container numbers shall be recorded on the laboratory data sheets. The lid numbers should match the container numbers to eliminate confusion.

NOTE 6—To assist in the oven-drying of large test specimens, they should be placed in containers having a large surface area (such as pans) and the material broken up into smaller aggregations.

10.4 Remove the lid (if used) and place the container with moist material in the drying oven. Dry the material to a constant mass. Maintain the drying oven at 110 ± 5°C unless otherwise specified (see 1.4). The time required to obtain constant mass will vary depending on the type of material, size of specimen, oven type and capacity, and other factors. The influence of these factors generally can be established by good judgment, and experience with the materials being tested and the apparatus being used.

NOTE 7—In most cases, drying a test specimen overnight (about 12 to 16 h) is sufficient. In cases where there is doubt concerning the adequacy of drying, drying should be continued until the change in mass after two successive periods (greater than 1 h) of drying is an insignificant amount (less than about 0.1 %). Specimens of sand may often be dried to constant mass in a period of about 4 h, when a forced-draft oven is used.

NOTE 8—Since some dry materials may absorb moisture from moist specimens, dried specimens should be removed before placing moist specimens in the same oven. However, this would not be applicable if the previously dried specimens will remain in the drying oven for an additional time period of about 16 h.

10.5 After the material has dried to constant mass remove the container from the oven (and replace the lid if used). Allow the material and container to cool to room temperature or until the container can be handled comfortably with bare hands and the operation of the balance will not be affected by convection currents and/or its being heated. Determine the mass of the container and oven-dried material using the same type/capacity balance used in 10.3. Record this value. Tight fitting lids shall be used if it appears that the specimen is absorbing moisture from the air prior to determination of its dry mass.

NOTE 9—Cooling in a desiccator is acceptable in place of tight fitting lids since it greatly reduces absorption of moisture from the atmosphere during cooling especially for containers without tight fitting lids.

11. Calculation

11.1 Calculate the water content of the material as follows:

$$w = [(M_{cws} - M_{cs})/(M_{cs} - M_c)] \times 100 = \frac{M_w}{M_s} \times 100 \quad (1)$$

where:

w = water content, %,
M_{cws} = mass of container and wet specimen, g,
M_{cs} = mass of container and oven dry specimen, g,
M_c = mass of container, g,
M_w = mass of water ($M_w = M_{cws} - M_{cds}$), g, and
M_s = mass of solid particles ($M_s = M_{cds} - M_c$), g.

12. Report

12.1 Test data forms or test data sheets shall include the following:

12.1.1 Identification of the sample (material) being tested, such as boring number, sample number, test number, container number etc.

12.1.2 Water content of the specimen to the nearest 1 % or 0.1 %, as appropriate based on the minimum sample used. If this method is used in concert with another method, the water content of the specimen should be reported to the value required by the test method for which the water content is being determined. Refer to Guide D 6026 for guidance concerning significant digits, especially if the value obtained from this test method is to be used to calculate other relationships such as unit weight or density. For instance, if it is desired to express dry unit weight to the nearest 0.1 lbf/f^3(0.02 kN/m^3), it may be necessary to use a balance with a greater readability or use a larger specimen mass to obtain the required significant digits the mass of water so that the water content can be determined to the required significant digits. Also, the significant digits in Guide D 6026 may need to be increased when calculating phase relationships requiring four significant digits.

12.1.3 Indicate if test specimen had a mass less than the minimum indicated in 8.2.

12.1.4 Indicate if test specimen contained more than one material type (layered, etc.).

12.1.5 Indicate the temperature of drying if different from 110 ± 5°C.

12.1.6 Indicate if any material (size and amount) excluded from the test specimen.

12.2 When reporting water content in tables, figures, etc., any data not meeting the requirements of this test method shall be noted, such as not meeting the mass, balance, or temperature requirements or a portion of the material is excluded from the test specimen.

13. Precision and Bias

13.1 *Statement on Bias*—There is no accepted reference value for this test method; therefore, bias cannot be determined.

13.2 *Statements on Precision*:

13.2.1 *Single-Operator Precision (Repeatability)*—The single-operator coefficient of variation has been found to be 2.7 percent. Therefore, results of two properly conducted tests by the same operator with the same equipment should not be considered suspect unless they differ by more than 7.8 percent of their mean.[8]

13.2.2 *Multilaboratory Precision (Reproducibility)*[9]—The multilaboratory coefficient of variation has been found to be 5.0 percent. Therefore, results of two properly conducted tests by different operators using different equipment should not be considered suspect unless they differ by more than 14.0 percent of their mean.

14. Keywords

14.1 consistency; index property; laboratory; mo analysis; moisture content; soil aggregate; water content

[8] These numbers represent the (1s) and (d2s) limits as described in Practice C 670.

[9] These numbers represent the (1s %) and (d2s %) limits as described in Practice C 670.

SUMMARY OF CHANGES

Committee D-18 has identified the location of selected changes to this standard since the last issue. (D 2216-92) that may impact the use of this standard.

(*1*) Title was changed to emphasize that mass is the basis for the standard.

(*2*) Section 1.1 was revised to clarify "similar materials".

(*3*) New 1.2 was added to explain a limitation in scope. The other sections were renumbered as appropriate.

(*4*) An information reference was included in 1.5.

(*5*) An information reference was included in 1.6

(*6*) A new ASTM referenced document was included in 2.1.

(*7*) New Footnotes 2, 3, and 5 were added and identified. Other footnotes were renumbered where necessary for sequential identification.

(*8*) Information concerning balances was added in 6.2

(*9*) Section 6.3 was revised to clarify the use of close-fitting lids, and a reference to Note 8 was added.

(*10*) In 6.4, "anhydrous calcium phosphate" was changed to "anyhydrous calcium sulfate" to correct an error and to agree with Note 3.

(*11*) A typo in 8.1 was corrected from "before" to "below" and a footnoted reference was added for information.

(*12*) A portion of 8.2 was deleted for clarity.

(*13*) A new 8.2.1 was added to clarify minimum mass requirements.

(*14*) Sections 8.3, 8.4, 9.3.3, and 12.1 were changed to substitute "test data form/sheet" for "report".

(*15*) Footnote seven was identified.

(*16*) Section 9.2.1 was revised to improve clarity and in

(*17*) The word "possible" was changed to "practical" in 9.2.3.

(*18*) Section 9.3.1 and 9.3.2 were revised to improve clarity and for practicality.
(*19*) A reference to Guide D 6026 was added in 12.1.2.
(*20*) Footnotes 8 and 9 were added to 13.2.1 and 13.2.2, respectively. These were inadvertently omitted from the 1992 version. These explanations provide clarity and information to the user.
(*21*) A Summary of Changes was added to reflect D-18's policy.

Standard Test Methods for
DENSITY OF SOIL AND SOIL-AGGREGATE IN PLACE BY NUCLEAR METHODS (SHALLOW DEPTH)[1]

This standard is issued under the fixed designation D 2922; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

These methods have been approved for use by agencies of the Department of Defense and for listing in the DoD Index of Specifications and Standards.

INTRODUCTION

These methods describe determination of the density of soil and soil-aggregate in place using nuclear equipment. In general, the total or wet density of the material under test is determined by placing a gamma source and a gamma detector either on, into, or adjacent to the material under test. These variations in test geometry are presented as the backscatter, direct transmission, or optional air gap approaches. The intensity of radiation detected is dependent in part upon the density of the material under test. The radiation intensity reading is converted to measured wet density by a suitable calibration curve. Principles of the nuclear test are discussed in the Appendix, as are some of its advantages and disadvantages. It should be noted that the density determined by these methods is not necessarily the average density within the volume involved in the measurement and that the equipment utilizes radioactive materials which may be hazardous to the health of users unless proper precautions are taken.

1. Scope

1.1 These methods cover the determination of the total or wet density of soil and soil-aggregate in place by the attenuation of gamma rays where the gamma source or gamma detector, or both, remain at or near the surface. The methods described are normally suitable to a test depth of approximately 2 to 12 in. (50 to 300 mm), depending on the test geometry used.

1.2 Three methods are described as follows:

	Section
Method A—Backscatter	9
Method B—Direct Transmission	10
Method C—Air Gap (Optional)	11

1.3 The values tested in inch-pound units are to be regarded as the standard. The metric equivalents of inch-pound units may be approximate.

2. Applicable Documents

2.1 *ASTM Standards:*

D 1556 Test Method for Density of Soil in Place by the Sand-Cone Method[2]

D 2167 Test Method for Density and Unit Weight of Soil in Place by the Rubber-Balloon Method[2]

D 2216 Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures[2]

D 3017 Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)[2]

3. Significance and Use

3.1 The methods described are useful as rapid, nondestructive techniques for the in-place determination of wet density of soil and

[1] These methods are under the jurisdiction of ASTM Committee D-18 on Soil and Rock.

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[2] *Annual Book of ASTM Standards*, Vol 04.08.

soil-aggregate. The fundamental assumptions inherent in the methods are that Compton scattering is the dominant interaction and that the material within the zone of influence for each test is homogeneous.

3.2 Test results may be affected by chemical composition, sample heterogeneity, and the surface texture of the material being tested. The techniques also exhibit spatial bias in that the apparatus is more sensitive to certain regions of the material under test.

4. Calibration

4.1 Laboratory calibration of the gage is established by determining the nuclear count rate of each of several materials at different and known densities and establishing a relationship between count rate and density. Sufficient data should be taken at each density to ensure a precision of at least twice the normal precision obtained in field use. Calibration can be accomplished by either laboratory or field methods. Laboratory methods are recommended due to the higher inherent accuracy of laboratory standards and instruments as opposed to field methods which require the volume measurement of an excavated hole.

NOTE 1—Different chemical compositions of the blocks or other materials can affect the count rate. Calibration curves may not be applicable to materials not represented in establishing the calibration curve.

4.1.1 Laboratory calibration should involve the use of a minimum of five homogeneous blocks sufficiently large to represent an infinite volume to the nuclear instrument. The density of these standards shall be determined to an accuracy of ±0.2 % (±0.3 lb/ft^3 at 160 lb/ft^3 or ±5 kg/m^3 at 2565 kg/m^3). Three of the standards shall be constructed of materials having gamma mass attenuation coefficients within ±1.0 % of each other over the range of gamma energy utilized by the gage for density measurement. These standards will be used to establish the gage response to density variations in the range from 100 to 170 lb/ft^3 (1600 to 2725 kg/m^3). The last two standards shall be materials that equally bracket the gamma mass attentuation coefficient of soils. Suggested materials are limestone and granite. The gage response will then be rotated about the zero density point on a plot or graphical representation such that it falls halfway between the limestone and granite data. This final response will be used in the field for measurement.

4.1.2 Field calibration may be used where laboratory calibration facilities are not available or where it becomes necessary to calibrate the instrument for materials that chemically are different than soils. A minimum of ten field tests should be used for establishing calibration by the field method so that a range of densities and materials will be represented. The sand-cone method in accordance with Test Method D 1556 or the rubber-balloon method in accordance with Test Method D 2167 may be used to determine the wet range of density of carefully selected field sites on which density data have been previously determined. As an alternative, nuclear data can be obtained on prepared containers of soil and soil-aggregate compacted to known densities. The containers must be sufficiently large to represent an infinite volume to the nuclear instrument. Data from either of these methods may be used to establish a new gage response by visually fitting a line to a plot of gage response to density over the range of densities found in the samples. It is more desirable to use the latter data, to rotate the laboratory calibration in 4.1.1, or a constant offset from this laboratory calibration, to fit the field data. Extreme care must be exercised in the determination of wet density in either the field sites or prepared containers. Because of the variability and scatter inherent in field tests and container preparation and compaction, this method is considered less accurate than techniques using calibration blocks.

NOTE 2—Use of blocks is advantageous because they are durable and provide stable density references. Blocks and prepared containers must be large enough not to change the observed count rate (or count ratio) if made larger in any dimensions. Dimensions of approximately 12 in. (300 mm) width by 14 in. (360 mm) depth by 22 in. (560 mm) length have proven satisfactory for equipment now available. For calibration of backscatter only, a depth of not less than 9 in. (230 mm) is adequate.

4.2 *Checking and Adjusting Calibration Data*—The calibration data for newly acquired instruments, instruments for which the calibration is more than one year old, or instruments that have been damaged and repaired may be checked by using the method of 4.1.2. A minimum of ten field tests must be used to compare with the existing calibration data in order to justify changing the calibration.

4.2.1 If each of the field tests varies by not

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each of the field tests varies by not

more than 3 % from the nuclear density and some of the field densities are greater and some less than the nuclear density, then adjustment of the calibration is not necessary.

4.2.2 If all of the field tests are more or all less than the nuclear density and the average of the difference exceeds 1 %, then adjust each subsequent nuclear density by the average difference.

4.2.3 The average difference found in 4.2.2 may be used to determine a new calibration response. Either rotation about a zero point or constant offset from the original calibration may be used.

NOTE 3—Adjusting calibration curves is a complex task and it should be attempted only by those knowledgeable in this field. Most manufacturers either provide this service or will offer assistance to the user.

5. System Specifications

5.1 Any equipment that is used under the requirements of this method shall satisfy the following specifications:

5.1.1 *Precision*—Precision of the system is determined from the slope of the calibration response and the statistical deviation of the count for the recommended period of measurement, which shall be at least 1 min:

$$P = \sigma / S \qquad (1)$$

where:
P = precision,
σ = standard deviation, counts per measurement period, and
S = slope, Δ counts per measurement period/(lb/ft^3) or (kg/m^3).

5.1.1.1 Determine the slope of the counts per measurement period at a unit weight of 125 lb/ft^3 (2000 kg/m^3). This can usually be determined from the calibration response and must be the true counts from the detector system before the display. Determine the counts per measurement period at the same density by the same method. The precision can be calculated by:

$$P = \sqrt{C/PC}/S \qquad (2)$$

where:
P = precision,
C = counts per measurement period,
S = slope, Δ counts per measurement period/(lb/ft^3) or (kg/m^3), and
PC = amount of prescale (Note 4) applied to the detector counts prior to display. The manufacturer will supply this value. If no prescale is built into the equipment, the value is 1.

NOTE 4—The value of prescale is the number by which the total count rate of the detector(s) is divided before display on the readout to eliminate the need for displaying non-significant digits. The value of P at a density of 125 lb/ft^3 (2000 kg/m^3) shall be no greater than ±1.0 lb/ft^3 (±16 kg/m^3) for the backscatter methods nor greater than ±0.35 lb/ft^3 (±6 kg/m^3) for direct transmission method.

5.1.1.2 If 5.1.1 cannot be performed as above, the precision can be computed by determining the standard deviation of at least 20 repetitive measurements (gage not moved after the first measurement) of material having density of 125.0 ± 5.0 lb/ft^3 (2000 ± 80 kg/m^3). In order to perform this procedure, the resolution of the count display, calibration response, or other method of displaying density must be equal to or better than ±0.1 lb/ft^3 (±1.6 kg/m^3).

5.1.2 *Chemical Error*—The error due to changes in chemical composition of materials having gamma mass attenuation coefficients less than those of granite or greater than those of limestone shall be not greater than ±2.5 % of backscatter methods and ±1.2 % for direct transmission with the source at a depth of 6 in. (150 mm).

5.1.2.1 If the instrument was originally calibrated by the method described in 4.1.1, then the chemical error can be easily determined by using the standard block data which was taken to determine the gage response. Using the gage count rate on the limestone standard and the calibrated gage response, determine the gage density of the limestone standard. This will normally be higher than the true density. Compute the percent error. Repeat the same procedure for the granite standard. This will normally be lower than the true density. The difference between the two percent errors (taking into account the sign of the error) divided by two will equal the chemical error.

5.1.2.2 If the gage was calibrated by some means other than 4.1.1 or if the original calibration data are not available, then other means must be used to determine the chemical error. Using the procedure of 5.1.2.1, the relative densities of the limestone and granite standard blocks were not important, but using this procedure the standards should preferably be within 5 lb/ft³ (80 kg/m³) of each other in order to eliminate the possibility of an improper calibration which could cause good accuracy and small chemical error at the limestone and granite density but with large errors at all other densities. A high-density limestone or marble standard is suggested. First measure the density and compute the percent error on each standard. The chemical error is then the difference between the two errors divided by two. The sum of the two errors represents the calibration accuracy.

5.1.3 *Surface Roughness Error*—The error caused by a 0.050-in. (1.3-mm) air gap introduced between the base of the gage and the surface of the material being measured should cause an error of no more than 4 % in the backscatter method nor more than 1% in the direct-transmission method with the source placed at a 6-in. (150-mm) depth. Older models of instruments currently in use may not meet this requirement. The users can minimize the effects of surface roughness by careful site preparation.

5.1.3.1 The effect of surface roughness can be measured by placing the instrument on a smooth flat surface after cleaning both the surface and the gage base and measuring the density. Next, elevate the gage by placing 0.050-in. (1.3-mm) spacers between the gage base and the material surface in such a way as to not interfere with the gage measurement zone. Remeasure the apparent density; the difference represents the gage error.

6. Safety Precaution

6.1 This equipment utilizes radioactive materials which may be hazardous to the health of the users, unless proper precautions are taken. Users of this equipment must become completely familiar with possible safety hazards and with all applicable government regulations. Effective operator instruction together with routine safety procedures such as source-leak tests, recording and elevation of film badge data, use of survey meters, etc., are an essential part of the operation of equipment of this type.

7. Apparatus

7.1 The apparatus may consist of items to perform Method A—Backscatter, Method B—Direct Transmission, or a combination of both. Items listed are common to both apparatus except where noted as Method A or Method B only. Apparatus for Method C—Air Gap (optional) is detailed in Section 11.

7.2 *Gamma Source*—An encapsulated and sealed radioactive source meeting the specific form requirements of Title 49 of the Code of Federal Regulations.

7.3 *Gamma Detector*—Any suitable type.

7.4 *Readout Device*—A suitable scaler with a resolution and range to display counts over the range of density for which the apparatus will be used. Usually the scaler will also contain other electronic devices and the necessary electrical power for operation.

7.5 *Housing*—The source, detector, readout device, etc., shall be in housings of rugged construction that are moisture- and dustproof. For Method B use, the housing shall contain a means of locating either the source of detector at a distance of 2 to 12 in. (50 to 300 mm) into a preformed hole in the material to be tested. The probe containing the source or detector shall be sufficiently rigid so as to maintain a constant distance along the measuring path length and also contain markings to indicate the depth to which the probe has been placed.

NOTE 5—The gamma source, detector, readout device, and power supply may be housed separately or combined and integrated with a nuclear moisture-measuring system.

7.6 *Reference Standard*—A device that isolates the instrument and provides a means of allowing the instrument to make a measurement that is constant within the reproducibility of the system. All calibrations will be made as a ratio to the reference standard count and all field measurements will be taken as a ratio to the reference standard count.

7.7 *Site-Preparation Devices*:

7.7.1 Method A equipment shall include a flat plate straightedge, or other suitable tool to be used to level the test site to the required smoothness.

7.7.2 Method B equipment shall, in addition to the above, include a hole-forming device such as an auger or pin having a nominal diameter equal to or up to ⅛ (3 mm) larger than the probe and also a guide to ensure that the hole is perpendicular to the test site surface.

7.8 *Transport Case*—Each system shall include a shipping and transport case to house the equipment and shall meet the U[illegible] D[illegible] ment of Transportation requirements in [illegible] 49 of the Code of Federal Regulations [illegible] exterior of the case shall contain [illegible] required by the regulations and radi[illegible] shall meet the "Yellow II" standards.

8. Standardization

8.1 All nuclear density instrumen[illegible] are [illegible] ject to long-term aging of the radio[illegible] source, detectors, and electronic syst[illegible] may change the relationship betw[illegible] rate and density. To offset this aging, [illegible] ments are calibrated as a ratio of the mea[illegible] ment count rate to a count rate [illegible] reference standard. The reference [illegible] should be in the same order of ma[illegible] higher than the range of measurement [illegible] rates over the useful density ra[illegible] ment.

8.2 Standardization of equi[illegible] th[illegible] erence standard is required at the start of [illegible] day's use and a permanent record of [illegible] should be retained.

8.3 Turn on the equipment and allo[illegible] stablization of the equipment in accor[illegible] with the manufacturer's recommend[illegible]

8.4 Take at least four repetitive [illegible] the normal measurement period and obta[illegible] mean. If available on the instrument, one [illegible] surement at a period of four times [illegible] period is acceptable. This constitutes [illegible] dardization check.

8.5 If the value obtained above is withi[illegible] limits set by Eq 3, the equipment is [illegible] to be in satisfactory condition and ma[illegible] If the value obtained is outside the limits [illegible] Eq 3, another standardization check shou[illegible] made. If the second standardizatio[illegible] within the limits, the equipment ma[illegible] but if it also fails the test, the equipment sh[illegible] be checked as recommended by the man[illegible] turer and the calibration checked ([illegible]) o[illegible] calibrated, or both.

$$N_s = N_o \pm 2.0\ \sqrt{N_o}/PC$$

where:

N_s = value of current standa[illegible] c[illegible] (8.4) on the reference st[illegible] (7.6[illegible]

N_o = average of the past fou[illegible] es o[illegible] taken for prior useage, and

PC = amount of prescale applied to [illegible] d[illegible] tor counts prior to display. The m[illegible] the equipment and shall meet the U.S. Department of Transportation requirements in Title 49 of the Code of Federal Regulations. The exterior of the case shall contain all labels required by the regulations and radiation levels shall meet the "Yellow II" standards.

8. Standardization

8.1 All nuclear density instruments are subject to long-term aging of the radioactive source, detectors, and electronic systems, which may change the relationship between count rate and density. To offset this aging, all instruments are calibrated as a ratio of the measurement count rate to a count rate made on a reference standard. The reference count rate should be in the same order of magnitude or higher than the range of measurement count rates over the useful density range of the equipment.

8.2 Standardization of equipment on the reference standard is required at the start of each day's use and a permanent record of these data should be retained.

8.3 Turn on the equipment and allow for stablization of the equipment in accordance with the manufacturer's recommendations.

8.4 Take at least four repetitive readings at the normal measurement period and obtain the mean. If available on the instrument, one measurement at a period of four times the normal period is acceptable. This constitutes one standardization check.

8.5 If the value obtained above is within the limits set by Eq 3, the equipment is considered to be in satisfactory condition and may be used. If the value obtained is outside the limits set by Eq 3, another standardization check should be made. If the second standardization check is within the limits, the equipment may be used; but if it also fails the test, the equipment should be checked as recommended by the manufacturer and the calibration checked (4.2) or recalibrated, or both.

$$N_s = N_o \pm 2.0\sqrt{N_o/PC} \quad (3)$$

where:

N_s = value of current standardization check (8.4) on the reference standard (7.6),

N_o = average of the past four values of N_s taken for prior useage, and

PC = amount of prescale applied to the detector counts prior to display. The manufacturer will supply this value. If no prescale is built into the equipment, the value is 1.

8.6 The value of N_s (8.4) will be used to determine the count ratios for the current day's use of the equipment. If, for any reason, measured densities become suspect during the day's use, another standardization should be performed.

NOTE 6—If the instrument is to be used either continuously or intermittently during the day, it is generally best to leave it in the "power on" or "standby" condition during the day to prevent having to repeat the standardization. This will provide more stable, consistent results.

NOTE 7—Standardization shall be performed in accordance with the manufacturer's recommendations and away from other radioactive sources, large masses of metal or vertical objects, free water, or other items that can affect the gage readings.

9. Procedure, Method A—Backscatter

9.1 Standardize the instrument (Section 8).

9.2 Select a test location where the gage in test position will be at least 9 in. (230 mm) away from any vertical projection.

9.3 Prepare the test site in the following manner:

9.3.1 Remove all loose and disturbed material and additional material as necessary to expose the top of the material to be tested.

NOTE 8—The spatial bias should be considered in determining the depth at which the gage is to be seated.

9.3.2 Prepare a horizontal area sufficient in size to accommodate the gage, by planing the area to a smooth condition so as to obtain maximum contact between the gage and material being tested.

9.3.3 The maximum void beneath the gage shall not exceed approximately ⅛ in. (3 mm). Use native fines or fine sand to fill these voids and smooth the surface with a rigid plate or other suitable tool.

NOTE 9—The placement of the gage on the surface of the material to be tested is critical to the successful determination of density. The optimum condition is total contact between the bottom surface of the gage and the surface of the material being tested. This is not possible in all cases. To correct surface irregularities, use of native fines or sand as a filler is necessary. The depth of the filler should not exceed approximately ⅛ in. (3 mm) and the total area filled should not exceed 10 % of the bottom area of the gage. Several trial seatings may be required to achieve these conditions.

9.4 Proceed with the test in the following manner:

9.4.1 Seat the gage firmly.

9.4.2 Keep all other radioactive sources away from the gage to avoid affecting the measurement

9.4.3 Secure and record one or more readings for the normal measurement period.

9.4.4 Determine the ratio of the reading to the standard count (9.1). From this ratio and the calibration, determine the in-place wet density.

NOTE 10—Some instruments have built-in provisions to compute the ratio, compute the in-place wet density, and display it to the operator automatically.

10. Procedure, Method B — Direct Transmission

10.1 Standardize the instrument (Section 8).

10.2 Select a test location where the gage in test position will be at least 9 in. (230 mm) away from any vertical projection.

10.3 Prepare the test site in the following manner:

10.3.1 Remove all loose and disturbed material, and remove additional material as necessary to expose the top of the material to be tested.

10.3.2 Prepare a horizontal area, sufficient in size to accommodate the gage, by planing the area of a smooth condition so as to obtain maximum contact between the gage and material being tested.

10.3.3 The maximum void beneath the gage shall not exceed approximately ⅛ in. (3 mm). Use native fines or fine sand to fill these voids and smooth the surface with a rigid plate or other suitable tool. The depth of the filler should not exceed approximately ⅛ in. (3 mm).

10.3.4 Make a hole perpendicular to the prepared surface using the guide and the hole-forming device (7.6.2). The hole shall be of such depth and alignment that insertion of the probe will not cause the gage to tilt from the plane of the prepared area. The depth of the hole must be at least 2 in. (50 mm) deeper than the depth to which the probe will be placed. The guide shall be the same size as the base of the gage, with the hole in the same location on the guide as the probe on the gage. The corners of the guide are marked by scoring the surface of the soil.

10.4 Proceed with testing in the following manner:

10.4.1 Set the gage on the soil surface, carefully aligning it with the marks so that the probe will be directly over the pre-formed hole.

10.4.2 Insert the probe in the hole.

10.4.3 Seat the gage firmly by rotating it about the probe with a back and forth motion.

10.4.4 Pull gently on the gage in the direction that will bring the side of the probe against the side of the hole closest to the detector (or source) location in the gage housing.

10.4.5 Keep all other radioactive sources away from the gage to avoid affecting the measurement.

10.4.6 Secure and and record one or more readings for the normal measurement period.

10.4.7 Determine the ratio of the reading to the standard count (10.1). From the ratio and the calibration, determine the in-place wet density.

11. Procedure, Method C—Air Gap (Optional)

11.1 If the nuclear gage errors due to calibration using materials with different chemical composition are in excess of maximum errors listed in 5.2, the air-gap method should be employed. It should be noted that the required use of two different site measurements may decrease the precision due to the statistics of the air gap measurement.

11.2 *Apparatus*:

11.2.1 All apparatus described in Section 7.

11.2.2 *Cradle or Spacers*, to support the gage at the optimum air gap above the material being tested. The cradles or spacers shall be so designed as to support the gage at optimum height without shielding the base of the gage. Figure 1 shows a typical air-gap cradle that demonstrates the principle. The cradle shown in Fig. 1 is not the only satisfactory method. Other methods which support the gage at the optimum air gap without shielding the base of the gage are satisfactory.

NOTE 11—Air-gap calibration curves and optimum air gap may be furnished for each gage by the manufacturer and can be readily checked by the user.

11.3 *Determination of Optimum Air Gap*—To determine the optimum air gap for use in the air-gap method, proceed as follows:

11.3.1 Use three or more different areas on which to make determinations. These areas

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compacted soil or soil-aggregate on w
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(4.1.2) or alternative prepared c air
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(4.1.2). The density of materials at th
areas should vary through a r ge
the densities of the materials ic
tested.

11.3.2 Place the density gage ove
area. Support the gage by block la
extreme edges of the gage so as t t
the space between the bottom o the
the surface of the test area.

11.3.3 Take and record readi fo
mal measurement periods in co s p
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11.3.4 By adding additional b
spacers, increase the air g n.
Take and record, and ave din
additional normal measur peri

11.3.5 Continue increasing the a
increments of ¼ in., securing a ag
for each air gap (11.3.3) until the is
in the counts per minute reading
increase in air gap.

11.3.6 On an arithmetic sca p
per minute as the ordinate vers ea
(in inches or millimetres) and draw
curve through the resulting points. R
peak air gap determined at t pe
curve.

11.3.7 Repeat procedures 11.3.2
11.3.6 over two or more additiona
materials of different density, d
peak air gap for each area.

11.3.8 Determine the average of th
gaps determined on all areas. This i
mum air gap. Use the optimu ai
establishing the calibration cu fc
gap method, and for all determinatio
sity by the air-gap method.

11.4 *Procedure*:

11.4.1 Standardize the instru ent

11.4.2 Select a test location wher
in test position will be at least 1 in.
away from any vertical pr
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11.4.3 Prepare the test the
manner:

11.4.3.1 Remove all loose an ist
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1. Procedure, Method C—Air Gap (Optional)

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Determination of Optimum Air Gap—
termine the optimum air gap for use in
air-gap method, proceed as follows:
.1 Use three or more different areas on
to make determinations. These areas

may be either blocks (4.1.1) or field sites of compacted soil or soil-aggregate on which density data have been previously determined (4.1.2) or alternative prepared containers of soil or soil-aggregate compacted to known densities (4.1.2). The density of materials at the selected areas should vary through a range including the densities of the materials which will be tested.

11.3.2 Place the density gage over the test area. Support the gage by blocks placed at the extreme edges of the gage so as not to obstruct the space between the bottom of the gage and the surface of the test area.

11.3.3 Take and record readings for two normal measurement periods in counts per minute and determine the average of the readings.

11.3.4 By adding additional blocks or spacers, increase the air gap by ¼ in. (6.3 mm). Take and record, and average readings for two additional normal measurement periods.

11.3.5 Continue increasing the air gap by increments of ¼ in., securing average readings for each air gap (11.3.3) until there is a decrease in the counts per minute readings with an increase in air gap.

11.3.6 On an arithmetic scale, plot counts per minute as the ordinate *versus* each air gap (in inches or millimetres) and draw a smooth curve through the resulting points. Record the peak air gap determined at the peak of the curve.

11.3.7 Repeat procedures 11.3.2 through 11.3.6 over two or more additional areas of materials of different density, and record the peak air gap for each area.

11.3.8 Determine the average of the peak air gaps determined on all areas. This is the optimum air gap. Use the optimum air gap for establishing the calibration curve for the air-gap method, and for all determinations of density by the air-gap method.

11.4 *Procedure*:

11.4.1 Standardize the instrument.

11.4.2 Select a test location where the gage in test position will be at least 12 in. (300 mm) away from any vertical projection. Plan sufficient area to accommodate the gage and cradle.

11.4.3 Prepare the test site in the following manner:

11.4.3.1 Remove all loose and disturbed material, and additional material as necessary to expose the top of the material to be tested. (See Note 8.)

11.4.3.2 Prepare a horizontal area, sufficient in size to accommodate the gage and cradle, by planing the area to a smooth condition so as to obtain maximum contact between the gage and material being tested.

11.4.3.3 The maximum void beneath the gage shall not exceed approximately ⅛ in. (3 mm). Use native fines or fine sand to fill these voids and smooth the surface with a rigid plate or other suitable tool.

Note 12—The air-gap method requires taking one or more readings in both the backscatter position and the air-gap position. The placement of the gage on the surface of the material to be tested is critical to the successful determination of density. The optimum condition is total contact between the bottom surface of the gage and the surface of the material being tested. This is not possible in all cases and to correct surface irregularities use of sand or similar material as a filler is necessary. The depth of the filler should not exceed approximately ⅛ in. (3 mm) and the total area filled should not exceed 10 % of the bottom area of the gage. Several trial seatings may be required to achieve these conditions.

11.4.4 Proceed with the test in the following manner:

11.4.4.1 Seat the gage firmly.

11.4.4.2 Keep all other radioactive sources away from the gage to avoid affecting the measurement so as not to affect the readings.

11.4.4.3 Secure and record one or more readings for the normal measurement period in the backscatter position.

11.4.4.4 Place the cradle, set at optimum air gap, on the test site, and place the gage on the cradle so that the gage is directly over the same site used for backscatter reading. When a direct-transmission type gage is used, set the probe in the retracted or backscatter position for this reading.

11.4.4.5 Take the same number of readings for the normal measurement period in the air-gap position as in the backscatter position (11.4.4.3).

11.4.4.6 Determine the air-gap ratio by dividing counts per minute obtained in the airgap position (11.4.4.5) by counts per minute obtained in backscatter position (11.4.4.3).

11.4.4.7 Determine the in-place wet density by use of the applicable calibration curve previously established.

Note 13—The air-gap ratio may be determined by dividing counts per minute obtained in the backscatter position by counts per minute obtained in the air-gap position or *vice versa*. Whichever ratio is used, a calibration curve using the same ratio must also be used.

12. Determination of Dry Density

12.1 To obtain dry density, use one of the following alternative methods:

12.1.1 If the water content is determined by nuclear methods, Test Method D 3017, subtract the pounds per cubic foot (kg/m^3) of moisture from the pounds per cubic foot (kg/m^3) of wet density, and obtain dry density in pounds per cubic foot (kg/m^3).

12.1.2 If the water content is determined by other methods, such as oven drying, Method D 2216, carbide method, etc., and is in the form of percent, proceed as follows:

$$\rho_d = [\rho_m/(w + 100)] \times 100 \qquad (4)$$

where:

ρ_d = dry density, lb/ft^3 (kg/m^3),
ρ_m = wet density, lb/ft^3 (kg/m^3), and
w = percent moisture in the specimen.

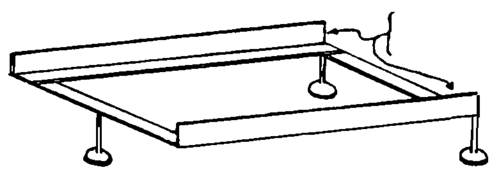
13. Report

13.1 The report shall include the following:
13.1.1 Location,
13.1.2 Elevation of surface,
13.1.3 Visual description of material,
13.1.4 Identification of test equipment (make, model, and serial number),
13.1.5 N_o, average of the past four values of N_s taken for prior usage,
13.1.6 N_s, value of the current standardization check (8.3) on the reference standard (7.5), and the method and date of standardization,
13.1.7 Count rate for each reading,
13.1.8 Count ratio,
13.1.9 Wet density.

NOTE 14—The count rate for each reading (13.1.7) and the count ratio (13.1.8) may be omitted from the report for instruments that have built-in provisions to take the ratio, compute the in-place wet density, and display it to the operator automatically.

14. Precision and Accuracy

14.1 The precision and accuracy of this standard has not been determined. No methods are available that provide absolute values of the density of soil or soil-aggregate mixtures in place against which these methods can be compared. The variability of soil does not permit duplication of test results for obtaining a meaningful statistical evaluation. Accuracy is a function of the care exercised in performing the calibrations and steps of the test and of the variability of the material being tested.



Welded metal approx. 1 by 1 by ⅛ in. (25.4 by 25.4 by 3.2 mm) angle.

FIG. 1 Typical Air-Gap Cradle

APPENDIX

X1. NOTES ON THE NUCLEAR TEST

X1.1 The equipment used in this method is of the surface type as opposed to that designed for use in deep borings. In general, and neglecting the associated electronics, this equipment consists of three principal elements: (*1*) a nuclear source emitting gamma rays, (*2*) a detector sensitive to these rays as they are modified by passing through the material being tested, and (*3*) a counter or scaler with provisions for automatic and precise timing, for determining the rate at which the modified gamma rays arrive at the detector. While rate meters are suitable, in principle, scalers are commonly used. In general, any source of gamma rays that are sufficiently numerous and properly energetic can be used in measuring the

density of soil and soil-aggregate. Sourc tat
with time, in terms of half-life, is an import dc
consideration and the sources most commonly
are cesium-137 and radium-226. The two te
must commonly used are gas-filled tub of
Geiger-Müller type and scintillation crysta us
of sodium-iodide. Detectors of the latter type
the potential of electronically varying the rang
energies of the gamma rays that are cou
detectors of the Geiger-Müller type, this ng
fixed in the design. For most available e pm
the source-detector geometry is fixed for backsc
gages and is adjustable to various preselected de
of direct transmission gages.

X1.2 Measurements are made using ga a
that largely reflect at reduced energy by sc rin
or by, direct transmission through the material u
test. In backscatter, the rays are emitted into
material from near its surface and some ar fle
at reduced energy back to the detector, gel
Compton scattering. In direct transmission so
or detector is inserted in the test materials an
contrast to the backscatter method, so e e
ted and unshielded rays can pres llo
straight-line path to the detector. sou
detector arrangement, the number reac
the detector is, over-all, a nonlinear function o
density of the material being tested. For u
range of soil and soil-aggregate densities th la
ship is such that the higher the density g
material, the lower the count rate.

X1.3 The determination of density by the nu
means of this method is indirect. To date he
ical approach has been developed that p cts
count rate for given equipment, geometry, ate
and density. As a result, the relationsip bet
material density and nuclear-count rate is determ
by correlation tests of materials at know ve
densities. Individual equipment manufact rs
ply a calibration curve with each set of th eq
ment. It has been found that these curves do
necessarily hold for all soils and soil-aggregates
cause of differences in chemical compositio Ap
ent variations in calibration may also be i ce
differences in seating, in background count, o
test variations. Because of these considerations,
visions are included in this method for checking
variations or changes. Different approach ha
used in checking calibration and those in e
eral use are given. For good practice, these ra
procedures should be followed with newly purch
equipment and with major component repl m
of in-service equipment.

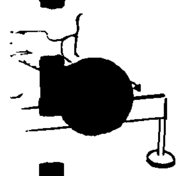
X1.4 The density determined by this ho
the wet or total density. It should be noted that
volume of soil or soil-aggregated represented in
measurements is indeterminate and will y v
the source-detector geometry of the equip t
and with the characteristics of the m ted
general, and with all other conditi ant,
more dense the material, the sma vol
involved in the measurement. The density de
mined is not necessarily the average densi wi
the volume involved in the measurement. ho
for the usual surface backscatter test equipment

.4 Identification of test equipment (... [illegible] del, and serial number),
N_o, average of the past four values of ... en [illegible] or usage,
.6 [illegible] e of the current standardiza- [illegible] on the reference standard (7.5),
[illegible] ethod and date of standardization,
7 Count rate for each reading,
8 Count ratio,
9 Wet density.

[illegible]—The count rate for each reading and the count ratio (13.1.8) may be omitted ... report for instruments that have built-in ... o take the ratio, compute the in-place wet ... display it to the operator automatically.

...ecision and Accuracy

... e precision and accuracy of this ... as not been determined. No methods ... ailable that provide absolute values of ... sity of soil or soil-aggregate mixtures in ... nst which these methods can be com- ... e variability of soil does not permit ... ation of test results for obtaining a mean- ... statistical evaluation. Accuracy is a func- ... of ... e care exercised in performing the ... s and steps of the test and of the ... bility of the material being tested.



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...ted, and (3) a counter or scaler with provi- ... automatic and precise timing, for determin- ... t which the modified gamma rays arrive ... tor. While rate meters are suitable, in ... lers are commonly used. In general, any ... gamma rays that are sufficiently numerous ... rly energetic can be used in measuring the

density of soil and soil-aggregate. Source stability with time, in terms of half-life, is an important design consideration and the sources most commonly used are cesium-137 and radium-226. The two detectors most commonly used are gas-filled tubes of the Geiger-Müller type and scintillation crystals, usually of sodium-iodide. Detectors of the latter type offer the potential of electronically varying the range of energies of the gamma rays that are counted. With detectors of the Geiger-Müller type, this range is fixed in the design. For most available equipment, the source-detector geometry is fixed for backscatter gages and is adjustable to various preselected depths of direct transmission gages.

X1.2 Measurements are made using gamma rays that largely reflect at reduced energy by scattering in, or by, direct transmission through the material under test. In backscatter, the rays are emitted into the material from near its surface and some are deflected at reduced energy back to the detector, largely by Compton scattering. In direct transmission the source or detector is inserted in the test materials and, in contrast to the backscatter method, some of the emitted and unshielded rays can presumably follow a straight-line path to the detector. In either source-detector arrangement, the number of rays reaching the detector is, over-all, a nonlinear function of the density of the material being tested. For the usual range of soil and soil-aggregate densities the relationship is such that the higher the density of a given material, the lower the count rate.

X1.3 The determination of density by the nuclear means of this method is indirect. To date no theoretical approach has been developed that predicts the count rate for given equipment, geometry, material, and density. As a result, the relationsip between material density and nuclear-count rate is determined by correlation tests of materials at known average densities. Individual equipment manufacturers supply a calibration curve with each set of their equipment. It has been found that these curves do not necessarily hold for all soils and soil-aggregates because of differences in chemical composition. Apparent variations in calibration may also be induced by differences in seating, in background count, and other test variations. Because of these considerations, provisions are included in this method for checking for variations or changes. Different approaches may be used in checking calibration and those in more general use are given. For good practice, these calibration procedures should be followed with newly purchased equipment and with major component replacements of in-service equipment.

X1.4 The density determined by this method is the wet or total density. It should be noted that the volume of soil or soil-aggregated represented in the measurements is indeterminate and will vary with the source-detector geometry of the equipment used and with the characteristics of the material tested. In general, and with all other conditions constant, the more dense the material, the smaller the volume involved in the measurement. The density so determined is not necessarily the average density within the volume involved in the measurement. Although for the usual surface backscatter test equipment and materials the gages are influenced by 6 to 7 in. (150 to 175 mm) of material, the top 1 in. (25 mm) of the material determines about one half of the measured count rate with the result that the observed density is largely determined by the density of the upper layers. For usual density conditions, the total count is largely determined by the upper 3 to 4 in. (75 to 100 mm) of soils and soil-aggregates. Where these materials are of uniform density, this characteristic of this method is of no effect. With direct-transmission gages the effect of vertical density variations may be eliminated. Other problems, however, can be introduced in the mechanics of inserting the source or the detector.

X1.5 The number of gamma rays emitted from a given source over a given time period are statistically random and follow a Poisson distribution. Because of this, the actual number of modified rays that are detected and counted in the density-measuring process should be sufficiently large to minimize the probability that the observed count reflects unacceptable variations. This is reflected in the standard deviation which is the square root of the total count. The over-all system accuracy in determining densities is also statistical in nature and appears to vary with the equipment used, the test conditions of laboratory *versus* field, as well as with materials and operators. Because of these variables, it is not possible to give precise numbers for system accuracy and precision of these methods. It is believed, however, that if the procedures herein are carefully followed, the standard deviation of the nuclear measured values, in terms of accuracy, will not be greater than on the order of some 3 lb/ft^3 (50 kg/m^3). In terms of precision or repeatability, determined without moving the test equipment, this should not be greater than on the order of 1 lb/ft^3 (20 kg/m^3).

X1.6 One of the most commonly used sources, cesium-137, is man made and as such its use is regulated by the Federal Government through the Atomic Energy Commission as well as by some state and local governments. Because radium is a naturally occurring material, its use is not now regulated by the Federal Government but is by some state and local governments. Among others, the objectives of these regulations are the use of radioactive materials in a manner safe to the operator and all others. Attention is directed to Section 6, Safety Precaution.

X1.7 The in-place nuclear density tests of this method offer several advantages over the older conventional methods (sand-cone, rubber-balloon, etc.), particularly in tests performed for the continuing control of construction. Among these, perhaps the principal advantage is the relative ease with which the test can be performed, thus freeing the operator from the physical tasks of digging holes and collecting and weighing bulky samples. However, it sacrifices the opportunity to examine the soil in depth. If information is sought on in-place densities only, and test determinations of maximum density are not involved, many more tests can be performed per day than by the older methods. In addition, apparently erratic measurements can be immediately detected and checked since the nuclear tests are more nearly nondestructive. These advantages accrue to organizations that are engaged in density measurements on a more or less continuous basis. Organizations that make infrequent or occasional density determinations may find that the advantages of the nuclear method can be offset by maintenance and start-up cosiderations such as periodically charging batteries, maintaining radiation exposure records, etc.

Designation: D 2936 – 8

Standard Test Met d DIRECT TENSILE ST SPECIMENS[1]

1. Scope

1.1 This test method covers the deter of the direct tensile strength of intact c rock specimens.

1.2 The values stated in nd to be regarded as the standard.

1.3 *This standard may involve ha terials, operations, and equipment. is does not purport to address all of t sa lems associated with its use. It is the re ity of whoever uses this standard co establish appropriate safety and h th and determine the applicability of r la tations prior to use.*

2. Applicable Documents

2.1 *ASTM Standards:*

E 4 Practices for Load Verification o Machines[2]

E 122 Recommended Practice C Sample Size to Estimate the Averag of a Lot or Process[3]

3. Significance and Use

3.1 Rock is much weaker in tension compression. Thus, in determining th condition for a rock structure, many ve employ the tensile strength of th co rock as the failure strength for the s Direct tensile stressing of rock is the m test for determining the tensile stre th

4. Apparatus

4.1 *Loading Device*, to a d axial load on the specimen, of suffi nt to apply the load at a rate confo in requirements of 6.2. The device shall be

4.3.3 Since travel time by the possible refracted
equal to the measured time and less than the
th travel time, it is concluded that the ray path
cted. If the velocity had been computed from
traig istance (20 ft) divided by the measured
(0. e value 4350 ft/s would be apparent

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Standard Test Method for BEARING RATIO OF SOILS IN PLACE[1]

This standard is issued under the fixed designation D 4429; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the determination of the bearing ratio (sometimes called the California Bearing Ratio (CBR)) of soil tested in place by comparing the penetration load of the soil to that of a standard material. This test method covers the evaluation of the relative quality of subgrade soils, but is applicable to subbase and some base-course materials. This test method is designed to test in-situ materials and corresponds to Test Method D 1883.

1.2 The values stated in inch-pound units are to be regarded as the standard.

1.3 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Applicable Documents

2.1 *ASTM Standards:*

D 1556 Test Method for Density of Soil in Place by the Sand-Cone Method[2]

D 1883 Test Method for Bearing Ratio of Laboratory Compacted Soils[2]

D 2167 Test Method for Density of Soil in Place by the Rubber-Balloon Method[2]

D 2216 Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures[2]

D 2937 Test Method for Density of Soil in Place by the Drive-Cylinder Method[2]

D 3017 Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)[2]

3. Significance and Use

3.1 Field in-place bearing ratio (CBR) tests are used for evaluation and design under any one of the following conditions: (*a*) when the degree of saturation (percentage of voids filled with water) is 80 % or greater, (*b*) when the material is coarse grained and cohesionless so that it is not significantly affected by changes in water content, or (*c*) when the soil has not been modified by construction activities during the two years preceding the test. In the last-named case, the water content does not actually become constant, but generally fluctuates within a rather narrow range. Therefore, the field in-place test data may be used to satisfactorily indicate the average load-carrying capacity.

3.2 Any construction activities, such as grading or compacting, carried out subsequent to the bearing ratio test will probably invalidate the results of the test.

NOTE 1—Field in-place tests are used to determine the relative strength of soils, subbase, and some base materials in the condition at which they exist at the time of testing. Such results have direct application in test section work and in some expedient construction, military, or similar operations. Also, as indicated in 3.1, field in-place tests can be used for design under conditions of nominal stability of water, density, and general characteristics of the material tested. However, any significant treating, disturbing, handling, compaction, or water change can affect the soil strength and make the prior to test determination inapplicable, leading to the need for retest and reanalysis.

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[1] This test method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.10 on Bearing Tests of Soils in Place.

Current edition approved Oct. 26, 1984. Published December 1984.

[2] *Annual Book of ASTM Standards*, Vol 04.08.

4. Apparatus

4.1 *Mechanical Screw Jack*—A manually operated mechanical screw jack equipped with a special swivel head for applying the load to the penetration piston, and designed with the following specifications:

4.1.1 Minimum capacity of 5950 lb (2700 kg),

4.1.2 Minimum lift of 2 in. (50 mm),

4.1.3 Detachable handle, 6 in. (150 mm) radius,

4.1.4 High-gear ratio, approximately 2.4 revolutions per 0.04 in. (1 mm) of penetration,

4.1.5 Medium-gear ratio, approximately 5 revolutions per 0.04 in. (1 mm) of penetration, and

4.1.6 Low-gear ratio, approximately 14 revolutions per 0.04 in. (1 mm) of penetration.

4.1.7 Other gear ratios may be used as desired if it is found to be more convenient to do so.

4.1.8 Other mechanical jacks with the same maximum load and lift may be utilized, provided that a uniform load-penetration rate of 0.05 in. (1.3 mm)/min can be achieved.

4.2 *Proving Rings*—Two calibrated proving rings having the following characteristics:

4.2.1 *Loading Range*—One proving load cell ring shall have a loading range of approximately 0 to 1984 lbf (8.8 kN), and the other proving ring shall have a loading range of approximately 0 to 5070 lbf (22.6 kN).

4.3 *Penetration Piston*—The penetration piston shall be 2 ± 0.004 in. (49.5 ± 0.1 mm) in diameter (nominal 3 in.^{2} (58 mm^2)) and approximately 4 in. (101 mm) in length.

4.3.1 *Piston Adapter and Pipe Extensions*—One piston adapter and internally threaded pipe extensions with connectors.

4.3.1.1 Pipe extensions shall be furnished in the following quantities and lengths (or other combinations of lengths totaling 8 ft (2.4 m)):

Number Required	Approximate Length
2	1.5 in. (38 mm)
2	4 in. (102 mm)
8	12 in. (305 mm)

4.4 *Dial Gages*—There shall be two dial gages for measuring proving-ring deflections reading to 0.0001 in. (0.0025 mm) and having approximately 0.25 in. (6.4 mm) travel, and one dial gage for measuring penetration reading to 0.001 in. (0.025 mm) and having approximately 1 in. (25 mm) travel, equipped with an adjustable dial clamp extension.

4.5 *Support for Penetration Dial*—One support made of 3 in. (76.2 mm) aluminum steel or wood channel approximately 5 ft (1.5 m) long.

4.6 *Surcharge Plate*—A circular steel plate 10 ± 0.02 in. (254 ± 0.5 mm) in diameter with a 2 ± 0.02 in. (53 ± 0.5 mm) diameter hole in the center. The plate shall weigh 10 ± 0.02 lb (4.54 ± 0.01 kg).

4.7 *Surcharge Weights*—Two "10-lb" (4.54 ± 0.01 kg) slotted surcharge weights 8.5 in. (216 ± 1 mm) in diameter, and two "20-lb" (9.08 ± 0.01-kg) slotted surcharge weights 8.5 in. in diameter.

4.8 *Truck (Reaction)*—A truck (or piece of heavy equipment) loaded sufficiently to provide a reaction of approximately 6970 lbf (31 kN). The truck shall be equipped with a suitable metal beam and an attachment, or attachments, at the rear end in order to provide a reaction for forcing the penetration piston into the soil. Suitable attachments or other provision shall be provided so that the truck may be jacked sufficiently to take the load off of the rear springs in order to permit the penetration test to be carried out without upward movement of the truck chassis. Approximately 2 ft (0.6 m) ground clearance is required to carry out the penetration test.

4.9 *Jacks*—Two truck-type jacks of 15-ton (14 Mg) capacity and having double-acting combination trip and automatic lowering.

4.10 *Miscellaneous Apparatus*—Other general apparatus such as sample containers for water and density determinations, spatula, straightedge, digging tools, etc.

NOTE 2—Fig. 1 shows a typical field setup for bearing ratio tests. Fig. 2 shows the disassembled bearing ratio apparatus.

5. Procedure

5.1 Prepare the general surface area to be tested by removing from the surface loose and dried material which is not representative of the soil to be tested. Produce a test area which is as smooth and horizontal as practicable. Where nonplastic base materials are encountered, extreme care shall be taken not to disturb the test surface. Spacing of the penetration tests shall be such that operations at one point will not disturb the soil at the next point to be penetrated. This spacing may range from a minimum of 7.0 in. (175 mm) in plastic soils to 15 in. (380 mm) in coarse granular soils.

5.2 Locate the truck so that the cent of bearing attachment is directly over the surfac be tested. Install the mechanical screw test with the swivel to the underside of the ac attachment. Place the truck jacks under h of the truck and lift the truck so that little o weight rests on the rear springs, making re the truck is level across the back.

5.3 Position the mechanical screw ja to correct position for the test, and connect proving ring to the end of jack. Then, ch piston adapter to the bottom of the pro g connect the necessary number of exte on come within 4.9 in. (125 mm) of the surfac be tested, and connect the penetratio pis Clamp the jack in place. Check the level ou on the jack to be certain the assembly ver and adjust it if necessary.

5.4 Place the "10-lb" (4.5-kg) e beneath the penetration piston en piston is lowered it will pass thr e c hole.

5.5 Seat the penetration piston un a of approximately 3 psi (21 kPa). For ra se use the high-gear ratio of the jack. For materials with an irregular surface, set the p on the thinnest practical layer of fine he screenings (20–40 mesh) or plaster of is.

5.6 If necessary in order to achieve a sm surface, raise the surcharge plate while the se load is on the piston and evenly spread ar sand to a depth of 0.12 to 0.24 in. (3 6 over the surface to be covered by the plate. serves to distribute the weight of the rc uniformly.

5.7 Add surcharge weights to the rc plate so that the unit load is equivalent t load intensity of the material or pave t will overlie the subgrade, or base, or b e that the minimum weight applied s b "10-lb" (4.5-kg) surcharge plate plus one "2 (9-kg) surcharge weight.

NOTE 3—This minimum weight creates int of loading equal to that created by the "10-lb ur weight used in the 6-in. (150-mm) diameter m the laboratory bearing ratio test (Test Method D

5.8 Attach the penetration dial cla t piston so that the dial rests upon u

5.9 Set the dial gages to zero

5.10 Apply the load to the pe p so that the rate of penetration is app in 0.05 in. (1.3 mm)/min. By using th ov

port for Penetration Dial—One sup-
in. (76.2 mm) aluminum steel or
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soils.

5.2 Locate the truck so that the center of the bearing attachment is directly over the surface to be tested. Install the mechanical screw test jack with the swivel to the underside of the reaction attachment. Place the truck jacks under each side of the truck and lift the truck so that little or no weight rests on the rear springs, making sure that the truck is level across the back.

5.3 Position the mechanical screw jack to the correct position for the test, and connect the proving ring to the end of jack. Then, attach the piston adapter to the bottom of the proving ring, connect the necessary number of extensions to come within 4.9 in. (125 mm) of the surface to be tested, and connect the penetration piston. Clamp the jack in place. Check the level mounted on the jack to be certain the assembly is vertical and adjust it if necessary.

5.4 Place the "10-lb" (4.5-kg) surcharge plate beneath the penetration piston so that when the piston is lowered it will pass through the center hole.

5.5 Seat the penetration piston under a load of approximately 3 psi (21 kPa). For rapid setting, use the high-gear ratio of the jack. For base materials with an irregular surface, set the piston on the thinnest practical layer of fine limestone screenings (20–40 mesh) or plaster of paris.

5.6 If necessary in order to achieve a smooth surface, raise the surcharge plate while the seating load is on the piston and evenly spread clean fine sand to a depth of 0.12 to 0.24 in. (3 to 6 mm) over the surface to be covered by the plate. This serves to distribute the weight of the surcharge uniformly.

5.7 Add surcharge weights to the surcharge plate so that the unit load is equivalent to the load intensity of the material or pavement which will overlie the subgrade, or base, or both, except that the minimum weight applied shall be the "10-lb" (4.5-kg) surcharge plate plus one "20-lb" (9-kg) surcharge weight.

NOTE 3—This minimum weight creates an intensity of loading equal to that created by the "10-lb" surcharge weight used in the 6-in. (150-mm) diameter mold in the laboratory bearing ratio test (Test Method D 1883).

5.8 Attach the penetration dial clamp to the piston so that the dial rests upon the dial support.

5.9 Set the dial gages to zero.

5.10 Apply the load to the penetration piston so that the rate of penetration is approximately 0.05 in. (1.3 mm)/min. By using the low-gear ratio of the jack during the test, a uniform rate of penetration can be maintained by the operator. Record the deflection of the proving ring at each 0.025 in. (0.64 mm) increment of penetration, to a final depth of 0.500 in. (12.70 mm). In homogeneous soils, penetration depths greater than 0.300 in. (7.62 mm) frequently may be omitted. Compute the bearing ratio in percent (See Section 6 for calculations).

5.11 At the completion of the test obtain a sample at the point of penetration and determine its water content. A density determination should also be made at a location about 4 to 6 in. (100 to 150 mm) away from the point of penetration. The density and water content shall be determined in accordance with the applicable test methods listed in Section 2.

6. Calculation

6.1 *Stress Penetration Curve*—Calculate the penetration stress for each penetration increment as applied force divided by piston area. Plot the stress versus penetration curve for each increment of penetration, as shown in Fig. 3.

6.1.2 In some instances the stress-penetration curve may be concave upward initially because of surface irregularities or other causes, and in such cases the zero point shall be adjusted as shown in Fig. 3.

6.2 *Bearing Ratio*—Using corrected stress values taken from the stress-penetration curve for 0.100 in. (2.54 mm) and 0.200-in. (5.08-mm) penetrations, calculate the bearing ratios for each by dividing the corrected stresses by the standard stresses of 1000 psi (6.9 MPa) and 1500 psi (10.3 MPa) respectively, and multiplying by 100. Also, calculate the bearing ratios for the maximum stress, if the penetration is less than 0.200 in., interpolating the standard stress. The bearing ratio reported for the soil is normally the one at 0.100 in. penetration. When the ratio at 0.200 in. penetration is greater, rerun the test. If the check test gives a similar result, use the bearing ratio at 0.200 in. penetration.

6.3 If the bearing ratio values at penetrations of 0.300, 0.400, and 0.500 in. (7.62, 10.16, and 12.7 mm) are desired, the corrected stress values for these penetrations should be divided by the standard stresses for 1900, 2300, and 2600 psi (13.1, 15.9, and 17.9 MPa) respectively, and multiplied by 100.

7. Report

7.1 The report shall include the following information on each test:

7.1.1 Test location,

7.1.2 Material,

7.1.3 Depth of test,

7.1.4 Stress-penetration curve,

7.1.5 Corrected bearing ratio at 0.1 in. (2.54 mm) penetration,

7.1.6 Corrected bearing ratio at 0.2 in. (5.08 mm) penetration,

7.1.7 Water content, and

7.1.8 Density.

8. Precision and Bias

8.1 The limiting factor with respect to this test method is that of the inherent non-uniformity of the soil (or base material) itself.

8.2 In cases where the soil tested is as uniform as field conditions ordinarily permit, it has been observed that for a series of three tests, the following results are obtained:

Bearing Ratio	Typical Range of Values
less than 10	3
10 to 30	5
30 to 60	10
greater than 60	25

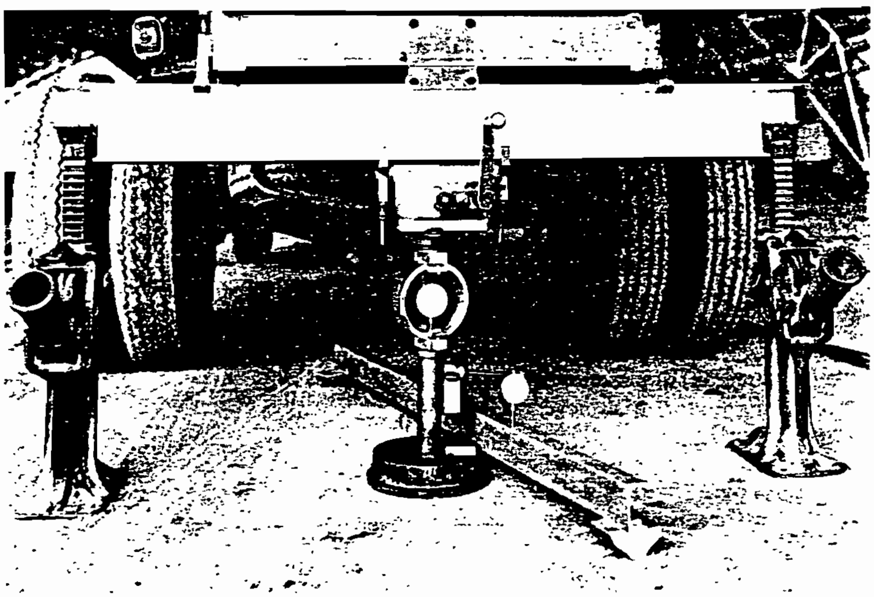

FIG. 1 Setup for Field In-Place Tests

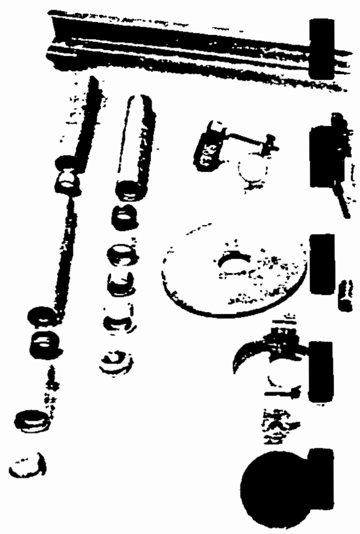

FIG. 2

Precision and Bias

5. The limiting factor with respect to this test d is that of the inherent non-uniformity of soil se material) itself.

5.2 where the soil tested is as uniform conditions ordinarily permit, it has been ed that for a series of three tests, the following results are obtained:

Bearing Ratio	Typical Range of Values
less than 10	3
10 to 30	5
30 to 60	10
greater than 60	25

Pl Tests

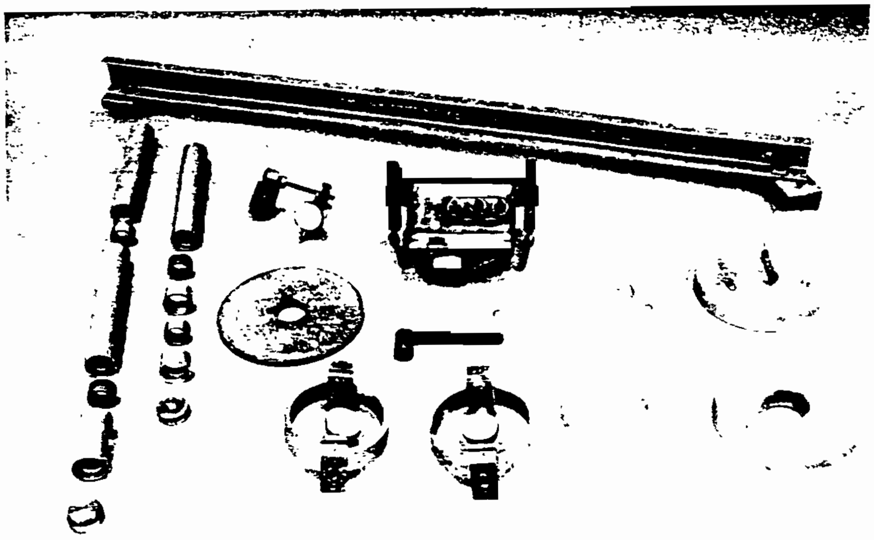

FIG. 2 Apparatus for Field In-Place tests

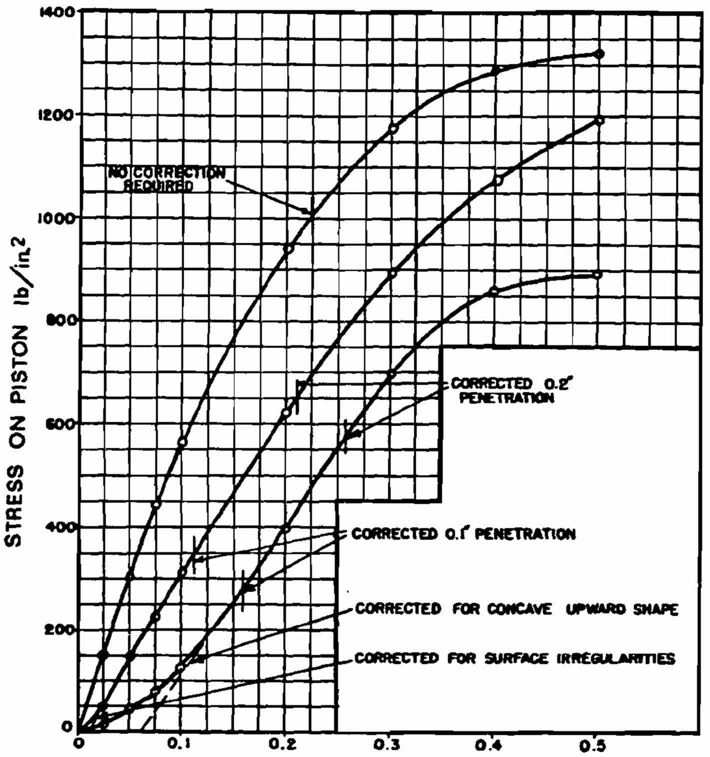

FIG. 3 Correction of Stress-Penetration Curves

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Designation: D 4435 - 8

Standard Method f
ROCK BOLT ANC

This standard is issued under the fixed design on
original adoption or, in the case of revision, t yea
A superscript epsilon (ε) indicates an editoria an

1. Scope

1.1 The objective of this metho to the working and ultimate capacities o bolt anchor. This method does not me entire roof support system eth does not include tests for p ed mine roof support system evaluation.

1.2 This method is applicable to me cement grout, resin, (epoxy, poly er. like), or other similar anchor syste

1.3 The values stated in inch-pound to be regarded as the standard.

1.4 *This standard may involve h ar terials, operations, and equipment. his does not purport to address all of the sa lems associated with its use. It is th res ity of whoever uses this standard t or establish appropriate safety and he th, and determine the applicability of regula tations prior to use.*

2. Descriptions of Terms Specific to Thi ard

2.1 *displacement*—The moveme of bolt head.

2.2 *failure*—the inability of the ancho or rock to sustain increased load wi u increasing deformation. In some i ar peak load itself cannot be sustained.

2.3 *load*—the total axial force on t bolt.

2.4 *pressure, stress*—the for n

2.5 *ultimate capacity*—th mu sustained by the anchor syste

2.6 *working capacity*—the load o th system at which significantly increas d ment begins.